Applying an alternative test of herding behavior: a case study of the Indian stock market

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ABSTRACT

The paper presents an alternative approach to test the herding behavior in the Indian equity market using symmetric properties of the cross sectional return distribution instead of the traditional standard deviation of the portfolio-based approach. Using the proposed approach, we find evidence of herding in the Indian market during the sample period. We also observe pronounced herding during the 2007 crash in the Indian equity market. Finally, we also observe that the rate of increase in security return dispersion as a function of the aggregate market return is lower in up market, relative to down market days, which stands contrary to the directional asymmetry documented by McQueen, Pinegar, and Thorley (1996).

1. Introduction:

Over the years, understanding the behavior of market participants has become a major challenge to researchers as well as practitioners. A number of papers have documented that the concept of rationality and the Efficient Market Hypothesis in finance have major shortcomings in modeling real life stock returns. Robert Shiller while analyzing the stock market crash of 1987 concluded that the crash was driven by human emotions instead of rational thinking by the investors. The Efficient Market Theory assumes that investors form rational expectations of future prices and discount all market information into expected prices in the same way. However, these assumptions of rationality underpinning the efficient market hypothesis are often challenged in reality as the observed returns display "herd behaviour" in many markets. The herding behavior describes a group of individuals who act to imitate the decisions of others or market in general without paying any attention to their own beliefs or information (Bikchandani and Sharma, 2000). Therefore, as under herding, the individual investors suppress their own private beliefs and imitate the market consensus, it has significant impact on security prices. Consequently, prices deviate from fundamental value, and the risk and return characteristics of stock prices get impacted.

A growing body of work has developed over the years, which have examined the herding behaviour across different scenarios. The theoretical models of herding behavior have been developed by Sunil Bhikchandani and Sunil Sharma (1992), Scharfstein and Stein (1990) and Devenow and Welch (1996). While the empirical studies have focused on testing herding in various events including cross country and cross market studies, Chan, Cheng and Khorana (2000), analyzed the herding behaviour in the US, Hong Kong, South Korea, Taiwan, and Japanese stock markets and have concluded against the existence of pervasive herding behaviour for most of their sample. In a more country specific studies Hwang and Salmon (2004), Demirer, and Kutan (2006), examined herding behavior in the stock market of South Korea and China, respectively. Herding behavior has also been examined in other markets, for example, the study by Gleason, Mathur and Peterson (2004) has tested herding for exchange traded funds and future markets. Wermers (1999) has tested the existence of herding behavior among mutual fund managers[1].

In the existing literature, barring a few exceptions, most of the empirical models of herding are based on Christie and Huang (1995) (hereafter referred to as CH) and Chang et al. (2000) (hereafter referred to as CCK) models[2]. Both CH and CCK models have used the cross sectional standard deviation (CSSD) and cross sectional absolute deviation (CSAD), respectively, across stock returns as a measure of average proximity of individual returns to the realized market return. In contrast, the paper proposes an alternative approach to test the

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[1] In a more recent paper, Tan, Chiang, Mason and Nelling (2007) have examined herding behavior in dual-listed Chinese A-share and B-share stocks. They found evidence of herding within both Shanghai and Shenzhen A-share markets that are dominated by domestic individual investors, and within both B-share markets, in which the foreign institutional investors are the main participants. Moreover, they found that herding is more pronounced under conditions of rising markets, high trading volume, and high volatility in Shanghai market, while no asymmetry was apparent in the B-share market.

[2] Hwang and Salmon (2004) have used other measure of herding.

herding behavior. This study complements the existing literature in two primary ways: First, the paper proposes an alternative methodology based on symmetric properties of the ensemble return distribution under herding. The methodology is based on the idea that investors under herding would suppress their own private beliefs and hence the security returns tend to be more symmetric towards the market return under herding. In contrast, the distribution would lack symmetry during the non-herding periods, which is consistent with the rational asset pricing model which predicts that the dispersion in returns will increase with the absolute value of the market return as investors would trade based on their diverse private information.

Second, practitioners and the popular press often ascribe the excess volatility in the emerging stock markets to the herding behaviour, which lead to market crash (e.g. Asian bubbles of 1997). Despite the speculation, no systematic study has attempted to test the herding behaviour particularly during the events of market crash. The paper therefore, aims to fill up this gap in the literature through a case study of the Indian stock market, particulary during the 2007 crash.

Over the years, India has emerged as one of the most favored destinations for foreign investors among the developing markets with one of the highest market capitalization. Since the liberalization of capital market in 1991, FII's investment in Indian equity market has crossed $60 billion[3]. The FII investment prospects for India are very bright considering the inherent advantages that the country has and its potential to absorb capital for its development and growth. Therefore, given the increasing importance of the Indian equity market as the most favored destination it is imperative for the Indian regulator to keep a constant vigil on herding in the market. The methodology proposed in this paper therefore can serve as an early warning system to detect the emergence of herding in the market.

The structure of the rest of the paper is as follows: Section 2 presents the methodology proposed in the paper to test the herding behaviour in the stock market and Section 3

[3] FII stands for Foreign Institutional Investors.

describes the data. Section 4 reports the empirical results, while section 5 concludes the paper.

2. Empirical Methodology:

Most of the empirical models of herding in the equity market are based on Christie and Huang (1995) and Chang et al. (2000) model. The rationale behind these models stems from the standard capital asset pricing model, which predicts a wider dispersion in returns across securities with increase in absolute value of the market return. However, in the presence of herd behaviour in which investors suppress their own rational beliefs to follow the collective decision in the market, security returns tend to converge towards the market return. Therefore, herd behaviour distinguishes itself from the standard prediction of capital asset pricing model leading to a testable hypothesis relating to the dispersions of the security returns and the market return.

