

Prior Return Effect in Indian Stock Market: An Intra-day Analysis

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Abstract

In a first of this kind, this paper examines the issue of prior return effect in Indian stock market in intra-day analysis using high frequency data. We document that in Indian stock market, security returns exhibit a reversal in their direction within few minutes of extreme price rises as well as price falls. However the speed with which the correction takes place is slightly different for good news events and bad news events. Indian investors tend to be optimistic as they immediately bring stock prices up following unjustified price falls but take time to bring stock prices down following unjustified price rises. These findings lend a further support to short-term overreaction literature. More importantly, these findings serve as a proof of predictability of the direction of future stock prices and consequent returns on an intra-day basis. It forwards important investment implications for traders, fund managers, and investors at large.

Keywords: Prior Return Effect, Contrarian Strategy, Overreaction Effect, Overreaction Hypothesis, Indian Stock Market, Intraday Analysis, High Frequency Data

1. Introduction

Since the beginning of 1980s, there has been a lot of research on capital market anomalies like size effect, value effect, turn-of-the year effect, weekend effect, the overreaction effect, and the momentum effect which seems to contrast the EMH¹. While the efficiency of stock markets was once virtually taken for granted, it is

¹ Efficient Market Hypothesis (EMH) asserts that the price of a security efficiently reflects all the information that is available to the public and that it is not possible for anyone to consistently outperform others and earn superior returns by using the information which is already reflected in security prices.

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now being seriously questioned again primarily due to the cumulating evidence on the predictability of stock returns based on their prior return behaviour. There is an extensive body of literature which documents this “Prior-return Effect”, i.e. the prior returns can explain the cross-sectional behaviour of subsequent stock returns. Various studies have provided evidence of the existence of winner-loser patterns in security returns. The literature on ‘prior-return effect’ basically documents two opposite phenomena; ‘return reversals’ and ‘return continuation’.

De Bondt and Thaler (1985) for the first time documented long-term return reversals for the U.S. stock market by demonstrating significant changes in the direction of stock returns, over long period of three to five years. They found that stocks that had been extreme losers during the past three or five years subsequently outperformed the market and stocks that had been extreme winners during the same period subsequently underperformed the market. They based their findings on the tendency of investors to overreact to unexpected good and bad news whereby initial price reaction is followed by subsequent correction in the form of return reversals such that the contrarian investment strategy that calls for buying past losers and selling past winner stocks produced above normal portfolio returns. They attributed these findings to the presence of “Overreaction Effect” in the stock market. While several studies reported findings further supporting the findings of DeBondt and Thaler (1985) (see for example, DeBondt and Thaler, 1987; Fama and French, 1988; Poterba and Summers, 1988; Chopra, Lakonishok and Ritter, 1992 etc.), many others have also offered few alternative or complementary explanations behind the successful performance of the contrarian investment strategy. Chan (1988) and Ball and Kothari

(1989) amongst others argued that the excess returns to these investment strategies are a normal compensation for their time-varying risk; Zarowin (1989, 1990) dismissed the overreaction phenomenon as another manifestation of size effect; Lakonishok, Shliefer and Vishny (1994) tested the profitability of contrarian strategies from the angle of value strategies which also calls for buying the stocks which performed poorly in the past and produced superior returns and reported that these strategies yield higher returns because they exploit the suboptimal behaviour of the typical investor who extrapolates past performance too far into the future. Nevertheless, stock market overreaction has been reported to be the most convincing reason behind observed return reversal.

On the other hand, there are number of studies which reported that during the intermediate horizons of three to twelve months, stock returns are observed to follow a return continuation pattern, i.e. stock which were the best performers of past few months continue to earn positive returns in the subsequent holding period of three to twelve months and vice-versa. Jegadeesh and Titman (1993) found evidence of price continuations over intermediate horizon of few months and attributed it to the presence of 'Momentum Effect' in stock returns. They demonstrated that a momentum strategy of sorting firms by their previous returns over the past 6-9 months and holding those with best prior performance and short selling those with worst prior performance generates an excess return of about 1% per month over the subsequent 6 months for U.S. stocks. Supportive evidence has also been offered by number of other studies including Chan (1988), Jegadeesh and Titman (1993), and Lakonishok *et al.* (1996), Lewellen (2002), Hvidkjaer (2006) etc.

Several related studies follow which tested market overreaction and underreaction over very short horizons of few days also and documented a mixed evidence of return reversals and return continuation over very short intervals of few days following extreme daily price changes. Various studies including Howe (1986), French and Roll (1986), Atkins and Dyl (1990), and Bremer and Sweeney (1991), etc. have reported evidence in support of short-term return reversals, while few including MacDonald and Power (1992) and Pritamani and Singal (2001) amongst others have offered a proof of investor underreaction and return continuation following positive as well as negative daily price shocks. Few others like Larson and Madura (2003) have also documented return reversals following positive shocks and return continuation following negative

shocks. Few studies also relate the observed patterns in subsequent returns to market micro-structure issues. Cox and Peterson (1994) documented that the bid-ask bounce and the degree of market liquidity accounts for substantial part of short-term price reversals.

Initially, majority of the empirical evidence on overreaction and momentum effects was concentrated towards U.S. Stock market data. But, with the increasing popularity, recognition and conviction of these well documented stock market phenomena, their investigation spread out internationally to other developed and matured stock markets worldwide including U.K (MacDonald and Power, 1991, 1992; Clare and Thomas, 1995; Dissanaik, 1997, 2002), Japan (Bremer, Hiraki and Sweeney, 1997; Chiao and Hueng, 2005), France (Bacmann and Francois, 1998), Germany (Lobe and Reiks, 2011), Brazil (Medeiros and Ribeiro, 2005), Turkey (Bildik and Gulay, 2002; Vardar and Okan, 2008), Egypt (Abdel and Ismail, 2012) etc. However, there is no enough evidence found, particularly for emerging capital markets including India, which can contribute towards the literature documenting the prior-return effect or to develop an explanation to the previous findings of U.S. and other international markets². Also, with the

2 There exists very inadequate evidence of the presence or the absence of the overreaction effect and the momentum effect in these markets. Wu (2004) documents the existence of overreaction effect in Chinese stock market; they observed a presence of much stronger long term mean reversion effect for Chinese stocks than for stocks in more mature markets. Sehgal & Balakrishnan (2002) document the presence of long term reversal effect and short term momentum effect in Indian stock market. Their findings suggested a presence of strong momentum effect in short-term returns with significantly positive payoffs of 1.27% per month to the momentum strategy and also the existence of return reversal phenomena with moderately positive payoffs to the contrarian strategy based on long-term past returns. Tripathi & Aggarwal (2009) also found a presence of statistically significant but asymmetric long term overreaction effect in Indian Stock Market. They observed significant reversal in the direction of losers' monthly returns but found no evidence of such a reversal in winners' returns and contended that abnormally positive returns to contrarian investment strategy in Indian stock market are largely driven by extremely positive returns to loser stocks during the test period. Maher & Parikh (2011) examined the short-term price behaviour of three size-conditioned Indian stock market indices in response to informational shocks and found evidence of underreaction to negative events in the medium and small capitalisation indices. They suggested uncertainty avoidance as a potential explanation of

opportunities of intra-day trading increasingly being exploited by investors in the stock markets, it becomes all the more desirable to investigate the applicability of this well documented effect using high frequency data, i.e. the intra-day stock price data observed over very short intervals of few minutes or hours within a trading day. However, majority of studies in this line of research have based their investigation on monthly or the daily returns data of the sample stocks.

Thus, in the present study, we investigate the Indian Stock Market, one of the leading emerging capital markets of the world, as a distinct market to explore the evidence of prior return effect in the cross-section data of intra-day returns of Indian stocks by using high frequency data. This is particularly important in the light of the fact that there is no or very little work published on the investigation of prior return effect using high frequency data especially in the context of emerging capital markets which continuously strive to move towards greater market efficiency. Further, Indian stock market differs from other stock markets in terms of institutional structures, cultural backgrounds, attitude of people towards stock market etc. which may affect the patterns in security returns in Indian market from those found for other stock markets.

The purpose of this study is threefold; firstly to investigate the evidence of prior return effect in the cross-section data of intra-day returns of Indian stocks; secondly, in the light of the possible explanations behind the existence of predictable patterns in subsequent security returns, the purpose is also to investigate whether the observed behaviour of security returns subsequent to extreme intra-day price changes is captured by the risk related explanation based on size effect³ or alternatively it is another manifestation of value effect⁴ or it is a

their observations for Indian stock market.

3 Chan (1988) argued that both winner and the loser portfolios experience large changes in their market values with the extreme rise or fall in the security prices. Taking the market value (market capitalisation) as a good proxy for risk, as suggested by the size effect literature, a decline in the price of a stock leads to an increase in the leverage and its risk. As a result, loser stocks happens to be much smaller and consequently much riskier than the winner stocks after the happening of an event of extreme price decline and thus, the higher returns to a loser stock subsequent to extreme price decline are a normal compensation for their increased risk and vice-versa for winner stock.

4 Value effect simply implies that out of favor value stocks

phenomenon distinct from it, and thirdly, to test whether it is possible to devise a trading strategy, based on the observed market behaviour following price shocks, which can beat the market on consistent basis and provide superior returns to investors.

The remainder of this article is organised as follows: the second section describes the data used for the purpose of this study followed by the third section which gives a detailed discussion of the methodology employed. Empirical results obtained by applying various statistical procedures are furnished in the fourth section. Finally, the fifth and last section concludes the study.

