Equity Market Reaction to Sharp Price Changes: Evidence from India

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One approach to examining the weak form of market efficiency is to test for investors' overreaction to large price changes. In this line of research, we examine investors' reactions to sharp price changes in the Bombay and National Stock Exchanges of India. We apply three thresholds of large daily price changes. Using daily data from January 2, 1995 through October 26, 2009, we examine investors' behavior within thirty days after the arrival of unexpected favorable and unfavorable news. Results: (a) the arrival of unexpected news causes sharp price changes and introduces a price shock, which increases market volatility. (b) The subsequent price adjustments have an upward corrective pattern. These results are consistent with the Uncertainty Information Hypothesis introduced by Brown, Harlow, and Tinic (1988, 1993).

INTRODUCTION

The price movement of equity indices after sharp price changes has been the subject of many studies in recent years. These studies relate to the overreaction and underreaction of equity markets in behavioral finance. According to the Overreaction Hypothesis (OH) introduced by DeBondt and Thaler (1985), investors tend to overreact to positive (negative) news by setting stock prices above (below) their intrinsic values at the time of announcement of good (bad) news. Due to this overreaction, the subsequent price movement of a stock market index will take a reversal trend, meaning that the subsequent price trend will be downward (upward) for the case of good (bad) news. In this case, there may be an opportunity for abnormal returns by taking a short (long) position after good (bad) news.

An opposing view is the Uncertain Information Hypothesis (UIH). Based on the UIH introduced by Brown, Harlow, and Tinic (1988 and 1993), the arrival of unexpected news (good and bad) increases market risk and induces investors to set equity prices below their fair values upon the arrival of both good and bad news. The subsequent price movement of an equity index will take an upward trend after the announcement of both good and bad news. If the subsequent price movement of the index follows the price pattern indicated by the UIH, then there may be an opportunity for abnormal returns by taking a long position after the initial positive and negative sharp price changes. Figure 1 in the appendix displays subsequent price adjustment patterns in reaction to the arrival of unexpected good and bad news under

OH and UIH. Panel A illustrates a pattern that is consistent with the OH hypothesis, where price adjustments show a reversal in response to unexpected information. Panel B shows the pattern of price adjustments as hypothesized by UIH, whereby price adjustments are positive or at least non-negative.

The purpose of this study is to examine the subsequent price movements (following a sharp price change) of the two major equity indices in India, namely the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). If there exists a consistently significant price movement subsequent to sharp price changes, then there is a possibility of designing an investment strategy to earn abnormal profit.

LITERATURE REVIEW

There are numerous academic research studies on investors' reaction to unexpected price changes in the equity markets of US and Europe[1]. Several other studies examine the investors' reaction to sharp price changes in the emerging markets[2]. There is also a limited number of studies focused on the emerging markets of Southeast Asia: Ajayi and Mehdian (1994) study Hong Kong and Korea stock markets; Chan (1996) examines the Hong Kong equity market; Wang et al. (2000), Yeh and Lee (2000), and Rezvanian et al. (2011) investigate the Chinese equity markets. To address comparative investors' overreaction in different countries, a few other studies, such as Lasfer et al. (2003), investigate investors' reaction to sharp price changes in both advanced and emerging markets. Others, such as Mazouz et al. (2009), examine price behavior of ten different Asian market indices after a sharp price decline. The results of all these studies generally indicate that, in most cases, investors' reaction to sharp price changes tends to agree with the Overreaction Hypothesis. They also suggest that there is a significant price reversal in equity markets after a sharp price change. This supports a contrarian investment strategy, which recommends purchasing a losing stock and selling a winning stock in order to earn an abnormal profit.

To the best of our knowledge, there are only two recently published papers that partially examine the overreaction of investors in the equity markets of India. Rastogi et al. (2009) examine both the Momentum and Overreaction phenomena in the Indian equity markets. They also include the effect of size in their study. Their results indicate that stocks of all size categories initially under-react to new information, thereby exhibiting momentum in the short run. Further, they show that there is investors' overreaction only in the low and high cap stocks. Khelifa et al. (2009) study the short-term price behavior of ten Asian stock indices, including the Bombay stock index. They show that the price reaction of investors after initial sharp price changes within the ten-day window depends on the magnitude and direction of a price shock.

They report that there is a substantial variation in the effects of shocks across the ten stocks indices, indicating that the price reaction varies by country. In the case of India, with a price shock of (+/-) 3% to 5%, they report positive (negative) Cumulative Abnormal Returns (CARs) following positive (negative) shocks, but their finding is not statistically significant. They also report a similar trend for the price shock range between +/- 5% and 10%. Only for extremely sharp price changes, i.e., greater than (+/-) 10%, do they show evidence of overreaction to both positive and negative price shocks.

OVERVIEW OF INDIA'S EQUITY MARKETS

The Indian equity market has grown into the third largest in the Asian region (excluding Japan and after China and Hong Kong) with a market capitalization of about $600 billion. The Indian equity market has twenty-three stock exchanges and over 9000 listed companies. The larger companies are listed on the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). The smaller and medium companies are listed with OTCEI (Over the Counter Exchange of India). The functions of the Indian Equity Market are supervised by SEBI (Securities Exchange Board of India). SEBI is the regulatory body for the Indian securities market. It was established in 1992 shortly after major economic reforms began in 1991. SEBI was granted statutory powers to control and supervise operations of all participants in the

Indian capital markets. In 1992, the Office of the Controller of Capital Issues (CCI) was abolished, and the administrative controls over the pricing of new equity issues were eliminated.

The Indian Equity Market has its origins in the 18th century, when shares of the East India Company were traded. However, until the end of the 19th century, the trading of securities was unorganized and the main trading centers were Calcutta (now Kolkata) and Bombay (now Mumbai). The Bombay Stock Exchange (BSE) was established in 1875. It was initially named the "Native Share and Share Broker Association." Until the early 1990s, the Indian Equity Market was heavily regulated by the Government of India. The onset of economic liberalization in 1991 brought about dramatic changes to the Indian Equity Market. Many restrictive laws were repealed, and the Securities Exchange Board of India (SEBI) became the principal regulator with powers similar to those of the Securities Exchange Commission (SEC) in USA. Unfortunately, the era of liberalization also saw some major scams that shook the confidence of the investors in the Indian equity market.

Two new stock exchanges, NSE (National Stock Exchange of India), established in 1994, and OTCEI (Over the Counter Exchange of India), established in 1992, gave the BSE (Bombay Stock Exchange) nationwide competition. In 1995-96, an amendment was made to the Securities Contracts (Regulation) Act of 1956 introducing options trading.

The BSE operated an open outcry trading system until 14 March 1995. This was replaced by a fully automated computerized trading system known as the BOLT (BSE On Line Trading) system. BOLT follows both order and quote-driven systems and facilitates efficient processing, automatic order matching, and faster execution of trades. Trading on the BOLT is conducted from Monday to Friday between 9:55 a.m. and 3:30 p.m. Transactions in "A" group stocks (stocks with largest market capitalization and turnover) can be carried forward from one settlement period to another and from the date of original transaction without any restriction as to the number of days. Transfer of ownership of securities is enabled through a date-stamped transfer deed, which is signed by the buyer and seller.

