Short- Sale Constraints and Dispersion of Opinion: Evidence from the Indian Equity Market

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Abstract

Short-sale constraints can inflate market prices, as bearish investors cannot act on their market views. Building on Chen et al. (2002), this paper models these effects in an equity market where short sale constraints indiscriminately bind all investors and stocks. According to model predictions, opinion dispersion leads to higher overpricing. The model is empirically tested in the Indian equity market. The Indian market provides a natural testing environment, as short sales were banned across the equity market during the period between 2001 and 2008. Various proxies of opinion dispersion are used, such as realized volatility, implied volatility, daily price range, and turnover. Overpricing is measured as the difference between the discounted futures price and the price of the underlying equity index. The empirical results offer supportive evidence of the positive relationship between opinion dispersion and overpricing in a market with short sale constraints.

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I. Introduction

The recent regulatory developments in the U.S. equity market have made short sale constraints an issue of major controversy amongst academics, regulatory agencies, and industry practitioners. SEC's short sales ban of 799 financial stocks in September 2008 was meant to avert the downward spiral of equity prices. Nevertheless, its effectiveness has been questionable. Christopher Cox, SEC chairman, recently admitted that the ban may have been a mistake,[1] as it did not succeed in preventing the prices from tumbling; to the contrary it led to a liquidity squeeze. The ban highlights the general regulatory uncertainty on short sales evidenced by the elimination of the decades old uptick rule[2] in 2007, only to be potentially reinstated next month.[3]

The pricing implications of short sales have been a subject of debate long before the current economic crisis. The finance community appears split in two camps, each one having formed strong opinions regarding the appropriate regulation of short sales Supporters of short sales argue that short sales allow the views of all investors, both optimists and pessimists, to be reflected in the market, facilitating, therefore, the efficient price discovery. The proponents of this view argue against short sale restrictions, which are viewed as obstacles to market efficiency and potentially leading to overpricing. On the other hand, opponents of unrestricted short sales argue that short sellers can place

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[1] Amit R. Paley and David S. Hilzenrath, "SEC Chief Defends His Restraint: Cox Rebuffs Criticism of Leadership During Crisis," *The Washington Post*, Wednesday, December 24, 2008; Page A01

[2] "The Commission originally adopted Rule 10a-1 in 1938 to restrict short selling in a declining market. Rule 10a-1(a)(1) provided that, subject to certain exceptions, a listed security may be sold short (A) at a price above the price at which the immediately preceding sale was effected (plus tick), or (B) at the last sale price if it is higher than the last different price (zero-plus tick)", "Amendments to Exchange Act Rule 10a-1 and Rules 201 and 200(g) of Regulations SHO," SEC. Retrieved on 2009-04-10.

[3] SEC is currently seeking public comment on restoring the rule in some modified version: Securities Exchange Commission, "SEC Seeks Comments on Short Sale Price Test and Circuit Breaker Restrictions", Press Release, 2009-76

downward pressure in the market and exacerbate a possible market panic. In their view, there should be short sale restrictions in place to avoid such precipitous psychological reactions. One of the most notorious examples cited by the opponents of unrestricted short sales is the case of black Wednesday in 1992, when George Soros sold short 10 billion British pounds, breaking the Bank of England.

The goal of this paper is to shed some light on the controversy over short sale constraints. Building on Chen et al. (2002), this paper models the pricing implications in a market where short sale constraints indiscriminately bind all investors and stocks. According to model predictions, opinion dispersion leads to higher overpricing. The model is empirically tested in the Indian equity market, which provides a natural testing environment, as short sales were banned across the equity market during the period between 2001 and 2008.

Overpricing is measured as the difference between the discounted futures price and the price of the underlying equity index. Various proxies of opinion dispersion are used, such as realized volatility, implied volatility, daily price range, and turnover. The empirical results offer supportive evidence of the relationship between opinion dispersion and overpricing in a market with short sale constraints.

The rest of the paper is organized as follows: Section II offers a review of the empirical literature on opinion dispersion's effects on overpricing in markets with short sale constraints. Section III sets the model and presents the model predictions. Section IV provides some background information on the most prevalent Indian equity index, S&P CNX Nifty and describes the structure of the Indian equity derivatives market. Section V describes the dataset used for this study. Section VI describes how overpricing is

measured and presents a univariate analysis. Section VII describes the proxies of opinion dispersion and presents some univariate results. Section VIII describes the empirical multivariate results of the model. Section IX describes future robustness tests and theoretical extensions of this paper. Finally, Section X concludes the paper.