2. Data

For the purpose of investigation of prior return effect in Indian stock market over very short horizon of few minutes and hours within a trading day, our study makes use of the cross-sectional data of intra-day share prices at interval of 30 minutes each (30 minutes tick data) available for stocks forming part of SandP CNX 500⁵ equity index during a period of one year beginning from 4th January, 2010 to 31st December, 2010 and the data for the same has been obtained from the database offered by Bloomberg. In Indian stock market, trading begins at 9:15 a.m. in the morning and continues upto 3:30 p.m. in the afternoon. Starting from 4th January, 2010 up to

outperforms glamour stocks. Value stocks are the stocks which are underpriced/undervalued and remained out of favor because they have performed poorly in the past and are expected to continue to perform poorly while glamour stocks are the overvalued stocks which have performed well in the past and are expected by the market to perform well in the future. Value effect postulates that a value strategy which calls for buying value stocks produces superior returns because these strategies are contrarian to “naïve” strategies followed by other investors who extrapolate past performance too far into the future and thus produce higher returns. Thus, value effect and the overreaction effect both seem to capture the similar sub-optimal behaviour of typical investors.

5 S&P CNX 500 is an index comprised of 500 equity securities which are traded on National Stock Exchange (NSE). It is India's first broad-based stock market index that represents about 96% of total market capitalisation and about 93% of the total turnover on NSE. The sample is a fair representative of the market performance as the industry weightages in the index mirror the industry weightages in the market. Also, the sample belongs to the 72 industries of the economy, hence representing a broad spectrum.

31st December, 2010, thirteen share price quotes at the interval of 30 minutes each have been obtained for each trading day beginning at 9:15 a.m. upto 3:15 p.m. Data on constituent firm's book value per share (required to calculate firm's book value to market value ratios) and number of shares outstanding (for calculation of firm's market capitalisation, defined as a product of number of shares outstanding and market price per share) has also been obtained and utilised to run multi-variate regression (described later). Intra-day return on SandP CNX Nifty⁶ Index for the corresponding period has been used as a proxy for the return on market index. It is considered as a benchmark index for the Indian equity market. The daily equivalent of annual interest rates on 91-day treasury bills has been used as a proxy for risk-free rate of return and the data for the same has been obtained from the official website of Reserve Bank of India, i.e. www.rbi.org.in.

3. Methodology

3.1. Investigating the predictability in the cross-sectional behaviour of security prices following extreme intra-day price changes

The basic idea behind the investigation of prior return effect in very short term is to examine the possibility that when the stock market is faced with some unanticipated new information pertinent to the value of stock, stock prices deviate systematically from their fundamental values, or alternatively they do not adjust rapidly to their new fundamental values such that by using the information available in their past prices and returns, their short-term future direction could be predicted. Atkins and Dyl (1990) stated that an extremely large change in the price of a common stock during a single trading day is most likely caused by unanticipated new information pertinent to the value of stock. Thus, the stock exhibiting large price changes provide an excellent opportunity to examine whether stock prices adjust rapidly and completely to new information or whether they adjust only partially to such information or whether they overreact to such information.

⁶ S&P CNX Nifty is an index comprised of 50 equity securities which are traded on NSE. It is a well diversified 50 stocks Index that covers 22 sectors of the Indian economy and represents about 67.27% of the free float market capitalisation of the stocks listed at NSE (as on September 30, 2012), accurately reflecting the overall market conditions.

Accordingly, we have applied the empirical testing procedures which are primarily based upon a design of event study methodology whereby we focus on stocks that have shown extreme price movements (referred to as 'event') in either direction within few minutes in a single trading day. Having identified such stocks, we form two portfolios, one for the *winners* that have experienced extreme rise in their prices and another for the *losers* that have experienced extreme decline in their prices, to test and verify if their immediate price behaviour over subsequent few minutes and hours is indeed predictable. Following procedure has been followed for the purpose of investigation:

1. Beginning on 4th January, 2010 up to 31st December, 2010, intra-day returns are calculated at interval of 30 minutes each starting from 9:15 a.m. upto 3:15 p.m. for each of the stocks included in our sample on each trading day. Returns recorded for 9:15 a.m. daily are calculated by comparing the price at 9:15 a.m. with the previous day's price at 3:15 p.m.

$$R_{i,t} = \frac{(P_{i,t} - P_{i,t-1})}{P_{i,t-1}} \quad (3.1)$$

where; $R_{i,t}$ is the return on stock i in period t , $P_{i,t}$ is the price of stock i in period t , and $P_{i,t-1}$ is the price of stock i in period $t-1$, i.e. the price recorded for 30 minutes past.

Similarly, the corresponding market returns ($R_{m,t}$) are also calculated using the above equation for Nifty index values.

2. Market-adjusted abnormal returns ($u_{i,t}$) are calculated for each of the stocks included in our sample by comparing the individual security returns with market returns for corresponding time slots at interval of 30 minutes on each trading day. There were in all 248 trading days in this period.

$$u_{i,t} = R_{i,t} - R_{m,t} \quad (3.2)$$

Stock return that represents a large abnormal price change measured in terms of market adjusted excess returns, $u_{i,t}$ at time $t=0$ is called an 'event' and the time of large abnormal price change is called an event tick.

3. Keeping into mind, the possibility to see a difference in market reaction to extreme price changes at the beginning of a trading day and at the mid of trading day, we fixed up two time slots for selecting

the event of extreme price change within a day; one at 9:15 a.m. daily to investigate market's abnormal reaction to extreme price changes during pre-noon hours and another at 12:15 p.m. daily to investigate market's abnormal reaction to extreme price changes during post-noon hours. Accordingly, we selected 3 securities with highest abnormal returns representing positive events and 3 securities with lowest abnormal returns representing negative events, at 9:15 a.m. and 12:15 p.m. separately on each trading day in our study period.

4. From these initial samples, certain events have been excluded on the grounds of market-microstructure related issues. Various studies in the past have found evidence showing that market microstructure effects, namely bid-ask bounce effect and infrequent trading, contributes to the observed predictable patterns in security prices. Thus, in order to avoid bid-ask spread and infrequent trading biasing our results, we take following measures, in accordance with the methodology followed by Lobe and Reiks (2011), to arrive at our final sample. Firstly, we have considered the stocks belonging to one of the major stock indices traded on National Stock Exchange, namely S and P CNX 500 Equity index. These stocks are highly liquid stocks because index members are selected according to their market capitalisation and free float. Secondly, we exclude all events where the selected security had a closing price of Rs. 10 or less at the time of event to avoid the biases caused by lower priced stocks and higher proportional bid-ask spreads⁷. Thirdly, we exclude all the events that do not show any non-zero return on at least two out of five ticks (of 30 minutes each) after an event. This will ensure that infrequently traded stocks are not included in our sample. From the resulting sample of event stocks, we followed with the formation of our winner and loser portfolio.
5. We tracked the abnormal returns of remaining event stocks five ticks prior to the event ($t = -5, -4, -3, -2, -1$) and five ticks following the event ($t = 1, 2, 3, 4, 5$). So, we have market-adjusted returns for 11 ticks corresponding to each event security in each of the two samples.

6. We take an average of the market-adjusted returns of positive event securities to represent a winner portfolio and negative event securities to represent a loser portfolio at $t = 0$ separately for events taking place at 9:15 a.m. and 12:15 p.m. This resulted into 248 event tick observations for winner portfolio and 248 event tick observations for loser portfolio corresponding to 9:15 a.m. and equally for 12:15 p.m.
7. Similarly we take the averages of the market-adjusted returns tracked for previous five ticks and subsequent five ticks for the positive and the negative event securities separately with respect to each event tick of 9:15 a.m. and likewise for event tick of 12:15 p.m. As a result, we have winner as well as loser portfolio's abnormal returns matrix with 11 columns (corresponding to $t = -5$ to $+5$) and 248 rows (corresponding to event days) individually for pre-noon period and post-noon period.

$$AR_{p,t,event\ tick} = \sum_{i=0}^N \frac{1}{N} u_{i,event\ tick}; \quad (3.3)$$

$t = -5$ to $+5$; $P = L$ or W ; event tick = 9:15 a.m. or 12:15 p.m.

where; $AR_{p,t,event\ tick}$ = Average of t^{th} tick's abnormal returns of winner securities or loser securities corresponding to each of the 248 event ticks for the winners as well as for the losers portfolio .

$u_{i,t,event\ tick}$ = Abnormal return of event security i , selected as winner or loser of respective event tick, for tick t .

may range from 0 to 3 since three winners and three losers are selected as positive and negative events respectively at 9:15 a.m. as well as 12:15 p.m., out of which any or all of them may have been excluded as per step 4 above.

8. Then for each of the 11 ticks we take a grand average of 248 abnormal return observations for winner portfolio as well as for loser portfolio so that we have one average abnormal return observation for each of the 11 ticks from -5 to +5 for the two portfolios respectively corresponding to 9:15 a.m. and similarly for 12:15 p.m..

$$AR_{p,t} = \sum_{event\ tick=1}^N \frac{1}{N} AR_{t,event\ tick}; \quad (3.4)$$

$t = -5$ to $+5$; $P = L$ or W ; $N=248$; event tick = 9:15 a.m. or 12:15 a.m.