In April 1995, the National Securities Clearing Corporation (NSCC) and in November 1996, the National Securities Depository Limited (NSDL) were set up for demutualized trading, clearing, and settlement. In February 2000, permission was granted for Internet trading and from June 2000, futures trading started. From 1 July 2001 forward, trading transactions (or "Badla") were discontinued and rolling settlement in all shares was introduced.

The Indian stock market has now evolved into one of the most important emerging markets in the world. Important regulatory changes—including improved market surveillance, improved trading mechanisms and the introduction of new financial instruments—have made it attractive for international investors. The rapid influx of Foreign Institutional Investors (FIIs) and the very impressive growth of the Indian corporate sector and mutual fund industry have further added to the allure of the Indian stock market. During the past few years, the Indian stock market has witnessed many important developments, including the introduction of screen-based trading, a depository system, derivative instruments, rolling settlement, etc. These changes, combined with the move toward greater transparency and market efficiency, have totally transformed the Indian stock market and have made it an attractive destination for both foreign institutional and individual investors.

The decision by the Reserve Bank of India, India's Central Bank, to allow foreign investment up to 49% in stock exchanges, depositories, and clearing corporations has resulted in many foreign players picking up stakes in Indian entities. Examples include:

- a 5% stake in the BSE by German Deutsche Boerse, Europe's leading stock exchange and transaction service provider,
- a 5% stake in the NSE by the New York Stock Exchange in the United States of America,
- and a 5% stake in the NSE by Goldman Sachs in addition to a stake in the Multi Commodity Exchange (MCX), India's largest commodity exchange.

Furthermore,

- other parties interested in investing in the BSE include the Singapore Stock Exchange and the NASDAQ in the United States of America,
- and it has been reported that the China Shanghai Stock Exchange and the South Korean stock exchange are interested in buying stakes in the Over the Counter Exchange of India (OTCEI).

The Indian equity market has attracted major global investors, primarily because of the fact that India's Gross Domestic Product (GDP) has been growing at a rate of about 8% for the past few years. The growth rate is expected to accelerate as India starts reaping the "demographic dividend." About 600 million in India are under the age of 25. The international exchanges believe that investments in Indian Stock Exchanges complement their global strategy and expand their reach. India is now the fourth largest country in the world in terms of Purchasing Power Parity (PPP). With the expected continuation of the current growth rate, it is likely to soon overtake Japan and become the third largest, just behind the US and China.

India now has become one of the most widely tracked emerging markets, with almost 1,000 Foreign Institutional Investors registered with the Securities Exchange Board of India (SEBI). The National Stock Exchange (NSE) has now become one of the top ten stock exchanges in the world in terms of trading volume. The BSE is second only to the NSE in trading volume but leads the NSE in terms of number of listed companies. The BSE existed as an association of persons for more than a century. But it was turned into a limited liability company last year. The regional stock exchanges in India are planning to consolidate before they go public. The top nine regional exchanges in India have approached the SEBI for access to both the NSE's and the BSE's trading platforms.

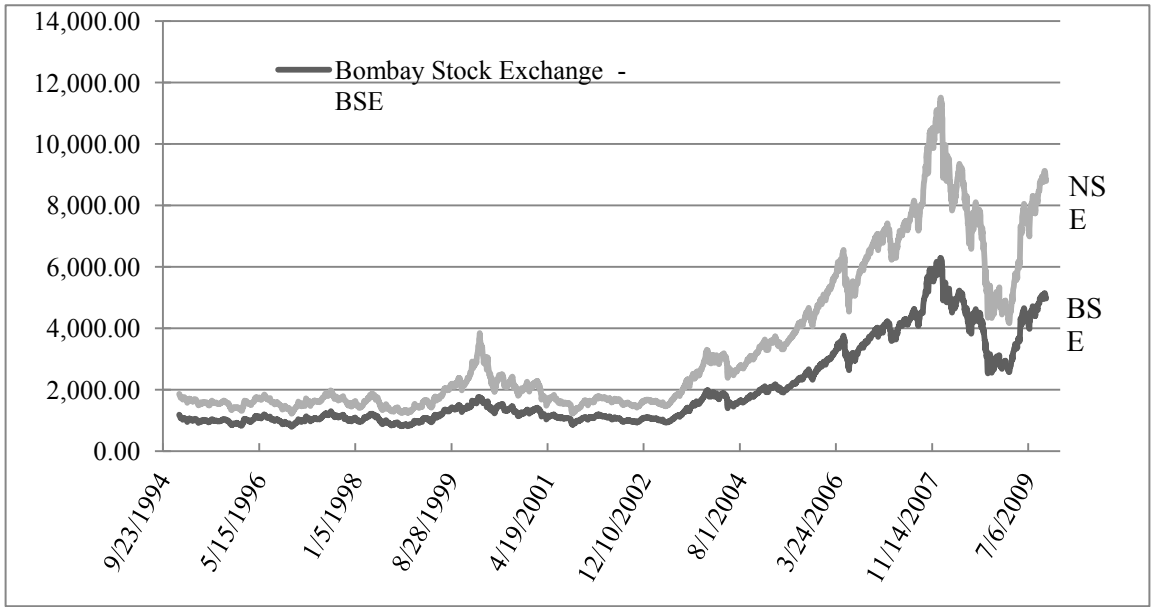
At the start of the year 2010, the BSE Index (the Sensex) touched the 17,500 mark. It has since crossed the 20,000 level. The inflow of funds from the Foreign Institutional Investors (FIIs) has crossed the 1 trillion rupee mark. The flow of funds into the Indian equity market occurs both through FIIs as well as through domestic investors, such as banks, insurance companies, hedge funds, mutual funds, and pension funds. The biggest Initial Public Offering (IPO) in Indian corporate history was that of Coal India. This offering was subscribed 15.28 times. The amount of funds mobilized through this IPO in just four days was 2.36 trillion rupees. This was more than the GDP of about 140 countries! Another public sector undertaking, Manganese Ore India Limited, which is the largest manganese company in India, is planning the second biggest IPO in Indian corporate history after the phenomenal success of Coal India's IPO. The Indian automotive sector is also poised to do well due to strong domestic demand. An important change, effective 1 October 2010 and affecting the Indian mutual fund industry, is that the mutual funds are now required to devise and implement a client identification program as well as authenticate the records of the identities and addresses of investors as per the provisions of the Prevention of Money Laundering Act of 2002 and guidelines issued by SEBI.

DATA AND RESEARCH METHOD

Data

In this study, we focus our attention on investors' reaction to sharp price movements in market indices rather than on individual stocks[3]. We use daily closing values of the Bombay Stock Index in India from January 2, 1995 through October 26, 2009. Figure 2 shows the trend of this index for the period under this study.

FIGURE 2
TREND OF INDIA'S EQUITY MARKET INDICES FROM INCEPTION TO 10/26/2009



After a long stagnant period until early 2003, the value of the Bombay Stock Exchange took a sharp increase and reached its peak at the end of 2007. Starting in early 2008, due to global financial crises, similar to other equity markets in different parts of the world, the index took a sharp downturn. The index then took an upward trend starting in the middle of 2009.