II. Literature Review

Miller (1977) was the first to study the pricing implications of short sale constraints. He argued that short sale constraints can inflate market prices as bearish investors cannot act on their market views. When opinion dispersion is high, the prohibition of short sales will lead to overpricing, as pessimistic investors cannot take short positions and remain out of the market. Miller assumes one risky asset in his model, which could represent the whole market, i.e. an index, or an individual stock. Most of the implications derived from Miller's hypothesis refer to individual stocks. Jarrow (1980) builds on Miller's model and shows that universal short sale constraints would lead to overpricing of the entire market. The overpricing hypothesis has recently been revisited by a series of papers that develop theoretical models (Chen et al., 2002; Hong and Stein, 2003) and a series of empirical papers.

Most of these papers test the effect of opinion dispersion on pricing under short sale constraints using data on individual U.S. stocks. In markets, like the U.S. one, where short sales are generally not prohibited, these studies proxy for the extent to which certain stocks are constrained. Short interest is one of the proxies widely used and it is estimated as the number of shares that are short over the total number of shares outstanding (Figlewski, 1981). When short interest is high, short sale constraints are not particularly

binding. Another proxy is the cost of borrowing (Jones and Lamont, 2002), i.e. the rebate rate, which represents the interest rate that the short seller needs to pay to borrow the stock. The higher this rate the more short sale constrained the equity (Boehme et al., 2006). An alternative measure of the level of the short sale constraint of a particular stock is the presence of an exchange traded option on the stock, since that offers a different way for pessimists to express their views (Boehme et al, 2006; Figlewski and Webb, 1993). One final way to approximate for short sales on a particular stock is to look at the level of institutional holdings, such as mutual funds that typically do not have short positions (Nagel, 2005; Asquith et al., 2005). There are also a few studies that look at foreign markets where there is a list of firms, whose stocks are under regulatory short sale ban. The list is often revised offering an ideal dataset for an event study. Hu (2008) provides evidence from the Taiwan market and Chang et al. (2008) look at individual short sale constrained stocks in Hong Kong.

In order to test the effect of opinion dispersion on the pricing of short sale constrained assets, it is essential to estimate different proxies that measure disagreement in the market. Miller (1977) proposes turnover as a proxy for opinion dispersion.[4]A series of papers have further used this measure of opinion dispersion (i.e. Boehme et al., 2006; Nagel, 2005; Goetzmann and Massa, 2005). Other popular proxies include dispersion in analysts' forecasts (Bohme et al., 2006; Diether et al., 2002), historical stock return volatility (Boehme et al., (2006); Goetzmann and Massa, 2005; Nagel, 2005, heterogeneity of trade among investor classes (Goetzmann and Massa, 2005).

[4] "Since much stock trading consists of investors who are pessimistic about a stock selling to those who are optimistic, turnover provides one measure of diversity of opinion (strictly speaking of changes in relative opinion)" Miller 1977

Most papers in the literature measure overpricing based on lower future returns. These papers assume that following the overpricing, the market price corrects itself. The size of the correction, evidenced by lower future returns, is a proxy of the previous overpricing. The time frame employed varies from paper to paper. Goetzmann and Massa (2005) find a negative effect of opinion dispersion on overnight returns. Boehme et al. (2006) find a negative effect of opinion dispersion on monthly and annual subsequent returns. Chen et al. (2002) and Nagel (2005) examine quarterly subsequent returns, while Desai et al. (2002) find annual negative subsequent returns. Asquith et al. (2005) examine monthly subsequent returns and they find that the constraint stocks underperform during the period of 1988-1992 only when the portfolio is estimated on an equally weighted basis, but not when it is estimated on a value weighted basis.

III. The Model

A two-period model is developed describing an equity market with short sale constraints, binding all stocks and investors. The model follows Chen et al. (2002), but it differs in that *all* investors are short sale constrained. The model assumes that there is one risky asset in the market. Investors choose how much to invest in that asset, considering that their only alternative is to invest in the riskless asset that has zero return. Time 0 is the valuation date for all investors. At time 1, the risky asset provides a terminal dividend F plus an error term ε, which is normally distributed with zero mean and standard deviation equal to unity. Investors have a constant absolute risk aversion utility function, which is mathematically described by a negative exponential function. Investors have diverse opinions of the risky asset's terminal value F. In fact, their views of the terminal value F

are uniformly distributed between [F-H, F+H]. Investors maximize their utility function in order to decide how much to invest in the risky asset.