⁷ Stocks with a price of less than Rs.10 are more likely to experience events because the tick size in percent of price is higher than for more expensive stocks (Lobe & Reiks, 2011). Also, it is very well-established that large stocks have a lower bid-ask spread (see, for example Stoll, 2000).

where; $AR_{p,t}$ = Winner or loser portfolio's Average abnormal return at tick t

9. To see the direction of returns we also calculated the cumulative average abnormal returns for the two portfolios. Cumulative average abnormal returns are simply summed intra-day abnormal returns over a specified event window.

$$CAR_{p,t} = \sum_{\tau=-5}^t AR_{p,\tau}; t = -5 \text{ to } +5; P = L \text{ or } W \quad (3.5)$$

10. Holding period returns are also calculated for the two types of portfolios in pre-noon as well as post-noon period, by calculating the Buy-and-hold average abnormal returns (BHR's) for five different holding periods starting from one tick holding period to five tick holding period after the event. Following procedure has been followed for this purpose:

- a. Buy-and-Hold return is calculated for each event security for one tick holding period upto five tick holding period after each event

$$R_{i,2-t} = \frac{P_{i,t} - P_{i,event\ tick}}{P_{i,event\ tick}}; t = 1,2,3,4, \text{ or } 5; \quad (3.6)$$

where; $R_{i,1-t}$ = Buy-and-Hold return on event security i for different holding period; $1-t$ represents holding period starting from tick 1 through tick t after an event

$P_{i,t}$ = Price of event security i at tick t after an event

$P_{i,event\ tick}$ = Price of event security i at the time of event

- b. Similarly we calculated the Buy-and-hold return for market index for corresponding holding periods' ticks.
- c. Buy-and-hold abnormal return is calculated for every event stock compared to the respective market index for different holding periods

$$AR_{i,1-t} = R_{i,1-t} - R_{index,1-t}; t = 1,2,3,4, \text{ or } 5; \quad (3.7)$$

- d. Average Buy-and-hold abnormal return is calculated for each of the five holding periods after each event by taking an average of the Buy-and-hold abnormal returns of that point (9:15 a.m. or 12:15 p.m.) positive or negative event securities separately for corresponding holding periods

$$AR_{P,1-t,event\ tick} = \sum_{i=0}^N \frac{1}{N} AR_{i,1-t,event\ tick}; \quad (3.8)$$

$t = 1,2,3,4, \text{ or } 5; P = L \text{ or } W$

N may range from 0 to 3 since three winners and three losers are selected as positive and negative events respectively at 9:15 a.m. as well as 12:15 p.m. daily out of which any or all of them may have been excluded to avoid market-microstructure related issues.

- e. Then for each of the five holding periods, we take a grand average of 248 Buy-and-hold abnormal return observations for winner portfolio as well as for loser portfolio so that we have one average Buy-and-hold abnormal return observation for each of the five holding periods for the two portfolios respectively and for pre-noon and post-noon period separately.

$$AR_{P,1-t} = \sum_{event\ tick=1}^N \frac{1}{N} AR_{1-t,event\ tick}; \quad (3.9)$$

$t = 1,2,3,4, \text{ or } 5; P = L \text{ or } W; N = 248; event\ tick = 9:15 \text{ a.m. or } 12:15 \text{ p.m.}$

11. Statistical significance of our average abnormal returns, cumulative average abnormal returns and Buy-and-hold average abnormal returns are measured using test statistics based on cross-sectional variance to see whether they are significantly different from zero. Non-parametric z-statistics are also presented. If they all turn out to be either significantly higher or lower than zero following the event, it can be inferred that stock returns follow predictable patterns after experiencing extreme price changes within a day.

3.2. Factors explaining the cross-sectional behaviour of security prices following extreme price changes

After analyzing the cross-sectional behaviour of security prices following extreme intra-day price changes, we aim to examine whether the extent and direction of market's abnormal reaction to extreme price changes are explained by any stock market anomalies based on stock characteristics, more specifically the firm's size and the value. For this purpose, we run the multi-variate regression on our post event Buy-and-hold average abnormal returns by incorporating the independent variables for size factor proxied by firm's market capitalisation (MCAP) and the value factor proxied by firm's book-to-market ratio (BTM) as at the time of event. We control for firm's size

to investigate whether the observed behaviour of security returns subsequent to extreme price changes is captured by the risk related explanation based on size effect. Also, value effect and the overreaction effect both seem to capture the similar sub-optimal behaviour of typical investors. Thus, we also verify whether the observed overreaction effect is another manifestation of value effect or it is a phenomenon distinct from it. Further, we incorporate the event ticks' abnormal returns (AR) as an independent variable in our regression analysis to analyse if the magnitude of subsequent returns is related to the magnitudes of initial gains or losses caused by the event, as documented by De Bondt and Thaler (1985). We regress these variables on our post event Buy-and-Hold average abnormal returns calculated for five different holding periods, after the event of extreme price changes observed at 9:15 a.m. daily for pre-noon hours and at 12:15 p.m. daily for post-noon hours, each tested separately to investigate the impact of these variables on different holding period returns. The regression model used is:

$$AR_{P,1_t, event tick} = \alpha + \beta_1 AR_{P, event tick} + \beta_2 MCAP_{P, event tick} + \beta_3 BTM_{P, event tick} + \varepsilon_{P, event tick} \quad (3.10)$$

where; $AR_{P,1_t, event tick}$ = Buy-and-hold average abnormal returns of winner or loser portfolio over the holding period 1_t corresponding to the event ticks;

$AR_{P, event tick}$ = Average abnormal returns of the winner or the loser portfolio at the time of event

$MCAP_{P, event tick}$ = Log of the average of the market capitalisation of the securities selected as winners (forming part of winner portfolio) or losers (forming part of loser portfolio) for each respective event tick

$BTM_{P, event tick}$ = Log of the average of the Book-to-market ratios of the securities selected as winners (forming part of winner portfolio) or losers (forming part of loser portfolio) for each respective event tick

$\varepsilon_{P, event tick}$ = Error term

Regressions are run with Newey-West heteroscedasticity and autocorrelation corrected standard errors.

3.3 Trading Strategy

To test the possibility of implementing a profitable trading strategy, which can generate excess returns by exploiting the detected patterns in subsequent security returns

following extreme intra-day price shocks, we formed zero-investment portfolio, which buys the negative event securities forming part of our loser portfolio and short sells the positive event securities forming part of our winner portfolio at each of the five consecutive ticks (of 30 minutes each) with respect to previous tick. Capital Asset Pricing Model (CAPM) has been used to test the level and significance of the returns generated by our zero-investment portfolio, whereby we regress the market return in excess of risk-free return on our average returns generated by negative event securities net of average returns generated by positive event securities for each of five subsequent trading ticks examined. Separate analysis has been done for trading strategy executed after a price shock observed at 9:15 a.m. and 12:15 a.m. daily. The regression model used is:

$$R_{L,t} - R_{W,t} = \alpha + \beta(R_{m,t} - R_{f,t}) + \varepsilon_t; t = 1, 2, 3, 4 \text{ or } 5; \quad (3.11)$$

where; $R_{L,t}$ = Average returns on negative event securities corresponding to each negative event, for t^{th} tick after an event

$R_{W,t}$ = Average returns on positive event securities corresponding to each positive event for, t^{th} tick after an event

$R_{m,t}$ = Return on market index for the corresponding period t

$R_{f,t}$ = Risk-free rate of return (daily equivalent of 91-day T-bill rates) for the corresponding period t

We postulate that statistically significantly positive coefficients of our regression model will imply excess returns generated by contrarian investment strategy and alternatively, statistically significantly negative coefficients will imply excess returns generated by momentum investment strategy.

4. Empirical Results

4.1. Statistics describing the Characteristics of the Sample

Table 1 (Panel A and Panel B) provides some statistics describing the characteristics of our sample securities included in the winner and the loser portfolio formed corresponding to event tick at 9:15 a.m. and 12:15 p.m. respectively. Positive event represents the event of extreme price increase (winners) and the negative event

represents the event of extreme price decrease (losers) at Tick 0.

Statistics reveal that the positive events sample and the negative events sample corresponding to event tick at 9:15 a.m. are quite different in terms of magnitude as well as distribution of their abnormal returns. The securities forming negative event sample are much diverse in their characteristics with larger standard deviations as compared to the securities forming positive event sample. In contrast, the variations shown in the negative event sample formed at 12:15 p.m. are, on average, relatively lesser than the variations observed for positive event sample. While the positive events recorded an average increase of approximately 5.72% in abnormal returns at 9:15 a.m. with average variation of 1.89%, negative events recorded an average drop of around 8.39% in abnormal returns with much higher variation to the extent of 11.24%. Alternatively, at 12:15

p.m., the positive events recorded an average increase of approximately 2.70% in abnormal returns with average variation of 1.04% as compared to an average drop of only 1.83% in abnormal returns of negative events with much smaller variations. Further, the magnitude of large abnormal returns of positive and negative event securities corresponding to event tick at 9:15 a.m. is much larger than the abnormal returns observed at 12:15 p.m. This is probably because of the fact that at the beginning of the trading sessions on any day, higher degree of uncertainty can be expected in market expectations and sentiments due to the developments which took place last day after the closure of trading in the stock market as compared to the uncertainty associated with developments taking place during the trading hours. This justifies our approach of separately analyzing the market's abnormal reaction to extreme price changes at the beginning of trading day and at the mid of trading day.