Table 1 presents summary statistics of the daily returns for the Bombay Stock Exchange, the National Stock Exchange, and several selected Pacific Basin countries for comparison.

TABLE 1
SUMMARY STATISTICS (IN %) FOR THE TWO MARKET INDICES OF INDIA AND THE MARKET INDICES OF SELECTED PACIFIC BASIN COUNTRIES

Index	Days	Mean (%)	Std. Dev. (%)	Maximum (%)	Minimum (%)
Shanghai A	4,311	0.117	3.041	110.68	-16.83
Shanghai B	4,012	0.039	2.288	14.82	-12.82
Shenzhen A	4,222	0.081	2.494	34.41	-17.83
Shenzhen B	3,829	0.055	2.245	14.8	-15.38
KSE[a]	4,730	0.0327	1.765	8.5	-12.02
STI[b]	4,436	0.0357	1.336	17.87	-18.53
KL[c]	4,352	0.0320	1.505	23.14	-21.46
AO[d]	4466	0.0334	0.827	6.254	-7.262
Nikkei	4,344	0.0021	1.262	7.55	-7.062
BSE[e]	3,640	0.0427	1.769	14.49	-11.931
NSE[f]	3,657	0.0393	1.742	16.334	-13.054

[a] Korea Composite Stock Price Index; [b] Straits Times Index (STI) Singapore; [c] Kuala Lumpur Composite Index (Malaysia) ; [d] All Ordinaries (Australia) ; [e] Bombay Stock Exchange (India) ; [f] National Stock Exchange (India)

As is evident from Table 1, the Bombay Stock Exchange (BSE) index exhibits higher average returns than other Asian regional indices, except for three Chinese indices (Shanghai A, Shenzhen A, and Shenzhen B). In terms of risk, measured by a range of returns and standard deviations, the Bombay equity index carries higher risk than any of the other Asian regional indices, except the three Chinese mainland equity indices mentioned above.

Research Method

We calculate the daily returns of the Bombay equity market index as follows:

$$R_{it} = ln\ (\ I_{it} / I_{it\text{-}1}) \times 100 \qquad (1)$$

Where R_{it} is the daily return of stock index *i* on day *t*, I_{it} and $I_{it\text{-}1}$ are the closing values of stock index *i* on days *t* and *t-1* respectively, *i* represents the Bombay market index used in this study, and *ln* is a natural logarithm. A similar analysis was conducted in regard to the National Stock Exchange (NSE) index[4].

To identify price shocks, we select a set of event days that are translated into large price changes in Bombay and National equity indices. Researchers have defined large price shocks in different ways, and no uniform definition prevails (Lasfer, Melnik, and Thomas 2003)[5]. We apply three thresholds of large price changes: positive and negative daily price changes of 3 percent or more; two standard deviations from the mean of market returns; and three standard deviations from the mean of market returns. The event days are labeled "favorable (unfavorable)" if the sign of change is positive (negative), and if the amount of the price change is greater (less) than or equal to each of the above three thresholds. In order to examine the reaction of investors to the previously defined favorable and unfavorable news, we track the daily price movements following each of the positive and negative price shocks using a thirty-day window. Some studies, such as Howe (1986), Brown and Harlow (1988), and Ketcher and Jordan (1994), suggest that correction to the overreaction takes place in a short time, in the next day or two , after the initial price change. However, other studies, such as Chan (1988), Ball and Kothari (1989), Chen and Sauer (1997), and Rezvanian et al. (2011) take a long-term view and examine the subsequent price movement of the market index up to forty days after the initial sharp price changes. There were some instances where successive price shocks fell within the thirty-day trading window after an initial price shock. We suspect that such successive price shocks may distort the effect of the initial price shock and may result in under-estimation of the price change (if negative), or its over-estimation (if positive). To eliminate this "double" counting of price movements following shocks, we withdraw any price shock that is followed by another one within the defined trading day windows of the previous shock. Table 2 provides the number of event days for the three defined price change thresholds used in this study. We also provide the remaining event days after dropping the event days that fell within the thirty-day trading window after an initial price shock.

TABLE 2
NUMBER OF EVENT DAYS FOR THE THREE MEASURES OF SHARP PRICE CHANGES

Panel A: Bombay Stock Exchange

	Measures of Price Changes	+/- 3%	Mean +/- 2std	Mean +/- 3std	Total
Number of event days	Positive	143	75	24	242
	Negative	167	118	34	319
	Total	310	193	58	561
Remaining event days*	Positive	18	13	10	41
	Negative	16	21	10	47
	Total	34	34	20	88

Panel B: National Stock Exchange

	Measures of Price Changes	+/- 3%	Mean +/- 2std	Mean +/- 3std	Total
Number of event days	Positive	126	78	25	229
	Negative	154	109	31	292
	Total	280	185	56	521
Remaining event days*	Positive	17	15	12	44
	Negative	24	23	7	54
	Total	41	38	19	98

*Remaining event days are the event days that remained after dropping the event days which fell within the thirty day trading day window of the previous price shock.

As is evident from Table 2, there is a total of 561 event days for the three measures of sharp price changes identified for the Bombay Stock Exchange—of which 242 days represent positive event days and the remaining 319 negative event days. For the National Stock Exchange, the total number of event days identified is 521, of which 229 represent positive event days and 292 negative event days. As explained above, to avoid any double counting effects, for each index, we drop the event days that occur within thirty days of the previous price shock. The second part of Table 2, Panels A and B, present the remaining event days. For the Bombay Stock Exchange (National Stock Exchange), there are 88 (98) remaining event days, of which 41 (44) event days represent the positive event days and 47 (54) event days represent the negative event days. Table 3 in the appendix presents the details of the remaining event days with the corresponding daily percentage price changes for each of the two indices and the three defined price changes. These are the event days on which we do our further analysis.

After identifying the event days, we track their price movements over the thirty-day post event window for both positive and negative price shocks.

To examine the volatility of stock indices after arrival of favorable and unfavorable news, we calculate the stock returns variance as follows:

$$Var = \left(\sum_{t=1}^{N_j} \left(R_{it} - \overline{R}_{ij} \right)^2 \right) \left(1 / N_j - 1 \right) \tag{2}$$

where

N_j = number of days in each category of j (j = 1 for all post-event days, j = 2 for favorable events, j = 3 for unfavorable events, and j = 4 for non-event days)

R_{it} = daily return of stock index *i* (Bombay) on day *t*

$\overline{R}$ = the average return of each category (post-event or non-event days)

We perform an F-test in order to test whether the volatility of post-event days is different from the volatility of non-event days. The null hypothesis is that the variance of returns during the post-event windows is equal to the variance of returns for the non-event days. It follows that the rejection of the null hypothesis provides evidence to indicate that there is a statistically significant difference between the level of risk during non-event periods and the level of risk in the post-event periods. We would expect the variance of returns in post-event windows to be significantly greater than the variance of returns for non-event days in order to establish that the arrival of unexpected information increases the post-event market volatility. We employ the same approach to test for the difference in risk between post-favorable events and post-unfavorable events. Table 4 provides the total number of days and variance of daily returns, along with the results for the F-tests for non-event days, and post-event days (positive post-event days and negative post-event days)[6].