To measure the return dispersion CH have proposed the cross-sectional standard deviation (CSSD) expressed as[4]:

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N}(R_{i,t} - R_{m,t})^2}{(N-1)}}$$

Where N is the number of securities in the portfolio, $R_{i,t}$ is the observed stock return of firm i at time t and $R_{m,t}$ is the cross-sectional average stock of N returns in the portfolio at time t. During herding, both CH and CCK suggest that investors are most likely to follow the consensus during the extreme market movement. They empirically test the hypothesis that equity market dispersions are relatively lower during periods of extreme market movement when compared to the average.

[4] While CCK proposed a variation with cross-sectional absolute deviation.

In contrast, this paper proposes an alternative test for herding. Though the method proposed in this paper is similar to that of CCK, they do not necessarily reach the same conclusion always. Our empirical model is based on the intuition that the rational asset pricing models predict not only that equity return dispersions are an increasing function of the market return but also that the relation is linear. If market participants tend to follow aggregate market behavior and ignore their own prior beliefs during periods of extreme average price movements, then the linear and increasing relation between dispersion and market return will no longer hold. In this paper, we extend the work of CCK (2000) by proposing a new and more powerful approach to detect herding based on equity return behavior. Using the symmetric properties of the ensemble return distribution, we examine the relation between the level of equity return dispersions and the overall market return. The proposed alternative measure to capture the symmetry of ensemble return distribution is defined as:

$$\gamma_t = \left| R_{Mean,t} - R_{Median,t} \right|$$

Where $R_{Mean,t}$ and $R_{Median,t}$ is the observed cross-sectional average and median of the N returns in the aggregate market portfolio at time t. In a symmetric distribution median coincides with the mean and therefore the difference between the cross sectional mean and median has been exploited in the paper to capture the extent of convergence of individual belief towards the common market behaviour. Therefore, by construct the symmetry in the cross sectional distribution would imply that γ_t would tend to zero. In the presence of herding, we expect that cross sectional return dispersions will decrease with an increase in the market return.

As a starting point in the analysis, we illustrate the relation between the proposed measure (γ_t) and the market return. Let R_i denote the return on any asset i, R_m be the return on the market portfolio, and $E_t(.)$ denote the expectation in period t. A conditional version of CAPM, proposed by Black (1972), is defined as follows:

$$E_t(R_i) = \gamma_0 + \beta_i E_t(R_m - \gamma_0)$$

where γ_0 is the return on the zero-beta portfolio, β_i is the time-invariant systematic risk measure of the security, i = 1, …, N and t = 1, …, T. Also, let β_m be the systematic risk of an equally weighted market portfolio. Hence,

$$\beta_m = \frac{1}{N}\sum_{i=1}^{N}\beta_i$$

Therefore, we can define the absolute difference between cross sectional mean and median of stock returns (γ) in period t as follows[5]:

$$\gamma_t = |Mean_t - Median_t| = (|\beta_{mt} - \beta_t^{median}|)E_t(R_m - \gamma_0)$$

Where β_t^{median} denotes the cross sectional median beta of the portfolio.

Given this, the increasing and linear relation between dispersion and the time-varying market expected returns can be easily shown as follows:

$$\frac{\partial \gamma_t}{\partial E_t(R_m)} = (|\beta_{mt} - \beta_t^{median}|) > 0$$

$$\frac{\partial^2 \gamma_t}{\partial E_t(R_m)^2} = 0$$

We use the ex-post data to test the presence of herding in the sample by using the relationship between γ_t and market return. However, it is important to note that a smaller value of γ_t, per se, is not a measure of herding, rather the lack of linear relation between γ_t and Rm is used to identify herding.

[5] The average γ is used as a proxy for expected γ , where the average γ is defined as an absolute difference between cross sectional average mean and average median.

Finally, a few points about the alternative measure warrant discussion: First, the proposed measure provides a more robust (both the necessary and sufficient) condition for convergence compared to that of the traditional measure, which only provides the necessary condition. In other words, by considering the shape of the ensemble cross sectional return distribution, the proposed measure is less prone to the presence of securities with extreme returns in the portfolio and hence provides a more reliable measure to establish herding. Further, since we are interested in evaluating the cross sectional dispersions during market stress when the distributions are more likely to be skewed, γ_t would provide more reliable measure of convergence in beliefs than the conventional measure such as CSSD. Second, though a quantitative estimate of the asymmetry of the distribution can also be captured by the higher order moments, we propose an alternative to the conventional measures such as skewness since the later could be biased for a small numbers of securities in the portfolio.

2.2 Empirical Models:

We define our basic model as:

$$\gamma_t = \alpha_0 + \alpha_1 \mid R_{m,t} \mid + \varepsilon_t \qquad (1.a)$$

Where slope in equation 1.a captures the relationship between γ_t and the average market return, which we have hypothesized to be positive under CAPM. However, in order to test the presence of herding we need to examine the nature of this relation. In fact, the lack of linearity in the association between γ_t and R_m is considered as an evidence of herding. To capture this we run the following empirical specification.

$$\gamma_t = \alpha_0 + \alpha_1 \mid R_{m,t} \mid + \alpha_2 R_{m,t}^2 + \varepsilon_t \qquad (1.b)$$

As we have hypothesized that under herding the individual investor's belief converges towards the average consensus of all market participants, we expect a non liner relation between γ_t and R_m captured by a negative and significant α_2 coefficient.

Further to test the robustness of the findings, we have also estimated an alternative specification proposed by CCK in equation 1.c. As proposed by CCK, since the direction of the market return may affect investor behavior we examine asymmetries in herd behavior during a market rise or fall. The herding regression is estimated separately for positive and negative market returns. Specifically, the equations estimated are as:

$$\gamma_t^{up} = \alpha + \alpha_1^{up} \, | R_{m,t}^{up} | + \alpha_2^{up} (R_{m,t}^{up})^2 + \varepsilon_t \qquad if \;\; R_{m,t} \geq 0$$
$$\gamma_t^{down} = \alpha + \alpha_1^{down} \, | R_{m,t}^{down} | + \alpha_2^{down} (R_{m,t}^{down})^2 + \varepsilon_t \qquad if \;\; R_{m,t} < 0 \qquad (1.c)$$

where, $R_{m,t}^{up}$, $R_{m,t}^{down}$ are the equal-weighted portfolio return at time t during the uptrend and down trend in the market respectively. A significant negative α_2 would indicate the evidence of herding.