Table 1: Descriptive Statistics of Winner and Loser securities identified for extreme intra-day price changes

Period analysed: January 2010 to December 2010. Abnormal return is the market-adjusted return for the sample securities at event tick 0; Price is the adjusted closing price of the sample securities recorded for event tick. Firm size is the size of the sample firms measured in terms of its market capitalisation at tick 0. Value per share is the Book value in proportion to the market value per share of the sample firms at tick 0. Tick 0 is the time of the event when large abnormal price change occurred in either direction.						
Panel A: Event Tick- 9:15 a.m.						
Event	Positive (Winners)			Negative (Losers)		
Sample Size	248			248		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Abnormal Return	5.72%	5.42%	1.89%	-8.39%	-3.83%	11.24%
Price (in Rs.)	408.58	293.20	418.273	449.20	318.81	391.97
Firm Size (in Rs. millions)	72437.38	28062.01	239345.6	138056.7	45266.57	313934.0
Value per Share (inRs.)	0.50	0.47	0.19	0.47	0.43	0.23
Panel B: Event Tick- 12:15 p.m.						
Event	Positive (Winners)			Negative (Losers)		
Sample Size	248			248		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Abnormal Return	2.70%	2.54%	1.04%	-1.83%	-1.67%	0.59%
Price (in Rs.)	397.89	269.80	417.21	396.06	309.27	299.97
Firm Size (in Rs. millions)	70960.99	20189.29	365528.0	41073.10	22975.92	47918.73
Value per Share (inRs.)	0.48	0.42	0.26	0.50	0.47	0.19

Average price of the two types of securities seems to be similar with similar variation. Furthermore, the two types of sample firms appear similar in terms of their value per share. Interestingly, the average firm size of negative events sample at 9:15 a.m. is much larger than the magnitude of the firm size of positive events sample, thus ruling out the argument that with a fall in market prices, corresponding firms becomes smaller in size than the firms experiencing a rise in their security's prices. Positive sample securities at 12:15 p.m. are observed to be larger in size than negative sample securities. Also, Table 1 shows that firms in our sample are not small. Firms in the two samples are noticed to be fairly large with median firm's value of more than Rs. 2800 crores and Rs. 2000 crores and stock price exceeding Rs. 270 and Rs. 290 respectively for event ticks at 9:15 a.m. and 12:15 p.m.

4.2. Measuring the Market's Abnormal Reaction during Pre-Noon Trading Hours following Extreme Price Changes at 9:15 a.m.

The average abnormal returns to an equally weighted portfolio of the sample of stocks, five ticks before and five ticks after experiencing a large change in their prices at 9:15 a.m. daily compared to previous day's price at 3:15 p.m., are calculated and presented in Table 2. Each tick represents successive intervals of 30 minutes; figures shown in the parentheses are the t-statistics based on cross-sectional variances. Results of non-parametric tests (testing whether the proportion of securities in the sample portfolio that have positive abnormal returns is significantly different from 0.5) are also provided in the table.

Evidence obtained for our winner portfolio suggests short-term overreaction to good news events; after experiencing an extreme rise in their price observed at 9:15 a.m. daily, generating significantly positive abnormal returns to the extent of 5.72 % on average, prices of the winner securities have reversed their direction downwards such that the average abnormal returns of our winner portfolio have turned significantly negative during the successive two ticks and it remained insignificantly negative for ticks 3, 4 and 5 as well. This is probably on account of some good news disseminated into the market after the closing of trading session during previous trading day that investors overreacted to such news causing the prices of such stocks to open at extremely high levels during

the next trading day. However, such an overreaction is subsequently corrected in the form of return reversals (due to fall in prices) over the following few hours, such that significantly positive returns earned by winner sample during the opening of trading session have turned significantly negative immediately within an hour following the event of extreme price rise and it remained negative atleast upto subsequent two to three hours after the event. However it is worth noting that the subsequent correction to the initial overreaction has been quite fast as most of the correction has taken place within as soon as an hour following the event; although, a larger proportion of securities have continued to record falling prices even after two hours of the event. Average abnormal returns of our winner portfolio during five ticks prior to event are only insignificantly positive (except for tick -1 when they are significantly positive on average)' thus ruling out the possibility of information leakage before coming into public domain.

Looking at the cross-sectional behaviour of securities forming part of our loser portfolio, results shown in Table 2 are again indicative of a very short term overreaction to the negative events as well. Loser portfolio which has been observed to experience extremely negative returns to the extent of -8.39% on an average at the opening of trading session has fairly regained a part of a substantial loss in their value within as soon as half an hour after the event; the average abnormal returns of our loser portfolio turned extremely positive during the following hour, generating significantly positive returns over half an hour following the event of extreme price fall at the opening of the day. Although the evidence strongly suggests the tendency of Indian investors to overreact to bad news events but it is also evident from our results that the stock market has been quite fast in its subsequent correction of this initial overreaction which can be noticed to have taken place in as soon as half an hour after the event. Subsequent to that, the prices of loser securities have got more or less stable generating insignificant returns, positive or negative. Also there are no signs of leakage of bad news in advance as the average abnormal returns of our loser securities during the last trading hours of previous trading day are non-negative for four out of five previous ticks. Infact, the loser securities on an average have recorded significantly positive returns at the closing of previous trading day which inturn rules out the possibility of advance information regarding upcoming bad news amongst market participants.

Table2: Average Abnormal Returns for five ticks before and five ticks after a stock experienced an extreme rise (winner) or extreme fall (loser) in its intra-day price observed at 9:15 a.m. daily

Period analysed: January 2010 to December 2010. Abnormal returns are the security's market-adjusted returns calculated for each successive interval (tick) of 30 minutes. Tick 0 corresponds to 9:15 a.m. when the event of large abnormal price change is observed. Mean abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of positive abnormal returns, with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)		Negative (Losers)	
Sample Size:	248		248	
Tick	Average Abnormal Returns	Proportion of positive abnormal returns	Average Abnormal Returns	Proportion of positive abnormal returns
-5	0.07%	0.45	0.00%	0.44*
	(1.72)	(-1.52)	(0.08)	(-2.03)
-4	0.04%	0.49	-0.04%	0.50
	(0.81)	(-0.38)	(-0.63)	(0.00)
-3	0.05%	0.46	0.09%	0.52
	(1.25)	(-1.40)	(1.86)	(0.51)
-2	-0.02%	0.40**	0.09%	0.50
	(-0.34)	(-3.18)	(1.82)	(0.13)
-1	-0.12%*	0.43*	0.40%**	0.58*
	(-2.15)	(-2.29)	(5.00)	(2.41)
0	5.72%**	1.00**	-8.39%**	0.00**
	(47.55)	(15.75)	(-11.76)	(-15.75)
1	-0.50%**	0.34**	0.82%**	0.78**
	(-6.02)	(-4.95)	(9.88)	(8.89)
2	-0.12%**	0.36**	0.07%	0.53
	(-2.72)	(-4.32)	(1.20)	(0.89)
3	-0.06%	0.44	0.06%	0.52
	(-1.46)	(-1.78)	(1.39)	(0.76)
4	-0.03%	0.43*	-0.01%	0.44
	(-0.76)	(-2.29)	(-0.38)	(-1.91)
5	-0.05%	0.38**	-0.02%	0.46
	(-1.76)	(-3.68)	(-0.74)	(-1.14)

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

Turning down to Table 3 which reports the results obtained from the measurement of Buy-and-hold abnormal returns (BHR's) for different holding periods of 30 minutes (tick 1) to few hours following an event of extreme price rise as well as extreme price fall at 9:15 a.m., supportive evidence has been found. These results are also indicative of a presence of strong overreacting behaviour on the part of Indian investors to almost any kind of news event. Buy-and-hold abnormal returns for winner portfolio are all statistically significantly negative

for all the holding periods. Also, as the holding period increases from few minutes to few hours following a steep rise in opening prices, the absolute magnitude of the negative buy-and-hold abnormal returns keep on increasing from significantly negative 0.51% for one tick holding period to significantly negative 0.76% for five tick holding period. This is largely suggestive of the fact that following an event of extreme rise in its opening price, stock prices reverse their direction downwards which continues atleast upto subsequent two to three hours,

Table 3: Buy-and-Hold Abnormal Returns (BHR) for different Holding Periods after a stock experienced an extreme rise (winner) or extreme fall (loser) in intra-day price observed at 9:15 a.m. daily

Period analysed: January 2010 to December 2010. Tick 0 corresponds to 9:15 a.m. when the event of large abnormal price change is observed. Buy-and-Hold abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of securities with positive Buy-and-Hold abnormal returns with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)			Negative (Losers)	
Sample Size:	248			248	
Tick	Buy-and-Hold Abnormal Returns	Abnor- mal Returns	Proportion of positive Buy-and-Hold abnormal returns	Buy-and-Hold Abnormal Returns	Proportion of positive Buy-and-Hold abnormal returns
1	-0.51%**		0.34**	0.82%**	0.78**
	(-6.07)		(-4.95)	(9.88)	(8.89)
[+1,+2]	-0.62%**		0.31**	0.89%**	0.75**
	(-6.81)		(-5.84)	(8.79)	(7.75)
[+1,+3]	-0.68%**		0.31**	0.95%**	0.77**
	(-6.87)		(-6.10)	(8.85)	(8.51)
[+1,+4]	-0.71%**		0.28**	0.93%**	0.75**
	(-6.57)		(-6.99)	(8.34)	(7.75)
[+1,+5]	-0.76%**		0.29**	0.91%**	0.72**
	(-6.75)		(-6.73)	(8.18)	(6.86)

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

generating significantly negative returns over subsequent holding periods within a same day. On the contrary, buy-and-hold abnormal returns of loser portfolio are all found to be statistically significantly positive for all the subsequent holding periods from 30 minutes to few hours. After experiencing a sharp fall in their opening prices, loser securities on an average have recorded higher prices within next few hours such that buying these securities at the time of extreme fall in their prices and holding them for different holding horizon ranging from subsequent few minutes to few hours generates significant positive returns to these securities.