TABLE 4
COMPARATIVE VARIANCE OF RETURNS AND F-TEST FOR EVENT DAYS (POSITIVE AND NEGATIVE) FOR THREE MEASURES OF SHARP PRICE CHANGES FOR THE TWO INDICES

Panel A: Price changes of +/- 3%

	Sample	Days	Variance (%)	F-test
Bombay Stock exchange	Non-event days	1,240	0.0422	a = 2.34***
	All post-event days	1,020	0.0927	b = 2.12**
	1) Positive event-days	540	0.1132	c = 1.98***
	2)Negative event-days	480	0.1247	d = 2.24*
National Stock exchange	Non-event days	990	0.0563	a = 2.02***
	All post-event days	1,230	0.8863	b = 1.96***
	1) Positive event-days	510	0.1231	c = 2.02***
	2)Negative event-days	720	0.1325	d = 1.67**

Panel B: Price Changes of Mean +/- 2 std

	Sample	Days	Variance (%)	F-test
Bombay Stock exchange	Non-event days	1,666	0.0458	a = 2.08***
	All post-event days	1,020	0.0821	b = 2.21***
	1) Positive event-days	390	0.0976	c = 2.11***
	2)Negative event-days	630	0.1238	d = 1.72**
National Stock exchange	Non-event days	1,635	0.0536	a = 2.23***
	All post-event days	1,140	0.8758	b = 1.69*
	1) Positive event-days	450	0.0556	c = 1.93**
	2)Negative event-days	690	0.0998	d = 1.88**

Panel C: Price Changes of Mean +/- 3 std

	Sample	Days	Variance (%)	F-test
Bombay Stock exchange	Non-event days	2,812	0.0652	a = 2.34***
	All post-event days	600	0.0873	b = 2.12***
	1) Positive event-days	300	0.0652	c = 1.98***
	2)Negative event-days	300	0.1221	d = 2.24***
National Stock exchange	Non-event days	2,847	0.0702	a = 2.02***
	All post-event days	570	0.0953	b = 1.96***
	1) Positive event-days	360	0.0853	c = 2.02***
	2)Negative event-days	210	0.1220	d = 1.67*

a) F-statistics value to test the null hypothesis that the variance of returns for non-event days is equal to the variance of returns for all post-event days.

b) F-statistics value to tests the null hypothesis that the variance of returns for positive event-days is equal to the variance of returns for non-event days.

c) F-statistics value to test the null hypothesis that the variance of returns for negative event-days is equal to the variance of returns for non-event days.

d) F-statistics value to test the null hypothesis that the variance of returns for positive event-days is equal to the variance of returns for negative event-days.

***, **, * indicates significant at 0.01, 0.05, and 0.1 levels, respectively

To calculate the Cumulative Abnormal Returns (CARs) for windows (positive and negative) for each of the three defined price changes post windows, we first calculate abnormal returns as the deviation of each return from the mean return of the non-event days for each index *i* on day *t* (t = +1…. +30) following an unexpected event *d.* Formally,

$$AR_{itd} = R_{itd} - \overline{R_{i3}} \tag{3}$$

where

AR_{itd} = Abnormal return for stock index *i* on day *t*, given event *d*
d = 1….n, where *n* represents each of the positive and negative price shocks.
R_{itd} = Return of index *i* on day *t* for event *d*
$\overline{R_{i3}}$ = Mean return of index *i* for non-event days.

Thus, the abnormal return AR_{itd} measures the difference between stock returns on each of the days within each window following a price surprise and the mean stock return for all non-event days.

Having calculated the abnormal return (AR_{itd}) as above, we then calculate, in a second step, the mean of abnormal returns ($\overline{AR_{it}}$) for index *i* on day *t* as:

$$\overline{AR_{it}} = (1/n)\left(\sum_{d=1}^{n} AR_{itd}\right), \quad t = +1..... + 30 \tag{4}$$

Finally, the CARs are generated by using the following equation:

$$CAR_{it} = CAR_{i(t-1)} + \overline{AR}_{it} \tag{5}$$

We perform a standard t-test to test whether the calculated CARs are statistically different from zero. The t-statistic is obtained as:

$$t = \frac{CAR_{it}}{\left[Var\ \left(CAR_{it}\right)\right]^{1/2}} \tag{6}$$

If the values of CARs following positive and negative price shocks are statistically significantly positive (or at least non-negative), then the reaction of investors is consistent with the prediction of the UIH. Alternatively, if the CARs exhibit a statistically significant corrective price reversal pattern [negative (positive) CARs following positive (negative) price shocks], then investors' reaction is consistent with the prediction of the OH.

EMPIRICAL RESULTS

As is evident from Table 4, for both indices, the variance of post-event days and its components (post-event positive and post-event negative event days) is higher than the variance of non-event days. At the same time, for each market index, the variance of returns in the negative post-event days is higher than the variance of returns in the positive post-event days. The results of the F-test, given in Panels A-C of Table 4, also statistically reject the null hypothesis of equality of variance of returns in non-event days compared to post-event days. This indicates that the arrival of information (good and bad news) to the markets increases volatility of market returns. However, the markets react to the arrival of bad news more strongly than they react to the arrival of good news, and this reaction is more pronounced in the National Stock Exchange than in the Bombay Stock Exchange. This result contradicts the findings of Khelifa

(2009), who reported that post-event volatility of the accumulative abnormal returns did not increase after the price shock[7].

Using equations 3-6, we calculated Cumulative Abnormal Returns (CARs), applying a thirty-day post-event window. Table 5 Panels A and B in the appendix, provides the CAR values along with the t-statistics for the three measures of price changes. Panel A reports the CAR values after price shock for the Bombay Stock Exchange, and Panel B provides similar information for the National Stock Exchange. As is evident from the first few columns of Panel A of Table 5, the price trend after a positive shock for the three price change measures follows a clear pattern. For the Bombay Stock Exchange, the CAR values for the three measures of price shock gradually increase and reach their maximum level around thirty days after the initial price shock. The CAR values after a positive price shock for National Stock Exchange, as reported on the first few columns of Panel B of Table 5, do not follow a clear pattern except for the largest price shock measure of mean +/-3 standard deviations.

The same trend is presented in Figure 3. The above results indicate that, for both indices, the investors under-react to positive price shock, and the post-positive shocks are followed by subsequent positive abnormal returns. This subsequent positive abnormal return is more pronounced in the Bombay Stock Exchange than in the National Stock Exchange.