Finally, since we have employed an equally weighted measure, our results may have been influenced by the presence of smaller stocks in the portfolio. Therefore, examining the relative influence of small versus large stocks is especially important in light of the fact that small stock portfolios may react differently under different conditions compared to the large stock portfolios (McQueen, Pinegar, and Thorley (1996)). Hence, to address this bias the paper examines the hypothesis of herding for portfolios of various sizes.

3. Data and Sample:

This section briefly describes the data used for testing herding in the Indian equity market. Christie and Huang (1995) argued that the herding behavior is often a short-term phenomenon and it can only be captured with a high frequency data. Further, Tan et al (2008) while analyzing herding behavior in the Chinese stock market have also concluded that the level of herding becomes more pronounced with the daily data than with weekly and monthly data. Therefore, following the existing literature the paper uses daily stock price data to test herding behaviour in the Indian equity market. In addition, the non-availability of intra-day data has also constrained us to use the data with next highest frequency i.e. the daily data. The daily data on stock prices and market capitalization for all firms listed on BSE-500 is collected over the period from January 1, 2003 to 31 March 2008, constituting 1301 observations[6].

Since, there have been new firms included in BSE-500 in the sample period for which only partial data was available we have considered a consistent set of firms in our analysis leading to a balanced sample of 349 firms. The data for this analysis is obtained from Capitaline database. The stock return for all the firms is calculated as:

$$R_t = 100 * (\log(P_t) - \log(P_{t-1})) .$$

A year-wise summary of observations are given in Table 1A.

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

Table 1B contains summary statistics for average daily return for BSE 349 companies[7]. In 2008, the mean value of average daily return is in negative and has a higher standard deviation, which confirms the turbulence in Indian Market during that period. The minimum average daily return (-5.101) was also observed on 21st January 2008. The second lowest minimum average daily return (-4.734) was observed on 17th May 2004 when Sensex slumped by 842 points due to political uncertainty in domestic market. Table 1C reports summary statistics for γ_t for BSE 349 companies. The γ_t is relatively lower in the year 2007 and 2008, indicating higher degree of homogeneity in expectations amongst the investors during those years. In contrast, the year 2003 records the highest γ_t indicating relatively lesser degree of homogeneity in expectations amongst the investors in this year. Figure 1A contrasts the proposed measure of herding (γ_t) with the market returns particularly during the various

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[6] Though the number of observations in 2008 is only 61, we still include this year in order to capture the recent stock market crash.

[7] BSE stands for Bombay Stock Exchange of India.

crash events in our sample. In all the major crash events of 2007, 2008 and 2006, we observe a significant drop in γ_t indicating a tale tell sign of herding. In Figure 1B we further contrast γ_t with CSSD, particularly during the market crashes of 2006 to 2008[8]. It is worthwhile to note that the precipitation in γ_t is more consistent than that of CSSD during these periods, indicating a strong sign of convergence towards common belief during those years. Notably, this can only be taken as an evidence of herding if the increment in γ_t decreases with absolute value of market returns. To examine this, in Figure 2 we plot the daily γ_t and the market return during 2003-2008. The association between γ_t and the market return appears to be non- linearly positive.

4.2. Regression Results

Table 2A and 2B report the result of the basic herding regression presented in equation 1.a and 1.b. The results based on daily data indicate that α_1 is significantly positive for most of the years and also for the total sample. This indicates that equity return dispersions actually tend to increase with the increase in absolute average return, confirming our prediction that γ_t increases with $|R_{m,t}|$. Most importantly, the nature of this association does not change even with the additional variable in the model, R^2_{mt}. The significant negative estimate of α_2 in equation 1.b (Table 2B) for the whole sample indicate that γ_t has increased at a decreasing rate as the average price movement increases. Indeed, the coefficients indicate that beyond a certain threshold, the γ_t may decline as $|R_{m,t}|$ becomes large. For example, substituting the estimated coefficients for total sample (α_1 =0.001 and α_2 = - 0.000192) we can estimate the threshold for $R_{m,t}$ as 2.60% where γt reaches its maximum[9]. This suggests that for large

[8] Figure 1B plots only a subsample of observations (2006-08) to get a sharper view of the event.

[9] The equation 1.b suggests that γt reaches its maximum value when $R_{m,t} = -(\alpha_1/2\alpha_2)$.

swings in the market return that surpass this threshold level, γ_t has a tendency to become smaller.

However, for the year-on-year exercise we observe some variation in the findings. The year such as 2004, 2005 and 2007 clearly indicate the presence of significant non-linear term, while it is not significant for the year 2003, 2006 and 2008. Therefore, though the results presented so far indicate a presence of significant herding in the India equity market, but it is not evenly distributed across all the years, suggesting that certain years happen to be more prone to herding than others.

Finally, in order to test the consistency of our methodology, we apply the new measure to test the herding in the U.S. equity market. The daily data on stock prices for all firms listed on S&P-500 is collected over the period from January 1, 2003 to 31 Dec 2008, constituting 1504 observations. Since, there have been new firms included in S&P-500 in the sample period for which only partial data was available we have considered a consistent set of firms in our analysis leading to a balanced sample of 454 firms. Table 2C reports the comparison of summary statistics for γ_t for S&P companies and BSE companies and as expected the γ_t is relatively lower for BSE companies as compared to S&P companies, indicating a higher degree of homogeneity in expectations amongst the investors in the Indian market. The estimates of the standard herding model reported in table 2D also do not provide any evidence of herding in the US market.