To analyse the trend in the direction of stock returns following extreme changes in daily opening prices, we calculated the cumulative average abnormal returns (CARs) for the two portfolios over the subsequent five ticks as reported in Table 4. Results reveal a strong evidence of reversal in the direction of security prices immediately within few minutes of extreme price change, both negative and positive. The cumulative average abnormal returns for our sample of winner stocks are

all statistically significantly negative with its absolute magnitude increasing for every subsequent tick. After recording an extremely positive return of 5.72% at the opening of the trading session, winner securities on an average continued to record falling prices over next few intervals of 30 minutes each so as to record significantly negative cumulative average abnormal returns to the extent of -0.76% after two and a half hours of the event. Similarly, for the loser portfolio as well, evidence shows a reversal in the direction of security prices; after experiencing an acute fall in their prices at the opening of trading session, prices of the loser securities immediately revert back upward, generating extremely positive and significant 0.82% returns within 30 minutes of sharp fall which further rose higher to record cumulative returns of 0.95% in another hour.

Figure 1 and Figure 2 respectively plots the CARs five ticks before and five ticks after a large change in price occurred at 9:15 a.m. for the entire sample of winner stocks and loser stocks. A declining trend in the average abnormal returns after a sharp rise at tick 0 is very much evident

Table 4: Cumulative Average Abnormal Returns (CAR) for different Holding Periods from Tick 1 to Tick 5 after a stock experienced an extreme rise (winner) or extreme fall (loser) in intra-day price observed at 9:15 a.m. daily

Period analysed: January 2010 to December 2010. Tick 0 corresponds to 9:15 a.m. when the event of large abnormal price change is observed. Cumulative average abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of securities with positive Cumulative abnormal returns, with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)		Negative (Losers)	
Sample Size:	248		248	
Tick	Cumulative Average Abnormal Returns	Proportion of positive Cumulative Average abnormal returns	Cumulative Average Abnormal Returns	Proportion of positive Cumulative Average abnormal returns
1	-0.50%** (-6.02)	0.34** (-4.95)	0.82%** (9.88)	0.78** (8.89)
[+1,+2]	-0.62%** (-6.77)	0.31** (-5.84)	0.89%** (8.89)	0.75** (8.00)
[+1,+3]	-0.68%** (-6.82)	0.31** (-6.10)	0.95%** (9.02)	0.77** (8.51)
[+1,+4]	-0.71%** (-6.52)	0.28** (-6.99)	0.94%** (8.47)	0.75** (7.87)
[+1,+5]	-0.76%** (-6.74)	0.29** (-6.60)	0.91%** (8.31)	0.72** (6.86)

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

from Figure 1 which clearly demonstrates a reversal in the direction of intra-day security returns and a very short-term overreaction following good news. Clearly, there is no visible trend in the behaviour of security returns prior to the event tick which suggests that there is no advance information of the favourable developments amongst the market participants in very short term. Figure 2 demonstrates reversal in the prices of loser securities; after a sharp fall at tick 0, security prices reversed upward immediately and continued to rise further and stayed at that level and slightly higher level during all the subsequent 30 minutes interval, substantiating the fact that market overreacts to bad news in very short term. During the trading hours prior to unfavourable developments, the average abnormal returns remained fairly stable at a same level and then rose upward immediately before witnessing a sharp fall at the opening of next trading day, which in turn dismisses the possibility of any leakage of

information or anticipation regarding bad news in very short term.

Figure 1: Cumulative Average Abnormal Returns (CAR) Five Ticks Before and Five Ticks after a large increase in price occurred at tick 0 (9:15 a.m. daily) for the entire sample of winner stocks

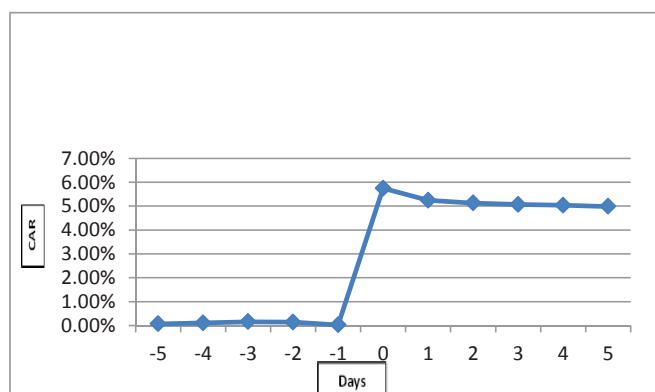
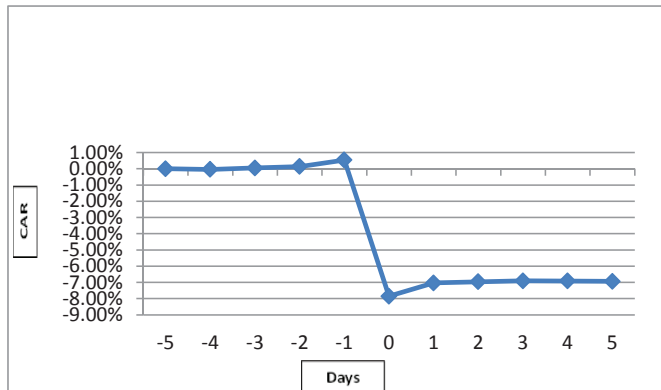


Figure 2: Cumulative Average Abnormal Returns (CAR) Five Ticks Before and Five Ticks after a large decrease in price occurred at tick 0 (9:15 a.m. daily) for the entire sample of loser stocks



4.3. Measuring the Market's Abnormal Reaction during Post-Noon Trading Hours following Extreme Price Changes at 12:15 p.m.

Table 5 presents the average abnormal returns for five ticks before and five ticks after a stock experienced a large increase or a large decrease in its price at tick 0, which corresponds to 12:15 p.m. daily, compared to previous 30 minute's price at 11:45 a.m. Results of non-parametric tests are also provided in the Table. Figures shown in the parentheses are the t-statistics based on cross-sectional variances. On an aggregate basis, the results obtained for the cross-sectional behaviour of securities following extreme price changes during post-noon trading hours are fairly consistent with the results obtained for pre-noon trading hours. There is an evidence of overreaction amongst the market participants to the favourable as well as unfavourable events during the mid of trading day also as is found for the developments taking place after the closing of trading day having its impact on next day's prices.

Table 5 clearly shows evidence of market overreaction to favourable news (probably) being available to the market participants during a trading day and its subsequent correction within few minutes and hours following such a reaction. After experiencing a sharp rise observed at 12:15 p.m., probably on account of some good news in the stock market, generating significantly positive abnormal returns to the extent of 2.70 % on average, prices of the winner securities have continuously tumbled down such that the extremely positive returns observed during the time

of event have in fact reversed into significantly negative -0.27% within few minutes of overreaction and prices further came down to record significantly negative average abnormal returns atleast upto two to three hours after the event. Further, the average abnormal returns analysed over previous five ticks prior to event points out towards the possibility of trades based on inside information of upcoming good news as the average abnormal returns are observed to be significantly positive for all previous ticks except tick -2 and -5 when they are insignificant.

Results also indicate very short term overreaction to the negative events as well. Loser portfolio which has been observed to experience extremely negative returns to the extent of -1.83% on an average at the time of negative event can be observed to regain a part of a substantial loss in their value within as soon as half an hour after the event. After an extreme fall in their prices at 12:15 p.m., loser securities experienced an upward turn in their prices such that the average abnormal returns of our loser portfolio turned positive during the following one to two hours. Also the major correction to the initial overreaction has occurred within subsequent few minutes as the loser portfolio recorded significantly positive average abnormal return of 0.22% measured during the next 30 minutes of the event. Subsequent to that, prices of loser securities have got more or less stable generating insignificant returns, positive or negative, which is again consistent with our findings for pre-noon trading hours. Average abnormal returns measured over previous few hours of event provides no evidence of leakage of bad news in advance; the average abnormal returns of our loser securities during the initial trading hours of a trading day are all non-negative for the previous five ticks. In fact, the loser securities on an average have recorded significantly positive returns of 0.44% immediately before few minutes of the event which in turn rules out the possibility of advance information regarding upcoming bad news amongst market participants.

Results obtained from the measurement of buy-and-hold abnormal returns (BHR's) for different holding periods of 30 minutes to few hours following an event of extreme price change at 12:15 p.m. daily, tabulated in Table 6, are also suggestive of a presence of strong overreacting behaviour on the part of Indian investors to almost any kind of news event during the later hours of trading session in a day. Buy-and-hold abnormal returns to the winner portfolio are statistically significantly negative

Table5: Average Abnormal Returns for five ticks before and five ticks after a stock experienced an extreme rise (winner) or extreme fall (loser) in intra-day price observed at 12:15 p.m. daily

Period analysed: January 2010 to December 2010. Abnormal returns are the security's market-adjusted returns calculated for each successive interval (tick) of 30 minutes. Tick 0 corresponds to 12:15 p.m. when the event of large abnormal price change is observed. Mean abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of positive abnormal returns, with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)		Negative (Losers)	
Sample Size:	248		248	
Tick	Average Abnormal Returns	Proportion of positive abnormal returns	Average Abnormal Returns	Proportion of positive abnormal returns
-5	0.02%	0.52	0.12%*	0.52
	(0.45)	(0.51)	(2.25)	(0.51)
-4	0.13%**	0.53	0.11%**	0.55
	(3.31)	(0.89)	(2.74)	(1.52)
-3	0.11%**	0.56	0.09%*	0.50
	(2.98)	(1.78)	(2.10)	(0.13)
-2	0.05%	0.50	0.15%**	0.56
	(1.41)	(0.00)	(3.29)	(1.90)
-1	0.22%**	0.64**	0.44%**	0.67**
	(5.34)	(4.57)	(7.99)	(5.46)
0	2.70%**	1.00**	-1.83%**	0.00**
	(40.66)	(15.75)	(-48.82)	(-15.75)
1	-0.27%**	0.30**	0.22%**	0.66**
	(-5.34)	(-6.22)	(5.99)	(5.08)
2	-0.12%**	0.39**	0.06%	0.53
	(-3.60)	(-3.43)	(1.74)	(0.89)
3	-0.08%*	0.40**	0.04%	0.48
	(-2.18)	(-3.17)	(1.21)	(-0.63)
4	-0.05%	0.38**	-0.05%	0.44
	(-1.47)	(-3.81)	(-1.65)	(-1.78)
5	-0.09%**	0.38**	-0.07%*	0.39**
	(-2.59)	(-3.81)	(-2.42)	(-3.43)