Panels A and B of Table 5 also present the Cumulative Abnormal Returns after negative price shock for the two indices. Review of the subsequent price movements after a negative price shock indicates a price reversal in both markets after the initial shock. The price reversal is clearer and stronger in the National Stock Exchange than in the Bombay Stock Exchange and more pronounced for larger negative price shocks (mean +/-2 std, and mean +/- 3 std) than for the smaller price shock (+/- 3%). For example, in the case of the National Stock Exchange and for the largest price shock measure (mean +/- 3 std), the CARs increase from 0.621% in the day that follows the negative price shock to 6.613% in the following thirty days. Similar patterns of price reversal, much less clear and with low magnitude, can also be seen in the Bombay Stock Exchange. For example, a clear pattern of price reversal for the negative price shock measured as the mean +/- 2 std exists in the Bombay Stock Exchange, but not for the other two price shock measures. It appears that investors in India overreact to the initial negative price shock by setting the equity prices much lower than their fundamental prices, and therefore, the subsequent price reversal is higher, which creates an opportunity to earn a large abnormal return after the initial negative price shock.

SUMMARY AND CONCLUSIONS

In this paper, we examine investors' reactions to sharp price changes using the two major equity markets in India, namely, the Bombay Stock Exchange and National Stock Exchange. We measure investors' reaction to sharp price changes by calculating Cumulative Average Returns of each index within thirty days after sharp price changes and using three thresholds of large price change definitions: positive and negative daily price changes of 3 percent or more, and two and three standard deviations from the mean of market returns. Based on our analysis of daily data from January 2, 1995 through October 26, 2009, our results indicate that: (a) The arrival of unexpected news in the equity markets in India, which causes a sharp price change, also introduces a price shock that increases market volatility; (b) the subsequent price adjustments within thirty days following the arrival of both favorable and unfavorable news have an upward corrective pattern; and (c) the price reversal is more pronounced in the National Stock Exchange (than in the Bombay Stock Exchange), and much stronger for larger negative price shocks (mean +/-2 standard deviations, and mean +/-3 standard deviations) than for smaller (+/- 3%) and positive price changes. The results shown here indicate that the arrival of unexpected information in equity markets in India increases market volatility and causes investors to overreact to the arrival of unexpected information by setting the equity prices below their true value. Within the next thirty days after the arrival of unexpected news, investors overcome their overreaction and cause an upward adjustment in the subsequent price trend. This reversal process of price adjustment is more pronounced in the National Stock Exchange and for large negative price changes. These results are consistent with the Uncertain Information Hypothesis (UIH) introduced by Brown, Harlow, and Tinic (1988 and 1993).

ENDNOTES

[1] The recent studies include Brown et al. (1988 and 1993), DeBondt and Thaler (1985 and 1987), Kadiyala and Rau (2004), Atkins and Dyl (1990), Park (1995), Ajayi and Mehdian (1994), Mun et al. (1999), Nam et al. (2001) and Ciubanu et al. (2008).
[2] The recent studies include: Da-Costa (1994) for Brazil; Brailsford (1992); Allen and Prince (1995), and Gaunt (2000) for Australia; Diacogiannis et al. (2005) for Greece; Bowman and Iverson (1998) for New Zealand; Alonzo and Gonzalo (1990) for Spain; Mehdian et al. (2004) for Turkey.
[3] With the exception of Richards (1996, 1997), Nam et al. (2001), Lasfer, Melnik, and Thomas (2003), and Ajayi and Mehdian (2004), other studies employ individual stock price data (rather than market index data) to examine investors' reaction to unexpected extreme price movements.
[4] We also performed Dickey-Fuller unit root test on each data series to test for stationarity of the series. The results, not reported, provide evidence to indicate that all return series used are stationary in their first differences.
[5] Howe (1986) considers weekly price changes exceeding 50 percent as large; Brown, Harlow and Tinic (1998) and Park (1995) use market model residuals to categorize large changes; Atkins and Dyl (1990) identify stocks with the largest single day price change in a 300-day window; Bremer and Sweeney (1991) classify price changes of at least 10 percent as large; Lasfer et al. (2003) define large price shocks as those recorded when returns exceed two standard deviations of the average market daily return.
[6] Non-event days are calculated by subtracting the event days and thirty trading days following the event days. We also subtracted the event days and the days following the event days where successive price changes fell within the thirty-day trading window after the initial price shock.
[7] This conclusion is based on the information using the price change of +/- 3%. It is not given in Table 4, but the results of the F-test using other measures of price changes (Mean +/- 2std, and Mean +/- 3std) lead to the same conclusion. We decided not to report them in the paper to save space.

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APPENDIX

TABLE 3
EVENT DAYS AND CORRESPONDING PRICE CHANGES (IN %)

Panel A: Bombay Stock Exchange

	Positive corresponding price changes			Negative corresponding price changes		
Date	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**
02/24/95	3.20	----	----	----	----	----
02/09/96	----	4.60	----	----	----	----
02/29/96	----	----	----	3.25	----	----
10/07/96	----	----	----	----	3.55	----
10/23/96	3.41	----	----	----	----	----
01/01/97	----	----	5.74	----	----	----
03/31/97	----	----	----	----	----	7.65
04/09/97	3.49	----	----	----	----	----

06/30/97	3.23	----	----	----	----	----
08/28/97	----	----	----	3.07	----	----
11/24/97	----	----	----	3.09	----	----
03/31/97	----	----	----	----	7.65	----
01/12/98	----	----	----	----	3.56	----
03/02/98	----	4.23	----	----	----	----
03/23/98	3.44	----	----	----	----	----
06/17/98	----	----	7.36	----	----	----
06/29/98	----	3.86	----	----	----	----
08/20/98	3.32	----	----	----	----	----
10/05/98	----	----	----	----	----	6.92
10/26/98	----	4.09	----	----	----	----
11/09/98	3.22	----	----	----	----	----
03/01/99	8.69	8.69	8.69	----	----	----
04/17/99	----	----	----	----	----	6.63
05/31/99	4.52	4.52	----	----	----	----
07/12/99	4.97	4.97	----	----	----	----
11/02/99	5.80	5.80	5.80	----	----	----
01/03/00	----	7.51	7.51	----	----	----
02/29/00	----	----	----	----	----	5.24
05/08/00	----	----	----	----	----	5.16
06/21/00	----	----	----	3.61	3.61	----
07/24/00	----	----	----	----	----	6.27
07/26/00	----	----	----	----	3.63	----
08/08/00	3.17	----	----	----	----	----
09/22/00	----	----	----	----	----	5.15
11/13/00	----	----	----	----	3.66	----
12/22/00	----	----	----	----	4.05	----
03/14/01	----	----	5.77	----	----	----
04/27/01	----	----	----	----	4.78	----
04/30/01	3.52	----	----	----	----	----
07/03/01	----	----	----	3.02	----	----
09/17/01	----	----	----	----	----	6.57
09/21/01	----	----	----	----	4.81	----
09/29/01	3.26	----	----	----	----	----
02/28/02	----	----	----	----	4.07	----
03/01/02	3.08	----	----	----	----	----
04/24/02	4.33	----	----	----	----	----
05/24/02	----	4.33	----	----	----	----
12/06/02	3.54	----	----	----	----	----
04/10/03	----	----	----	3.89	3.89	----
09/15/03	----	----	----	----	4.04	----
09/18/03	----	----	----	3.03	----	----
01/23/04	----	5.17	----	----	----	----
03/15/04	----	----	----	3.08	----	----
05/28/04	----	----	----	4.56	4.56	----
01/05/05	----	----	----	3.07	----	----
04/15/05	----	----	----	3.04	----	----
09/22/05	----	----	----	3.45	3.45	----
06/15/06	----	----	6.85	----	----	----
07/17/06	----	----	----	----	3.53	----
07/20/06	3.28	----	----	----	----	----
09/11/06	----	----	----	3.09	----	----