The table 2E presents the estimates of our equation 1.c which captures the potential herding during the up market movements. In contrast to the down market movement reported in table 2 F, the negative significant α_2 in almost all the years indicate a wide spread prevalence of herding in the Indian market, particularly during the upward movements in the market. However, for the falling market we do not observe the similar trend as most of the results strongly confirm the prediction that γ_t increases with $R^2_{m,t}$. Furthermore, in all six years, the rate of decrease in the up market is higher than that of the down market. This suggests that the rate of increase in return dispersion (as measured by γ_t) as a function of the aggregate market return, is lower when the market is advancing than when it is declining. This stands contrary to the directional asymmetry documented by McQueen, Pinegar, and Thorley (1996) where all stocks tend to react quickly to negative macroeconomic news, but small stocks tend to exhibit delayed reaction to positive macroeconomic news[10].

4.2. Robustness Test:

Since we have employed an equally weighted measure, the aggregate results reported in Table 2 (A, B, E, and F) may be influenced by the smaller stocks in BSE. Therefore, having found evidence of herding for a sample of 349 companies, the phenomenon is further examined for both small and large stock portfolios. As argued earlier, examining the relative influence of small versus large stocks is especially important in light of the fact that small stock portfolios may react to news differently as compared to the large stock portfolios. For instance, McQueen et al. (1996) have documented that small stocks respond slowly to good news, and this slowness could result in extra dispersion in up markets, and bias against

[10] In an unreported exercise, we have also estimated the specification using CH model as in equation 1.D.

$$\gamma_t = \beta_0 + \beta_1 D^{Up} + \beta_2 D^{Dw} + \varepsilon_t \qquad (1.D)$$

Where D^{Up} and D^{Dw} are the dummy variables at time t that take value one when the market return lie in the extreme upper and lower tail of the distribution respectively. We have used both 1% and 5% of the distribution on either tail to indentify the extreme market movements. In most of the estimates, the coefficient on D^{UP} dummy turned out to be positive except 2004, but statistically insignificant. This indicates that the equity return dispersion actually tend to increase rather than decrease during the extreme positive market movements validating the prediction of the CAPM. On the other hand, the estimates of D^{DW} exhibits negative coefficient in year 2004 and 2007, while it is statistically significant only in year 2007. However, it is important to note that the two methods may provide conflicting results to indentify herding. In fact, CH approach requires a far greater magnitude of non-linearity in the return dispersion and mean return relationship for evidence of herding than suggested by rational asset pricing models (Chang et al, 2000).

detecting evidence of herding in Table 2. Table 3A and 3B reports the estimation results for small and large stocks respectively.

In order to create portfolios of small and large stocks, the paper uses the benchmark market capitalization of Rs. 1500 Crores, as a threshold[11]. The firms with market capitalization of less than Rs.1500 crores have been distinguished as small stocks while firms with market capitalization worth more than Rs.1500 crores have been identified as large stocks. Table 3 shows a year wise distribution of large and small stocks for our sample[12].

The size-based tests reported in Table 3A and 3B provide further support to the full sample results. In Table 3A and 3B, α_2 turns out to be significantly negative for the years 2004, 2005 and 2007 for small firms indicating evidence of herding in small stock portfolio, while for the large stock portfolio, it is significant only for the year 2007. Further, the level of herding seems to be more pronounced for small stock portfolio for all these years where the Indian Stock market has witnessed crash.

Finally, we contrast our results with that of CKK model with CSAD as dependent variable. The results are presented in table 4. It is interesting to note that though the CCK model identifies non-linearity in 2007, however it is not statistically significant. Therefore the decline in γ_t is much sharper than the CSAD during 2007 which is consistent with our argument that in the presence of extreme events the relation between γ_t and the market return could be more effective in identifying herding.

In sum, the asymmetric regressions along with the earlier estimates establish two important facts: First, the results clearly show a significant presence of herding among the market

[11] The National Stock Exchange, during our study period, defined mid-cap stocks as companies with a total daily market capitalization between Rs 150 crore and Rs 1,500 crore. Therefore, Rs 1500 Crore is used as cut-off in the paper to identify the large stock companies.

[12] Since we have used the daily market capitalization as a proxy of size, the number of observations in each year varies as the market valuation of firm changes over time.

participants, particularly during the year 2007. Second, though herding is more prevalent for small stocks, it is also observed for large firms as well in 2007. Therefore, the result indicates that the widespread herding observed in 2007, is witnessed across the stocks and is not driven either by large or small capitalization stocks. Hence, the important question we need to address is what makes the year 2007 different from the rest of the years. To facilitate the analysis we have listed all major stock market crashes during our sample period 2003-2008 in the appendix. It is evident that 2007 has happened to be one of the most volatile years in the Indian stock market history witnessing several events of significant market crashes. Therefore, the fact that our results coincide with the anecdotal belief in the popular press that several crash in 2007 was due to herding, also corroborate our conclusion that the Indian equity market is prone to herding particularly during the crashes. To check the robustness of this claim, we augment our basic model (1.b) with an interaction dummy, which captures the time effect of crash years. The dummy (D_t) takes value one for observations in year 2006-2008 as these years have witnessed several major market crashes. The estimated coefficients and the corresponding p values for our model are:

$$\gamma_t = \underset{(0.00)}{0.0011} + \underset{(0.00)}{0.00117}*|R_{mt}| - \underset{(0.00)}{0.00016}*R_{mt}^2 - \underset{(0.00)}{0.00042}*|R_{mt}|*D_t + \varepsilon_t$$

The significant estimate of D_t indicates that γ_t indeed rises at a slower rate with market returns during the crash year than the rest of the years suggesting the possibility of herding amongst the investors during these years[13].