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

for different holding periods. Also, as the holding period increases from few minutes to few hours following a steep rise in the prices, the absolute magnitude of the negative buy-and-hold abnormal returns keeps on increasing from significantly negative 0.27% for one tick holding period to significantly negative 0.61% for five tick holding period. On the other hand, buy-and-hold abnormal returns of loser portfolio are all found to be statistically significantly positive for all the subsequent

holding periods from 30 minutes to few hours following extreme decline in intra-day prices. After experiencing a sharp fall in their prices at 12:15 p.m., loser securities on an average have recorded higher prices within next few hours such that buying these securities at the time of extreme fall in their prices and holding them for different holding horizon ranging from subsequent few minutes to few hours generates significant positive returns to these securities to the extent of 0.18% to 0.31% as reported for

Table 6: Buy-and-Hold Abnormal Returns (BHR) for different Holding Periods after a stock experienced an extreme rise (winner) or extreme fall (loser) in intra-day price observed at 12:15 p.m. daily

Period analysed: January 2010 to December 2010. Tick 0 corresponds to 12:15 p.m. when the event of large abnormal price change is observed. Buy-and-Hold abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of securities with positive Buy-and-Hold abnormal returns with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)		Negative (Losers)	
Sample Size:	248		248	
Tick	Buy-and-Hold Abnormal Returns	Proportion of positive Buy-and-Hold abnormal returns	Buy-and-Hold Abnormal Returns	Proportion of positive Buy-and-Hold abnormal returns
1	-0.27%**	0.30**	0.22%**	0.66**
	(-5.35)	(-6.22)	(5.95)	(5.08)
[+1,+2]	-0.40%**	0.30**	0.27%**	0.65**
	(-6.60)	(-6.35)	(6.12)	(4.70)
[+1,+3]	-0.48%**	0.27**	0.31%**	0.65**
	(-6.81)	(-7.37)	(6.25)	(4.83)
[+1,+4]	-0.52%**	0.25**	0.26%**	0.61**
	(-6.65)	(-7.75)	(4.84)	(3.56)
[+1,+5]	-0.61%**	0.27**	0.18%**	0.54
	(-7.24)	(-7.24)	(3.07)	(1.40)

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

our sample. This in turn substantiates the fact of investors' overreaction to good news as well as bad news during the continuation of trading session in a day.

Supportive evidence can be found in Table 7 which reports the results obtained from the measurement of Cumulative average abnormal returns (CARs) of our two portfolios over the subsequent five ticks of 30 minutes interval each following extreme price changes observed at 12:15 p.m. daily. Evidence strongly indicates reversal in the direction of security prices immediately within few minutes following the event of extreme price rise as well as fall during the later hours of a trading day. The cumulative average abnormal returns for our sample of winner stocks are all statistically significantly negative with its absolute magnitude increasing for every subsequent tick. After recording significant return of 5.72% at 12:15 p.m., winner securities on an average have recorded a continuous fall in their prices over next few intervals of 30 minutes each so as to record significantly negative cumulative average abnormal returns to the extent of -0.61% after two and a half hours of the event.

Alternatively, prices of loser securities revert back upward immediately after experiencing negative event at 12:15 p.m. so as to generate significantly positive cumulative average abnormal returns tick after tick. The immediate reversal in the prices of loser securities resulted into extremely positive and significant 0.22% returns within 30 minutes of sharp fall which further rose higher so as to record cumulative returns of 0.31% in another hour.

Graphical presentation of CARs five ticks before and five ticks after the event observed at 12:15 p.m. is shown in Figure 3 and Figure 4 for the winner and the loser portfolios, respectively. An immediate reversal in the direction of security returns after a sharp rise at tick 0 is clearly evident from Figure 3 which in turn validates the tendency of market participants to exhibit a very short-term overreaction following good news. Also, a rising trend in security returns during hours prior to event possibly suggests insider trading activities. In contrast, Figure 4 depicts an upward bounce in the direction of losers' returns post event. After experiencing a sharp fall at tick 0, prices of loser securities reversed their direction

Table 7: Cumulative Average Abnormal Returns (CAR) for different Holding Periods from Tick 1 to Tick 5 after a stock experienced an extreme rise (winner) or extreme fall (loser) in intra-day price observed at 12:15 p.m. daily

Period analysed: January 2010 to December 2010. Tick 0 corresponds to 12:15 p.m. when the event of large abnormal price change is observed. Cumulative average abnormal returns are presented, with cross-sectional t-values in parentheses. Proportion of securities with positive Cumulative abnormal returns, with corresponding t-values in parentheses is also provided.

Events	Positive (Winners)		Negative (Losers)		
Sample Size:	248		248		
Tick	Cumulative Average Abnormal Returns	Proportion of positive Cumulative Average abnormal returns	Cumulative Average Abnormal Returns	Proportion of positive Cumulative Average abnormal returns	
1	-0.27%**	0.30**	0.22%**	0.66**	
	(-5.34)	(-6.22)	(5.99)	(5.08)	
[+1,+2]	-0.40%**	0.30**	0.27%**	0.66**	
	(-6.60)	(-6.35)	(6.21)	(4.95)	
[+1,+3]	-0.47%**	0.27**	0.31%**	0.66**	
	(-6.81)	(-7.37)	(6.37)	(4.95)	
[+1,+4]	-0.52%**	0.25**	0.26%**	0.63**	
	(-6.64)	(-7.75)	(4.98)	(4.07)	
[+1,+5]	-0.61%**	0.27**	0.19%**	0.56	
	(-7.21)	(-7.11)	(3.21)	(1.78)	

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

upward immediately to reach a higher level and continued to rise further and stayed at that level and slightly higher level during one to two hours of event before falling randomly thereafter. It is again suggestive of market overreaction to bad news in very short term. A fairly rising trend can be noticed in the direction of security returns during the minutes and hours prior to unfavourable developments which indicates that bad news does not get leaked in advance and the market participants do not anticipate such news in a very short term.

On the basis of our primary findings, it can be contended that in a very short term, the investors in Indian stock market tend to overreact to almost any kind of news, good or bad. This initial overreaction is however subsequently corrected immediately within few minutes upto few hours within a trading day itself such that security returns immediately experience a reversal in their direction following the events. However the speed with which the correction takes place is slightly different for good news events and bad news events. The subsequent correction following extreme price falls occurs as soon

as within few minutes of negative events with almost entire correction taking place in next 30 minutes itself. In contrast, the subsequent correction of extreme price rises accompanying favourable developments though occurs within few minutes of overreaction but it continues upto few hours subsequent to that. This is indicative of the optimism on the part of Indian investors who immediately brings stock prices up following unjustified extreme price falls but takes time to bring stock prices down following unjustified extreme price rises.

4.4. Large Price Changes and Subsequent Cross-Sectional Returns Behaviour: Analysing the Possible Explanations

Our initial findings suggested that in a very short term, security returns reverse their direction immediately after experiencing extreme changes in their intra-day prices. The next step obviated by these findings is to investigate as to what may be the possible reason behind such an observed pattern of subsequent security prices

and returns following extreme intra-day price changes. One of the possible explanations is that it is probably because of the behavioural biases on the part of market participants to overreact or under react to previous large price changes. Alternatively, it is also conjectured that it is because of the response of the market participants to the changing risk accompanying extreme price changes and a corresponding change in firm's size or instead it is actually another manifestation of value effect. To this end, we also investigate whether the observed behaviour of security returns subsequent to extreme intra-day price changes is captured by the risk related explanation based on size effect or it is another manifestation of value effect or it is a phenomenon distinct from it.

Figure 3: Cumulative Average Abnormal Returns (CAR) Five Ticks Before and Five Ticks after a large increase in price occurred at tick 0 (12:15 p.m. daily) for the entire sample of winner stocks

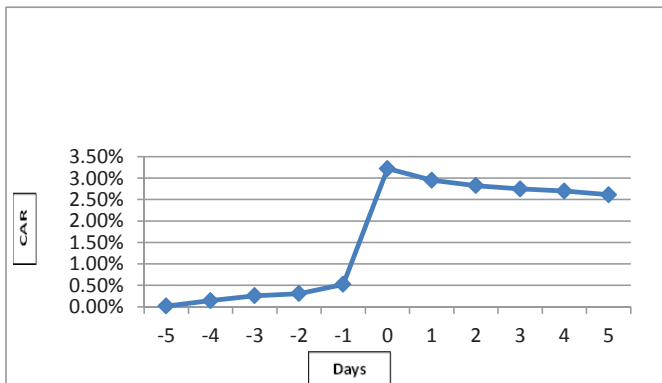


Figure 4: Cumulative Average Abnormal Returns (CAR) Five Ticks Before and Five Ticks after a large decrease in price occurred at tick 0 (12:15 p.m. daily) for the entire sample of loser stocks

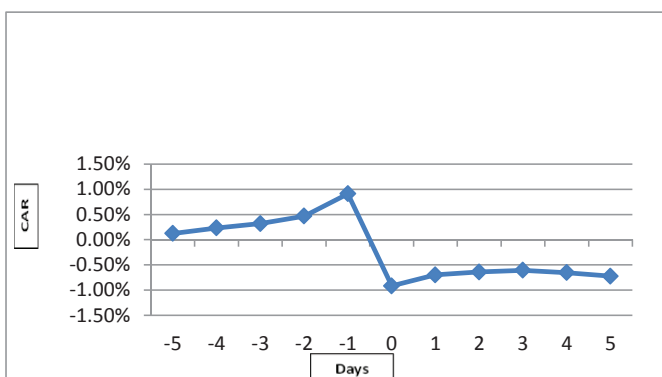


Table 8 highlights the least squares estimates obtained from cross-sectional regressions corresponding to Equation 3.10 conducted for 248 winners and 248 losers identified at 9:15 a.m. daily. Regression results for positive events are tabulated in Panel A and the corresponding results for negative events are furnished in Panel B of the table.