12/12/06	----	----	----	3.35	----	----
04/02/07	----	----	----	4.55	4.55	----
08/16/07	----	----	----	----	4.42	----
02/17/07	----	----	----	----	4.40	----
03/25/08	----	----	6.24	----	----	----
03/31/08	----	----	----	4.32	4.32	----
07/23/08	----	----	6.21	----	----	----
07/29/08	----	----	----	----	3.86	----
11/11/08	----	----	----	----	----	6.24
01/07/09	----	----	----	----	----	7.12
02/02/09	----	----	----	----	3.55	----
04/02/09	----	4.47	----	----	----	----
05/18/09	----	----	16.75	----	----	----
07/14/09	----	3.72	----	----	----	----
Total # of obs.	18	13	10	16	21	10

Panel B: National Stock Exchange

	Positive corresponding price changes			**Negative corresponding price changes**		
Date	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**
01/23/95	----	----	----	3.19	----	----
03/16/95	----	----	----	3.99	3.99	----
05/02/95	----	----	----	----	3.59	----
05/05/95	3.02	----	----	----	----	----
11/13/95	----	----	----	3.38	----	----
02/29/96	----	----	----	3.45	3.45	----
04/24/96	4.40	4.40	----	----	----	----
05/29/96	3.15	----	----	----	----	----
07/23/96	----	----	----	3.02	----	----
01/15/97	----	5.17	----	----	----	----
01/16/97	----	----	----	3.16	----	----
02/28/97	----	----	5.94	----	----	----
03/31/97	----	----	----	----	----	8.84
04/09/97	3.90	3.90	----	----	----	----
07/09/97	3.15	----	----	----	----	----
10/29/97	6.96	6.96	6.95	----	----	----
01/12/98	----	----	----	3.72	3.72	----
03/03/98	----	----	----	3.21	----	----
04/15/98	----	3.93	----	----	----	----
06/17/98	----	----	7.04	----	----	----
06/24/98	----	3.69	----	----	----	----
08/20/98	----	3.56	----	----	----	----
08/28/98	----	----	----	3.20	----	----
10/05/98	----	----	----	----	7.36	7.36
10/26/98	3.36	----	----	----	----	----
02/27/99	----	4.17	----	----	----	----
03/03/99	3.49	----	----	----	----	----
04/26/99	----	----	----	----	----	5.30
05/31/99	4.78	4.59	----	----	----	----
07/12/99	----	4.78	----	----	----	----
08/18/99	3.03	----	----	----	----	----

10/07/99	----	----	5.38	----	----	----
11/02/99	4.78	4.78	----	----	----	----
01/03/00	----	----	7.28	----	----	----
01/11/00	----	----	----	----	3.77	----
05/02/00	----	----	----	----	----	5.34
05/11/00	----	----	----	4.39	4.39	----
07/24/00	----	----	----	5.86	5.86	5.86
09/22/00	----	----	----	----	4.88	----
10/11/00	----	----	----	3.04	----	----
03/14/01	----	----	6.00	----	----	----
04/27/01	----	----	----	3.78	3.78	----
09/17/01	----	----	----	----	----	5.30
09/21/01	----	----	----	5.09	5.09	----
11/19/01	3.09	----	----	----	----	----
02/28/02	----	----	----	----	4.05	----
03/01/02	3.10	----	----	----	----	----
05/27/02	3.44	----	----	----	----	----
04/10/03	----	----	----	4.34	4.34	----
08/26/03	----	3.64	----	----	----	----
09/24/03	3.25	----	----	----	----	----
01/23/04	----	4.26	----	----	----	----
02/19/04	----	----	----	3.08	----	----
05/28/04	----	----	----	5.02	5.02	----
07/08/04	----	----	----	3.15	----	----
01/05/05	----	----	----	3.46	3.46	----
04/15/05	----	----	----	3.47	3.47	----
09/22/05	----	----	----	----	3.60	----
09/26/05	3.16	----	----	----	----	----
06/15/06	----	----	6.11	----	----	----
07/17/06	----	----	----	----	3.78	----
07/20/06	3.03	----	----	----	----	----
09/11/06	----	----	----	3.08	----	----
12/12/06	----	----	----	3.51	3.51	----
04/02/07	----	----	----	5.04	5.04	----
08/16/07	----	----	----	----	4.48	----
10/23/07	----	----	5.44	----	----	----
03/25/08	----	----	5.81	----	----	----
03/31/08	----	----	----	4.29	4.29	----
07/23/08	----	5.43	5.81	----	----	----
07/29/08	----	----	----	----	----	----
11/11/08	----	----	----	----	----	----
11/21/08	----	----	5.50	----	----	----
01/07/09	----	----	----	----	----	6.18
02/02/09	----	----	----	----	----	----
04/02/09	----	4.81	----	----	----	----
05/18/09	----	----	17.74	----	----	----
07/06/09	----	----	----	----	6.02	----
07/14/09	----	----	----	----	----	----
Total # of obs.	17	15	12	24	23	7

TABLE 5
POST-EVENT CUMULATIVE ABNORMAL RETURNS (IN %)