[13] In an unreported result, we have added an additional interaction term to explore the impact on non-linearity during the crash years. However we have not observed any significant change in the nature of association during the crash year, implying a parallel shift in the relation between γ_t and market return.

5. CONCLUSION

In this paper, we examine the investment behavior of market participants of the Indian equity market, specifically during the episodes of market crashes. The paper proposes an alternative methodology to test the tendency on the part of market participants to herd around the market consensus. In contrast to the traditional standard deviation of the portfolio based approach, our study proposes an alternative methodology to test the herding behavior using symmetric properties of the ensemble return distribution. Our empirical tests indicate that during periods of extreme price movements, equity return dispersions for the Indian equity market tend to decrease rather than increase, thereby providing evidence of the presence of herd behavior. However, the year-on-year analysis reveals variations in the extent of herding witnessed by the Indian equity market during the sample period and significantly, the years of major crashes have witnessed pronounced herding among the market participants. We also observe that the rate of increase in security return dispersion as a function of the aggregate market return is lower in up market, relative to down market days, which stands contrary to the directional asymmetry documented by McQueen, Pinegar, and Thorley (1996). A series of robustness test also corroborates our conclusions.

Lastly, more researches on herding behaviour using the alternative measure proposed in this paper would provide further insight into the usefulness and consistency of this approach.

Appendix:

Table 1 A : 10 biggest falls in the Indian stock market history (2003-2008)

Crash Event Date	Description of the Crash
Jan 21, 2008	The Sensex saw its highest ever loss of **1,408** points at the end of the session on Monday. The Sensex recovered to close at 17,605.40 after it tumbled to the day's low of 16,963.96, on high volatility as investors panicked following weak global cues amid fears of the US recession.
Jan 22, 2008	The Sensex saw its biggest intra-day fall on Tuesday when it hit a low of 15,332, down 2,273 points. However, it recovered losses and closed at a loss of **875** points at 16,730. The Nifty closed at 4,899 at a loss of 310 points. Trading was suspended for one hour at the Bombay Stock Exchange after the benchmark Sensex crashed to a low of 15,576.30 within minutes of opening, crossing the circuit limit of 10 per cent
May 18, 2006	The Sensex registered a fall of **826** points (6.76 per cent) to close at 11,391, following heavy selling by FIIs, retail investors and a weakness in global markets. The Nifty crashed by 496.50 points (8.70%) to close at 5,208.80 points.
December 17, 2007	A heavy bout of selling saw the index plunge to a low of 19,177 - down 856 points from the day's open. The Sensex finally ended with a huge loss of **769** points (3.8%) at 19,261. The NSE Nifty ended at 5,777, down 271 points.
October 18, 2007	The Sensex registered a hefty loss of **717** points (3.8%) at 17,998. The Nifty lost 208 points to close at 5,351.
January 18, 2008:	The Sensex ended with a hefty loss of **687** points (3.5%) at 19,014. The index thus shed 8.7% (1,813 points) during the week. The NSE Nifty plunged 3.5% (208 points) to 5,705.
November 21, 2007:	Following weakness in other Asian markets, the Sensex saw relentless selling. The index tumbled to a low of 18,515 - down 766 points from the previous close. The Sensex finally ended with a loss of **678** points at 18,603. The Nifty lost 220 points to close at 5,561.
August 16, 2007:	The Sensex, after languishing over 500 points lower for most of the trading session, slipped again towards the close to a low of 14,345. The index finally ended with a hefty loss of **643** points at 14,358.

April 02, 2007:	The Sensex opened with a huge negative gap of 260 points at 12,812 following the Reserve Bank of India's decision to hike the cash reserve ratio and repo rate. The index tumbled to a low of 12,426 before finally settling with a hefty loss of **617** points (4.7%) at 12,455.
August 01, 2007	Unabated selling across-the-board saw the index tumble to a low of 14,911. The Sensex finally ended with a hefty loss of **615** points at 14,936. The NSE Nifty ended at 4,346, down 183 points. This is the third biggest loss in absolute terms for the index.

Source: www.rediff.com

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Table 1A: Distribution of observations over the sample period.

Year	No. of observations
2003-2008	1318
2003	253
2004	254
2005	251
2006	250
2007	249
March,2008	61

Table 1B: Summary Statistics: Average Daily Return (BSE 349 companies)

	Mean	Standard Deviation	Minimum	Maximum
2003	.152	.582	-1.626	1.822
2004	.057	.763	-4.734	2.635
2005	.092	.499	-2.355	1.475
2006	.050	.709	-3.311	2.305
2007	.083	.556	-2.207	1.591
2008	-.314	1.374	-5.101	3.036

Table 1C: Summary Statistics: γ_t (BSE 349 companies)

	Observations	Mean	Minimum	Maximum
2003	253	0.0022	0	0.0103
2004	254	0.0014	0	0.0047
2005	251	0.0014	0	0.0039
2006	250	0.0014	0	0.0101
2007	249	0.0013	0	0.0086
2008	61	0.0012	0	0.0053
Overall	1318	0.0015	0	0.0103

Figure 1A: Trends in γ_t **and Market Returns during various market crashes (2006-2008).**