Looking at Panel A of Table 8, the estimated coefficients for firms value (BTM) at the time of event are insignificant in explaining the post event abnormal returns for any of the intra-day holding periods subsequent to the event. The estimated coefficients for firm's size (MCAP) are found to be significantly positive for the four different holding periods except one tick holding period, which in turn suggests some relationship between firm size at the time of event and the subsequent holding period returns. However, it is worth mentioning that size effect postulates negative relationship between the firm size and its subsequent returns. But, our results are largely showing significantly positive coefficients of the size variables for different holding periods, which is infact anomalous to the well documented size effect. Further, the intercept coefficients are statistically significantly negative for all except one tick holding period, which dismisses the possibility that the observed overreaction is just a manifestation of size or value effects. The coefficients of event tick abnormal returns (AR) are also found to be insignificant in explaining the post event abnormal returns, which in turn indicates no association between the magnitudes of subsequent returns with the magnitudes of initial gains. Thus it can be inferred from our findings that any of the two alternative explanations i.e. the size and the value effect, does not capture the observed overreaction for our winner portfolio and also there is no evidence found for the presence of magnitude effect in our sample.

For the loser portfolio as well, the coefficients of value variable as well as event day abnormal returns variable are largely insignificant for all the holding periods analysed (Panel B), thus indicating that observed reversals in our loser portfolios' returns are not a manifestation of value effect nor there is any association between the magnitude of subsequent returns with the magnitudes of initial losses. Interestingly, our results show a significant negative relationship between firm's size at the time of event and the subsequent intra-day holding period returns as documented by size effect literature and thus firm's size has been found to play an important role in explaining the post event holding period returns

Table 8: Least Squares Estimates from Cross-Sectional Regressions (Equation 3.10) for 248 Losers and 248 Winners identified at 9:15 a.m. daily

Period analysed: January, 2010 to December, 2010. Buy-and-Hold abnormal returns (BHR) for different holding periods following event tick 0 corresponding to 9:15 a.m. are the dependent variable. Average abnormal returns (AR), market capitalisation (MCAP) and book-to-market ratios (BTM) calculated at event tick 0 for the securities forming part of our winner or the loser portfolio are the independent variables.

Dependent Variable	C	AR	MCAP	BTM	Adj. R ²	F-stat
Panel A: Positive Events (Winners)						
BHR ₁	-0.013	-0.061	0.001	-0.001	0.002	1.125
	(-1.72)	(-1.13)	(1.54)	(-0.39)		
BHR ₁₋₂	-0.021*	-0.052	0.002*	0.001	0.006	1.530
	(-2.28)	(-0.84)	(2.20)	(0.57)		
BHR ₁₋₃	-0.028**	-0.042	0.002**	0.003	0.017	2.401
	(-2.96)	(-0.69)	(2.94)	(1.30)		
BHR ₁₋₄	-0.038**	-0.025	0.003**	0.004	0.031	3.637
	(-3.71)	(-0.37)	(3.45)	(1.62)		
BHR ₁₋₅	-0.036**	-0.040	0.003**	0.004	0.024	2.979
	(-3.13)	(-0.60)	(2.90)	(1.36)		
Panel B: Negative Events (Losers)						
BHR ₁	0.032**	-0.001	-0.002*	0.003	0.047	5.062
	(3.24)	(-0.18)	(-2.40)	(1.01)		
BHR ₁₋₂	0.034**	-0.001	-0.002*	0.000	0.022	2.850
	(3.32)	(-0.26)	(-2.58)	(0.11)		
BHR ₁₋₃	0.040**	-0.004	-0.003**	-0.000	0.034	3.927
	(3.86)	(-0.54)	(-3.23)	(-0.13)		
BHR ₁₋₄	0.039**	-0.001	-0.003**	0.000	0.027	3.336
	(3.25)	(-0.22)	(-2.65)	(0.04)		
BHR ₁₋₅	0.045**	-0.003	-0.003**	-0.001	0.046	4.981
	(3.87)	(-0.52)	(-3.41)	(-0.18)		

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

generated for loser portfolio during the same day. But, at the same time, the intercept coefficients of our regression results are statistically significantly positive for all the holding periods analysed. Thus, firm's size alone do not capture the post event behaviour of abnormal returns and there are some other important factors, probably the investor overreaction, which is playing significant role in explaining the return reversals observed for loser portfolio within few hours following extreme price falls.

Results obtained from cross-sectional regressions (corresponding to Equation 3.10) conducted on the intra-day holding period returns subsequent to extreme price changes observed at 12:15 p.m. daily are presented in Table 9.

Results obtained for our winner portfolio, tabulated in Panel A of Table 9, show that neither the estimated coefficients for firms value (BTM) or the firm's size

Table 9: Least Squares Estimates from Cross-Sectional Regressions (Equation 3.10) for 248 Losers and 248 Winners identified at 12:15 p.m. daily

Period analysed: January, 2010 to December, 2010. Buy-and-Hold abnormal returns (BHR) for different holding periods following event tick 0 corresponding to 12:15 p.m. are the dependent variable. Average abnormal returns (AR), market capitalisation (MCAP) and book-to-market ratios (BTM) calculated at event tick 0 for the securities forming part of our winner or the loser portfolio are the independent variables.

Dependent Variable	C	AR	MCAP	BTM	Adj. R ²	F-stat
Panel A: Positive Events (Winners)						
BHR ₁	0.002	-0.094	-0.000	0.001	0.004	1.304
	(0.39)	(-1.18)	(-0.36)	(0.57)		
BHR ₁₋₂	0.002	-0.086	-0.000	-0.000	-0.002	0.829
	(0.46)	(-1.36)	(-0.73)	(0.32)		
BHR ₁₋₃	0.003	-0.075	-0.001	-0.000	-0.005	0.595
	(0.55)	(-1.02)	(-1.06)	(-0.02)		
BHR ₁₋₄	0.001	-0.054	-0.000	-0.000	-0.009	0.277
	(0.21)	(-0.59)	(-0.84)	(-0.11)		
BHR ₁₋₅	-0.003	-0.067	-0.000	-0.000	-0.009	0.232
	(-0.45)	(-0.60)	(-0.19)	(-0.16)		
Panel B: Negative Events (Losers)						
BHR ₁	0.004	-0.121	-0.000	-0.000	0.008	1.706
	(1.11)	(-1.55)	(-1.09)	(-0.09)		
BHR ₁₋₂	-0.003	-0.295**	0.000	0.000	0.051	5.396
	(-0.57)	(-3.57)	(0.06)	(0.22)		
BHR ₁₋₃	-0.008	-0.281**	0.001	0.000	0.039	4.380
	(-1.37)	(-3.45)	(1.05)	(0.44)		
BHR ₁₋₄	-0.002	-0.255**	-0.000	-0.000	0.020	2.714
	(-0.36)	(-2.69)	(-0.04)	(-0.19)		
BHR ₁₋₅	0.001	-0.238*	-0.000	-0.001	0.011	1.937
	(0.18)	(-2.11)	(-0.59)	(-0.33)		

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

are found to be significant for any of the post event holding period analysed. Also, the coefficients of event tick abnormal returns (AR) are found to be insignificant in explaining the post event abnormal returns, which in turn indicates no association between the magnitude of subsequent returns with the magnitudes of initial gains occurring at the mid of trading day. Thus it can be inferred from our findings that neither the size effect nor the value effect captures the observed overreaction for our winner portfolio during the continuation of trading hours in a day and also there is no evidence found for the presence of magnitude effect in our sample. For loser portfolio

(Panel B), the regression results came in line with those observed for winner portfolio in terms of the size factor and the value factor as the coefficients of size variable as well as value variable are entirely insignificant for all the holding periods analysed. It indicates that observed reversals in our loser portfolio subsequent returns during the post-noon trading hours are neither captured by well documented size effect nor they can be said to be the another manifestation of value effect. However, an association is found between the magnitudes of losers' holding returns with the magnitudes of initial losses. The estimated coefficients of event tick abnormal returns (AR)

are found to be significantly negative for four out of five holding periods except 30 minutes holding period which indicates that in our loser sample, the securities which experienced largest price declines observed at 12:15 p.m. daily have experienced largest price reversals in the subsequent hours of trading. This validates the findings of De Bondt and Thaler (1985) for long term overreaction.

From the overall findings, it can be concluded that in Indian stock market, size and value based explanations does not explain the cross-sectional behavior of security returns immediately following extreme intra-day price shocks. We conjecture that the patterns of intra-day return reversals observed for our winner and the loser portfolio are basically driven by the behavioural biases on the part of market participants to overreact to unexpected information in a very short term.