Panel A: Bombay Stock Exchange

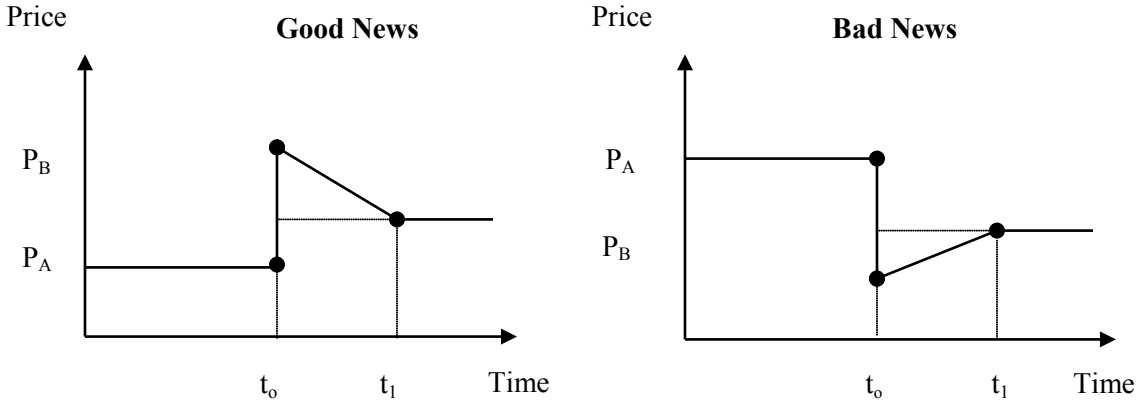
	CARs (positive) in%			CARs (negative) in%		
Days	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**
1	-0.012	0.749	0.491	-0.449	0.680	2.128
2	0.652	0.404	-0.664	-0.420	1.289	1.409
3	1.171	0.830	-0.809	0.047	1.592	0.164
4	1.020	0.783	-1.845	0.518	1.906	-0.914
5	1.049	1.183	-0.317	0.655	2.502	-1.361
6	1.212	0.693	-0.567	0.515	3.126	-2.064
7	1.595	0.970	0.182	0.731	3.225	-1.618
8	1.974	1.485	-0.043	0.952	3.466	-2.224
9	2.265	1.820	0.929	1.057	4.207	-3.226
10	2.019	1.515	1.803	0.888	4.294	-3.071
11	1.797	1.579	1.156	1.082	4.458	-3.298
12	1.868	2.161	1.002	1.569	4.399	-3.556
13	2.357	3.037	1.499	1.606	4.694	-2.824
14	2.493	2.968	2.003	1.274	4.901	-2.970
15	2.573	3.164	2.159	1.477	4.702	-1.663
16	2.548	3.647	2.418	1.734	4.568	-1.724
17	2.402	3.126	3.115	2.189	4.905	-1.069
18	2.023	2.352	2.926	1.855	4.716	0.114
19	2.365	1.728	2.079	2.033	4.806	0.387
20	3.119	1.576	1.540	1.722	5.044	0.584
21	3.179	2.045	2.794	1.751	5.145	1.543
22	3.068	2.740	2.667	1.895	4.914	1.986
23	2.746	2.330	2.635	1.760	4.490	1.202
24	2.974	2.415	3.044	1.506	4.052	1.295
25	2.478	3.062	2.876	1.925	4.038	1.710
26	2.652	4.323	3.422	2.025	3.901	1.743
27	3.009	4.666	3.375	1.537	4.768	1.591
28	3.178	5.231	3.786	1.148	4.884	1.964
29	3.376	5.650	4.506	0.469	4.831	2.328
30	4.210	6.497	3.852	1.072	4.800	1.811

Panel B: National Stock Exchange

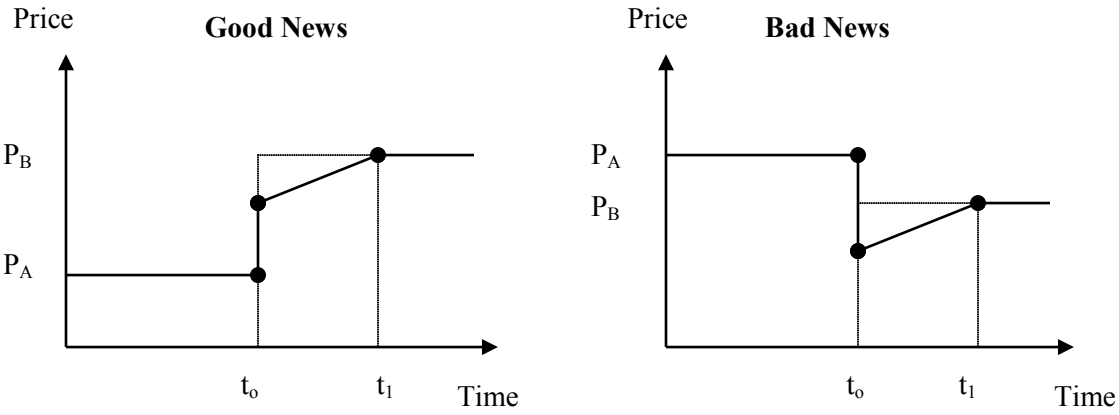
	CARs (positive) in%			CARs (negative) in%		
Days	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**	**+/-3%**	**Mean +/-2std**	**Mean +/-3std**
1	-1.122	-0.077	0.626	-0.052	0.361	0.621
2	-0.757	0.072	-0.430	-0.198	0.648	1.904
3	-0.440	0.169	-0.076	-0.042	1.002	2.001
4	-0.074	0.104	-0.263	-0.127	0.717	0.837
5	0.291	0.966	0.177	-0.085	0.878	0.841
6	0.713	0.731	-0.652	0.184	0.944	1.307
7	0.741	0.617	-0.293	0.155	1.027	1.519
8	0.761	0.880	0.028	0.155	1.158	1.290
9	0.764	0.952	0.029	0.369	1.549	1.649
10	0.843	0.761	0.285	0.170	1.322	1.896
11	0.735	0.655	0.377	0.320	1.297	1.756
12	0.641	0.854	-0.080	0.584	1.471	3.053
13	0.519	1.209	-0.177	1.070	1.995	3.296
14	0.712	0.689	-0.001	1.245	2.134	2.807
15	1.085	1.150	0.001	1.248	1.910	3.158
16	1.084	1.753	0.436	1.293	2.131	3.633
17	1.040	1.457	0.641	1.611	2.325	3.687
18	0.646	0.986	0.412	1.535	2.473	3.892
19	0.517	0.766	-0.814	1.496	2.561	4.589
20	0.041	0.328	-1.770	2.023	3.230	5.412
21	0.090	0.131	-1.007	2.295	3.697	5.730
22	-0.339	0.528	-1.363	2.224	3.698	4.852
23	-0.843	0.266	-1.403	2.086	3.418	5.213
24	-0.657	0.403	-0.995	1.774	3.360	6.235
25	-0.462	1.391	-1.137	1.897	3.108	6.810
26	-0.484	2.418	-0.977	1.994	3.370	6.266
27	-0.232	2.237	-1.425	2.236	4.083	6.293
28	-0.237	2.041	-0.913	2.786	4.659	6.876
29	-0.639	1.093	-0.401	2.839	4.656	6.303
30	0.073	1.477	-1.364	3.503	4.986	6.513