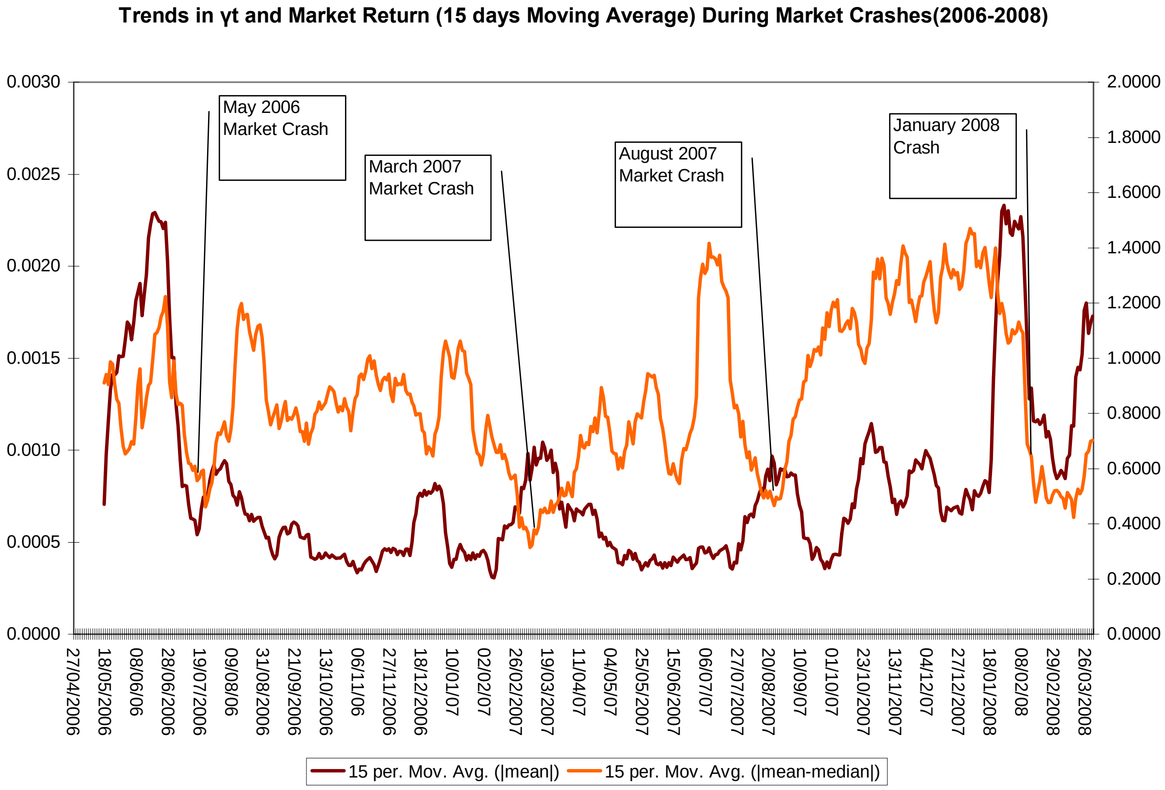

Figure 1B: Trends in γ_t **and Market Returns during various market crashes (2006-2008).**

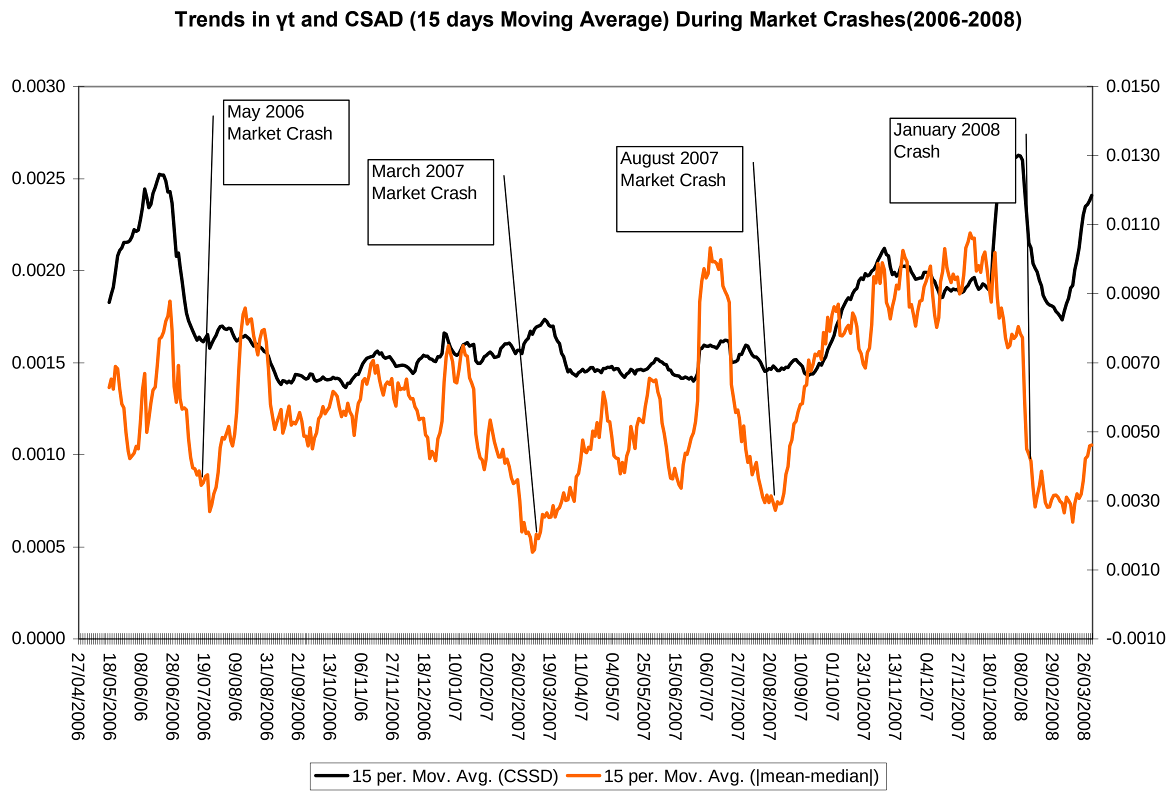

Figure 2: Relation between γt and Market Returns during the sample period.