4.5. Testing the Profitability of Investment Strategy Executed over Few Ticks Following Extreme Intra-day Price Changes

Since our primary findings indicate that in Indian stock market, security prices do exhibit predictable patterns following extreme intra-day price changes, we also seek to investigate whether investors can establish profitable investment strategies to take advantage of these detected predictable patterns in subsequent security returns and earn superior returns in a very short term of few hours within a trading day. For this purpose, we formed zero-investment portfolio which buys the negative event securities forming part of our loser portfolio and short sells the positive event securities forming part of our winner portfolio at each of the five consecutive ticks (of 30 minutes each) vis-à-vis previous tick after the event of extreme price change observed at 9:15 a.m. daily and 12:15 a.m. daily. To examine if our trading strategy of buying losers and short-selling winners with a holding period of one trading tick earns returns in excess of risk premium offered by the market, we regress the market return in excess of the risk-free return on our average returns generated by negative event securities net of average returns generated by positive event securities for each of five subsequent trading ticks examined.

Least squares estimates obtained from cross-sectional regressions corresponding to equation 3.11 on intra-day tick by tick average returns of our zero investment portfolios are provided in Table 10. Panel A describes the

results of our investment strategy executed during pre-noon trading hours, for the five subsequent ticks examined after the event observed at 9:15 a.m. daily and Panel B describes the results of our investment strategy executed during post-noon trading hours, for the five subsequent ticks examined after the event observed at 12:15 p.m. daily. For our investment strategy executed upto three subsequent ticks after an extreme change observed in the opening prices, the coefficients are found to be statistically positively significant (Panel A), which in turn implies that in Indian stock market, it is indeed possible to earn excess returns on an intra-day basis, that too within few minutes upto one to two hours of occurrence of extreme changes in the opening prices of the securities. Results from our sample shows that by implementing the contrarian investment strategy at a time of event of extreme movements in the opening price of securities, one can generate superior returns in Indian stock market to the extent of 1.3% within as soon as few minutes of extreme price change which can further be enhanced by additional 0.1% to 0.2% in the next hour. Further, if we look at the β coefficients, they are insignificant for all the subsequent ticks, except for tick 5. This indicates that the returns generated through the execution of our investment strategy are not a compensation for the corresponding market risk of this strategy and thus they represent the excess returns generated from this investment strategy. This is consistent with the overreaction hypothesis which suggests that if both the losers and the winners had overreacted to price shocks, the contrarian investment strategy of forming a zero-investment portfolio that buys past losers and short-sells past winners will generate returns in excess of market risk premium.

Results of our investment strategy executed during post-noon trading hours (Panel B) are largely consistent with the results obtained for pre-noon trading hours. During the post-noon trading hours also, the contrarian investment strategy has been found to generate significantly positive returns to the investors within few minutes to one and a half hour of event; coefficients of our investment strategy executed upto three subsequent ticks after the event observed at the mid of the trading session in a day are found to be statistically positively significant, which again suggests the possibility to earn excess returns on an intra-day basis in Indian stock market. The magnitude of excess returns generated within few minutes of extreme price change observed at the mid of the trading hours is as high as 0.5% which can further be improved by additional

Table 10: Least Squares Estimates from Cross-Sectional Regressions (Equation 3.11) run on intra-day tick by tick average returns of zero-investment portfolio

Period analysed: January, 2010 to December, 2010. These results are obtained from the following regression:
 Return on Zero-investment portfolio which buys the negative event securities forming part of our loser portfolio and short sells the positive event securities forming part of our winner portfolio, at each of the five consecutive ticks (of 30 minutes each) vis-à-vis previous tick after the event of extreme price change is observed, are the dependent variables. coefficients represents portfolio's returns in excess of market risk premium and the portfolio's sensitivities to the market risk are represented by the coefficients. Figures in the parentheses are the cross-sectional t-statistics.

Panel A: Event Tick- 9:15 a.m.

Dependent Variable				F-stat
$R_{L,1}-R_{W,1}$	0.013**	0.473		0.631
	(6.71)	(0.72)		
$R_{L,2}-R_{W,2}$	0.002**	0.019		0.953
	(2.67)	(0.06)		
$R_{L,3}-R_{W,3}$	0.001**	0.558		0.092
	(2.60)	(0.84)		
$R_{L,4}-R_{W,4}$	0.000	0.167		0.587
	(0.34)	(0.53)		
$R_{L,5}-R_{W,5}$	0.000	-0.437*		0.051
	(0.27)	(-2.04)		

Panel B: Event Tick- 12:15 p.m.

Dependent Variable				F-stat
$R_{L,1}-R_{W,1}$	0.005**	0.037		0.017
	(7.43)	(0.12)		
$R_{L,2}-R_{W,2}$	0.002**	-0.085		0.163
	(3.65)	(-0.50)		
$R_{L,3}-R_{W,3}$	0.001**	0.068		0.110
	(2.64)	(0.39)		
$R_{L,4}-R_{W,4}$	-0.000	-0.347*		4.820
	(-0.20)	(-2.05)		
$R_{L,5}-R_{W,5}$	0.000	0.335*		0.053
	(0.86)	(2.14)		

* statistically significant at 5% level of significance

** statistically significant at 1% level of significance

0.1% to 0.2% in the next hour. β coefficients are again found to be insignificant for the three subsequent ticks during which the coefficients are significantly positive, which in turn indicates that these excess returns are not a compensation for the corresponding market risk of this strategy.

Noticeably, the magnitude of excess returns of 1.3% earned immediately during 30 minutes of extreme change in opening prices is much higher than the magnitude of excess returns of 0.5% earned during 30 minutes of extreme price change observed in the middle of the trading day. This is probably because of the fact that the magnitude of

change observed in the opening prices of selected winner and loser securities, which is 5.72% and -8.39% on average respectively, has been much larger than the magnitude of change observed in prices at 12:15 p.m., which is 2.70% and -1.83% on average for the corresponding winner and loser securities. Thus, the consequent correction to the initial overreaction during pre-noon trading hours is expected to be larger than that for post-noon trading hours, generating in turn higher returns to the contrarian strategy executed immediately after the extreme movements in opening prices compared to mid-session price movements. Thus, it is more profitable to execute this strategy in response to extreme price movements in the opening prices of the securities as compared to its execution during the middle of the trading day. However, implementation of these strategies also requires handling the transaction costs as much of the potential profits from these strategies may be eliminated if the transaction costs are not managed well. Our findings are consistent with the findings of Wang et al. (2009) who documented the profitability of intra-day contrarian strategies for Taiwan stock market, however, the magnitude of excess returns to contrarian strategies found in our results are much larger than the magnitude of the abnormal returns documented by them. Also, it is worth mentioning that our findings are conditional based on the validity of the CAPM. But, overall it can be concluded that this conventional single asset pricing model has failed in explaining the excess returns generated by the contrarian investment strategy executed over very short horizon of few minutes and hour of extreme price changes within a trading day.

5. Conclusions

On the basis of our overall findings, we document that in Indian stock market, security returns do exhibit predictable patterns in a very short term of few minutes and hours following extreme intra-day price shocks. They exhibit a reversal in their direction within few minutes of extreme price rises as well as price falls. Irrespective of the time in a day when the developments take place and comes into public domain, both favourable as well as unfavourable events are accompanied by overreaction causing the stock prices to jump up high accompanying favourable developments and to decline acutely following unfavourable developments, which is subsequently followed by a correction such that prices and the consequent returns reverse their direction immediately

within few minutes of extreme price rises as well as declines. However the speed with which the correction takes place is slightly different for good news events and bad news events. While the subsequent correction occurs as soon as within few minutes of extreme price movements, it almost completes in next 30 minutes itself following extreme price falls but it continues upto few hours subsequent to extreme price rises. It denotes optimism on the part of Indian investors who immediately brings stock prices up following unjustified price falls but takes time to bring stock prices down following unjustified price rises.

As far as the alternative explanations behind the subsequent behaviour of security returns are concerned, evidence indicate that the observed reversals are neither captured by the well documented size effect nor they can be said to be the another manifestation of value effect. We conjecture that the patterns of intra-day return reversals observed for our winner and loser portfolio are basically driven by the behavioural biases on the part of market participants to overreact to unexpected information in a very short term.

Assuming that transaction costs do not influence winner-loser returns, superior returns can be earned within few minutes to an hour of extreme price change observed in intra-day prices by executing a contrarian investment strategy. Evidence also indicates that these superior returns are not a compensation for the corresponding market risk of this strategy and thus they represent the excess returns generated from this investment strategy. This is consistent with the overreaction hypothesis which suggests that if both the losers and the winners had overreacted to price shocks, the contrarian investment strategy will generate returns in excess of market risk premium. Further, it is found that it is more profitable to execute this strategy in response to extreme price movements in the opening prices of the securities as compared to its execution during the middle of the trading day. However, these findings are conditional based on the validity of CAPM.

These findings lend a further support to short-term overreaction literature; infact they are an addition to this literature as it suggests that not only in short-term of few days, but in a very short-term of few hours within a trading day, there is a strong evidence of overreaction to good as well as bad news. More importantly, these findings serve as a proof of predictability of the direction

of future stock prices and consequent returns on an intra-day basis. It forwards important investment implications for traders and fund managers; they can improve their investment performance simply by executing the contrarian investment strategy during few hours within a trading day, without getting involved into the complexities of fundamental and technical analysis for investment management, provided that transaction costs are handled efficiently as much of the potential profits from these strategies may be eliminated if the transaction costs are not managed well. At the same time, small and retail investors must be very cautious in timing their investments ensuring that the security prices are not in much deviation from their fundamental values, as in the case of overreaction and under reaction; otherwise there is a possibility that they may lose. Overall, our results raise doubt on the efficiency of Indian stock market; they indicate that Indian stock market is not even weak form efficient. Thus, there is a large scope for improved policy regulations; policy regulators need to focus more on the operational and informational efficiency of Indian stock market to improve the market microstructures.

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