FIGURE 1
STOCK PRICE REACTION TO UNEXPECTED INFORMATION
FOLLOWING GOOD AND BAD NEWS

Panel A: OH

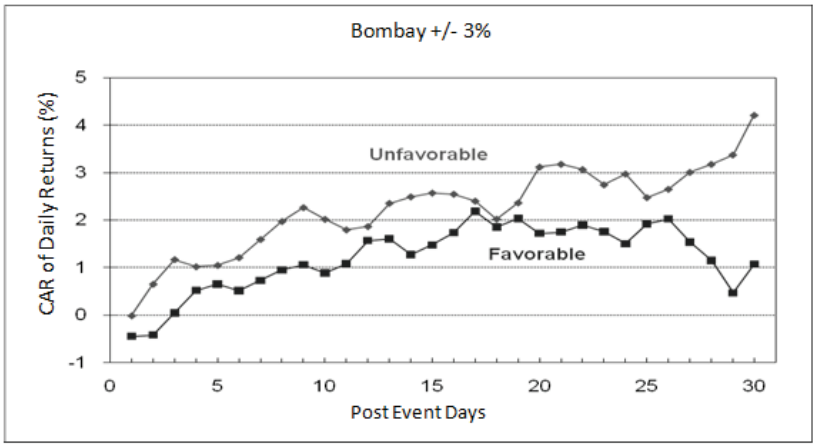


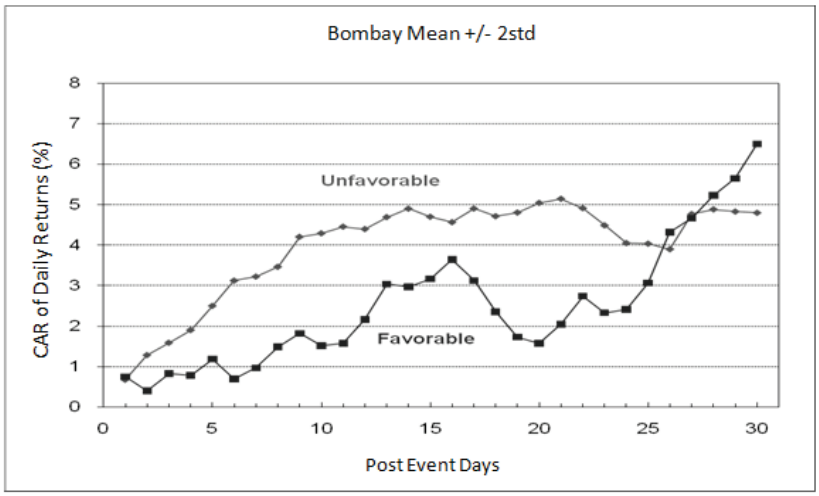
Panel B: UIH

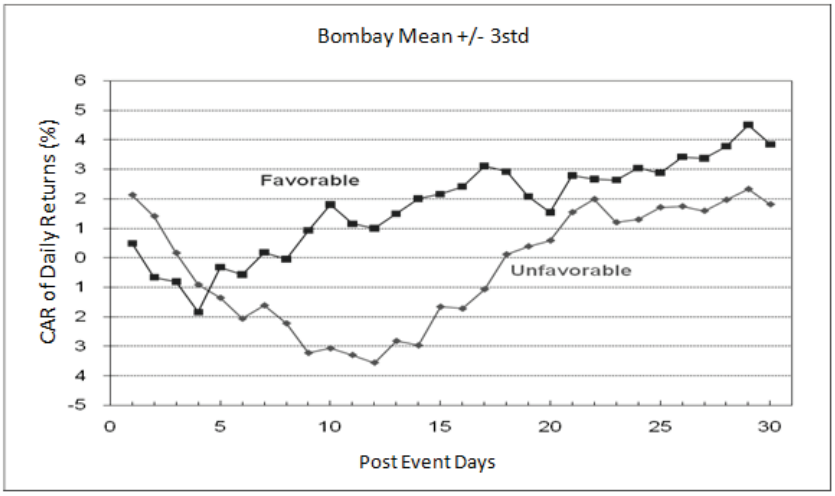


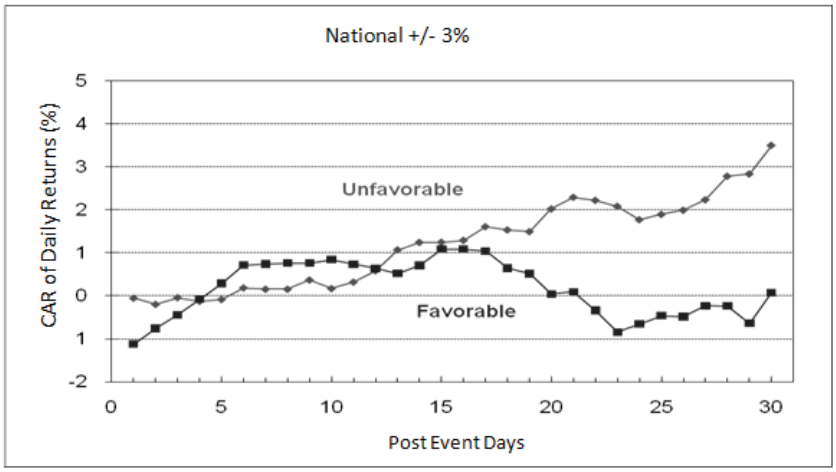
where
P_A = price before the news
P_B = price after the news

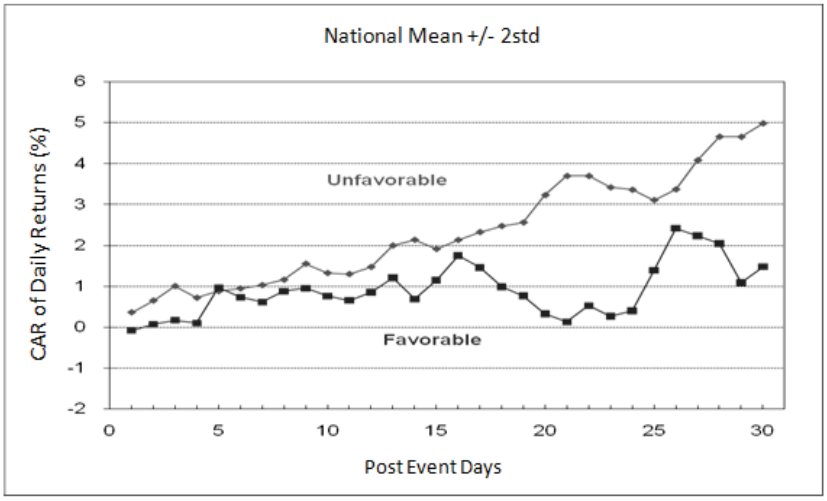
FIGURE 3
GRAPH OF CARS FOR THE TWO MARKET INDICES UNDER THE THREE MEASURES OF SHARP PRICE CHANGES

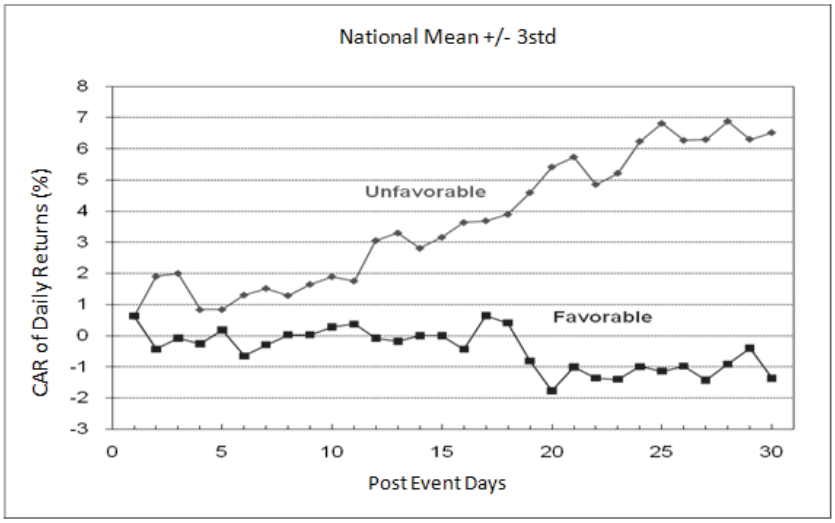







National +/- 3%
CAR of Daily Returns (%)
Unfavorable
Favorable
Post Event Days


National Mean +/- 2std
CAR of Daily Returns (%)
Unfavorable
Favorable
Post Event Days


National Mean +/- 3std
CAR of Daily Returns (%)
Unfavorable
Favorable
Post Event Days