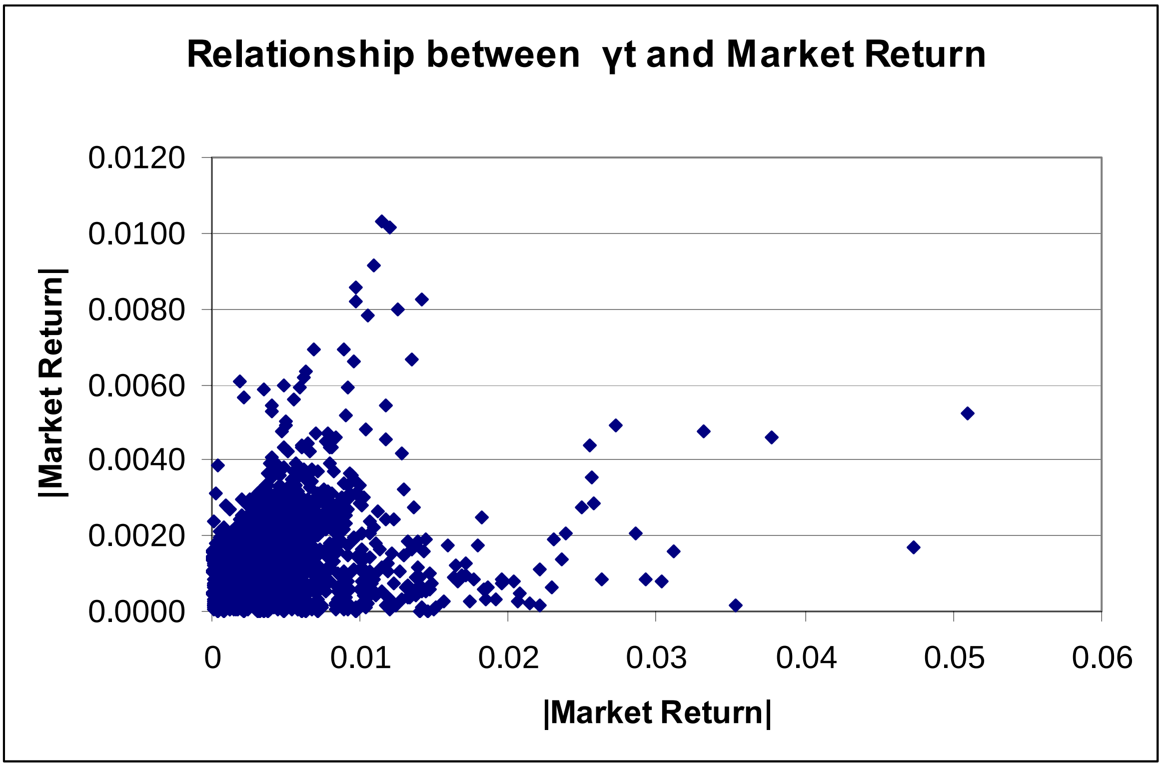

Table 2A: Analysis of Herding Behavior in Indian Stock Market (BSE 349 Companies)

	All	2003	2004	2005	2006	2007	2008
α_0	0.00126 (0.000)	0.00095 (0.000)	0.00135 (0.000)	0.0013 (0.000)	0.0011 (0.000)	0.00119 (0.000)	0.00078 (0.000)
α_1	0.000516 (0.000)	0.002512 (0.000)	0.00008 (-0.770)	0.000179 (-0.310)	0.00055 (0.000)	0.000327 (0.000)	0.00045 (0.000)
Adjusted R-square	0.04	0.22	0.002	0.004	0.07	0.01	0.16
N	1318	253	254	251	250	249	61

Note: This table reports the regression results for the following model:

$$\gamma_t = \alpha_0 + \alpha_1 | R_{m,t} | + \varepsilon_t \quad (1.a)$$

The model is estimated for the whole sample as well as for the individual years, 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 2B: Analysis of Herding Behavior in Indian Stock Market (BSE 349 Companies)

	All	2003	2004	2005	2006	2007	2008
α_0	0.001124 (0.00)	0.000741 (0.00)	0.001198 (0.00)	0.001064 (0.00)	0.00116 (0.00)	0.00075 (0.00)	0.00128 (0.00)
α_1	0.001 (0.00)	0.0036 (0.00)	0.00055 (0.01)	0.00128 (0.00)	0.00037 (0.23)	0.00241 (0.00)	-0.00068 (0.03)
α_2	-0.000192 (0.00)	-0.00091 (0.16)	-0.00016 (0.02)	-0.00078 (0.00)	0.00008 (0.54)	-0.00141 (0.00)	0.0003 (0.00)
R-square	0.05	0.22	0.02	0.04	0.07	0.10	0.31

Note: This table reports the regression results for the following model :

$$\gamma_t = \alpha_0 + \alpha_1 | R_{m,t} | + \alpha_2 R^2_{m,t} + \varepsilon_t \quad (1.b)$$

The model is estimated for the whole sample as well as for the individual years, 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 2C: Summary Statistics of BSE γ_t and S&P γ_t

	Mean	Standard Deviation	Minimum	Maximum
BSE γ_t	0.001	0.001	0.00	0.01
S&P γ_t	0.048	0.040	0.00	0.28

Table 2D: Analysis of Herding Behavior in U.S. Market

	2003	2004	2005	2006	2007	2008
α_0	0.031 (0.00)	0.038 (0.00)	0.03 (0.00)	0.041 (0.00)	0.035 (0.00)	0.049 (0.00)
α_1	0.076 (0.00)	0.068 (0.078)	0.068 (0.07)	0.051 (0.17)	0.026 (0.24)	0.051 (0.00)
α_2	-0.043 (0.063)	-0.057 (0.28)	-0.022 (0.69)	-0.013 (0.77)	-0.009 (0.65)	0.00 (0.31)
Adjusted R-square	0.064	0.02	0.064	0.028	0.01	0.30

Note: This table reports the regression results for the following model :

$$\gamma_t = \alpha_0 + \alpha_1 | R_{m,t} | + \alpha_2 R_{m,t}^2 + \varepsilon_t \quad (1.b)$$

Table 2E: Analysis of Herding Behavior in Rising Indian Stock Market (BSE 349 Companies)

	2003	2004	2005	2006	2007	2008
α_0	0.00060 (0.03)	0.00121 (0.00)	0.00103 (0.00)	0.00108 (0.00)	0.00079 (0.00)	0.00111 (0.00)
α_1	0.00482 (0.00)	0.00190 (0.00)	0.00364 (0.00)	0.00238 (0.00)	0.00353 (0.00)	0.00104 (0.25)
α_2	-0.00124 (0.09)	-0.00069 (0.00)	-0.00282 (0.00)	-0.00105 (0.00)	-0.00193 (0.00)	-0.00031 (0.33)
Adjusted R-square	0.385	0.141	0.208	0.134	0.203	-0.013

Note: Note: This table reports the regression results for the following model

$$\gamma_t^{up} = \alpha + \alpha_1^{up} \mid R_{m,t}^{up} \mid + \alpha_2^{up} (R_{m,t}^{up})^2 + \varepsilon_t \qquad if \ R_{m,t} \geq 0 \quad (1.C)$$

The model is estimated for the individual years, 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 2F: Analysis of Herding Behavior in declining Indian Stock Market (BSE 349 Companies)

	2003	2004	2005	2006	2007	2008
α_0	0.00109 (0.00)	0.00064 (0.00)	0.00074 (0.00)	0.00066 (0.00)	0.00060 (0.00)	0.00118 (0.00)
α_1	0.00051 (0.72)	-0.00012 (0.36)	-0.00077 (0.01)	-0.00080 (0.00)	-0.00015 (0.69)	-0.00092 (0.00)
α_2	0.00045 (0.68)	0.00006 (0.14)	0.00046 (0.00)	0.00062 (0.00)	0.00008 (0.69)	0.00036 (0.00)
Adjusted R-square	0.03377	0.0133	0.055	0.683	-0.022	0.649

Note: Note: This table reports the regression results for the following model

$$\gamma_t^{down} = \alpha + \alpha_1^{down} \mid R_{m,t}^{down} \mid + \alpha_2^{down} (R_{m,t}^{down})^2 + \varepsilon_t \qquad if \ R_{m,t} < 0 \quad 1.C$$

The model is estimated for the individual years, 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 3: No. of Large and Small Stocks on a yearly basis

Year	Large	Small	Total
2003	70	279	349
2004	101	248	349
2005	140	209	349
2006	195	154	349
2007	232	117	349
2008	255	94	349

Table 3A: Analysis of Herding Behavior in Indian Stock Market (Small Stock Companies)

	2003	2004	2005	2006	2007	2008
α_0	0.00090 (0.00)	0.0012 (0.00)	0.00124 (0.00)	0.00138 (0.00)	0.00089 (0.00)	0.00126 (0.00)
α_1	0.00303 (0.00)	0.00095 (0.00)	0.00146 (0.00)	0.00052 (0.19)	0.00269 (0.00)	-0.00026 (0.30)
α_2	0.00006 (0.92)	-0.00033 (0.00)	-0.00065 (0.00)	0.00017 (0.28)	-0.00147 (0.00)	0.000108 (0.04)
Adjusted R-square	0.2602	0.051	0.038	0.110	0.099	0.089

Note: This table reports the regression results for the following model:

$$\gamma_t = \alpha_0 + \alpha_1 |R_{m,t}| + \alpha_2 R_{m,t}^2 + \varepsilon_t \quad (1.b)$$

The model is estimated for the small stock firms for 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 3B: Analysis of Herding Behavior in Indian Stock Market (Large Stock Companies)

	2003	2004	2005	2006	2007	2008
α_0	0.00083 (0.00)	0.00076 (0.00)	0.00094 (0.00)	0.00108 (0.00)	0.00077 (0.00)	0.00139 (0.00)
α_1	0.00163 (0.00)	0.00045 (0.03)	0.00055 (0.26)	0.00031 (0.25)	0.00178 (0.00)	-0.00070 (0.04)
α_2	-0.00063 (0.07)	0.00012 (0.02)	-0.00054 (0.17)	-0.00001 (0.86)	-0.00096 (0.00)	0.00030 (0.00)
Adjusted R-square	0.069	0.243	-0.000	0.018	0.058	0.237

Note: Note: This table reports the regression results for the following model:

$$\gamma_t = \alpha_0 + \alpha_1 | R_{m,t} | + \alpha_2 R_{m,t}^2 + \varepsilon_t \quad (1.b)$$

The model is estimated for the large stock firms for 2003-2008. Please note that the numbers in the parentheses are p-value.

Table 4: Analysis of Herding Behavior in Indian Stock Market (BSE 349 Companies) using CCK model.

	All	2003	2004	2005	2006	2007	2008
α_0	0.0073 (0.00)	0.0102 (0.00)	0.008912 (0.00)	0.00775 (0.00)	0.00 74 (0.00)	0.0076 (0.00)	0.0107 (0.00)
α_1	0.00257 (0.00)	0.0019 (0.77)	-0.0007 (0.15)	-0.00086 (0.11)	0.00145 (0.03)	0.00048 (0.51)	0.00045 (0.68)
α_2	0.00015 (0.05)	-0.0011 (0.31)	0.00013 (0.37)	-0.00414 (0.22)	-0.0004 (0.14)	-0.00029 (0.53)	-0.00029 (0.31)
R-square	0.35	0.009	0.01	0.01	0.02	0.001	0.05

Note: Note: This table reports the regression results for the following model :

$$CSAD_t = \alpha_0 + \alpha_1 | R_{m,t} | + \alpha_2 R_{m,t}^2 + \varepsilon_t \quad (1.d)$$

The model is estimated for the whole sample as well as for the individual years, 2003-2008. Please note that the numbers in the parentheses are p-value.