In order to determine whether overpricing is driven by opinion dispersion, the price of assets needs to be estimated. Assuming investors face a constant supply of shares Q, the equilibrium price depends on investors' aggregate demand function. We will derive the aggregate demand by aggregating *individual* demands.

In particular, every investor i faces the following optimization problem:

$$Max\{E(U(W)) = E(-e^{-b*\tilde{W}})\}$$

$$s.t.$$

$$\tilde{W} = W_0 * \tilde{R}_p$$

$$\tilde{R}_p = R_f + w*(\tilde{R} - R_f)$$

where b = absolute risk aversion

W_0= initial wealth

$\tilde{W}$ = expected wealth

R_p = expected cumulative portfolio return

R_f = cumulative risk free rate, which in this model is assumed to be equal to 1.

$\tilde{R}$ = cumulative return for the risky asset

w = proportion invested in the risky asset

Therefore the demand curve for every unconstrained investor would be :

$$Q_i^{DU} = \frac{1}{b}\ (F_i\text{-}P)$$

But, since we have assumed that short sale constraints bind every investor, the demanded quantity cannot be negative. Therefore, the demand for every short sale constrained investor is :

$$Q_i^{DC} = Max\{\ \frac{1}{b}\ (F_i\text{-}P),0\ \}$$

The derivation of the demand function for every investor is reported in Appendix 1.

Since investors opinions are uniformly distributed between (F-H, F+H) the aggregate demand should be the sum of the individual demands.

If the price is below the worst view of the risky asset's terminal value (F - H), then the expected quantity will be equal to:

$$Q^{DC1} = \frac{1}{2H}\int_{F-H}^{F+H}\frac{1}{b}(F_i - P^{C1})dF_i = Q^{DU} \longrightarrow P = F - Q^{DU}b = P^C = P^U$$

which concides with the total demand if there were no short sale constraints (Q^{DU})

However if the price is above the level of the most pessimistic view of the risk asset's terminal value, the expected total demand will be equal to:

$$Q^{DC2} = \frac{1}{2H}\int_{P}^{F+H}\frac{1}{b}(F_i - P)dF_i \longrightarrow P = F + H - 2\sqrt{HQ^{DC2}b} = P^C > P^U$$

Solving the integrals and rearranging leads to some interesting pricing implications. More specifically:

If $H < \frac{Q}{\gamma_b} : P^C = F - \frac{Q}{\gamma_b} = P^U$

and

If $H \geq \frac{Q}{\gamma_b} : P^C = F + H - 2 * \sqrt{\frac{H * Q}{\gamma_b}} \geq P^U$

where $\gamma_b = \frac{1}{b}$, called risk tolerance

Therefore, the model predicts that below a certain level of opinion dispersion, the price of the risky asset in the market will be identical to the prevailing price under no short sale constraints. At those levels, the price is independent of the level of opinion dispersion. However, when the level of opinion dispersion is above a certain level, the price of the risky asset, influenced by opinion dispersion, will be higher than the prevailing price under no short sale constraints. Thus, beyond that level of opinion dispersion, the model predicts that there will be overpricing. Higher dispersion of opinion will lead to higher overpricing. Finally, the expected return will be equal to F – P and it will be negatively affected by dispersion of opinion when there is considerable disagreement in the market. The intermediate steps and the derivative calculations are reported in Appendix 1.2.

According to the model, when there is agreement as to the price of the asset at time 1, i.e. minimal opinion dispersion, all investors will invest an amount at time 0 that will be less than the amount expected in the future. Therefore, investors will not need to short the asset, and, thus, the existence of short sale constraints will make no difference. Because of the general agreement, no overpricing will be observed. However, when there is *disagreement* as to the future price of the asset, short sale constraints make a difference. The pessimists, who would otherwise short the asset in a no-constraint environment, can no longer express their views by shorting the asset, and they will, thus, simply stay out of the market. The price will inevitably only reflect the opinion of the optimists who are willing to buy the asset because they believe that the future price will increase. This price will be higher than the price that would prevail, if the pessimists were allowed to express their views in the market through short selling. When the opinion dispersion is highest, the overpricing in the market will also be the highest. Finally,

higher overpricing will translate in lower future returns as the market corrects itself in the final period. Therefore, high opinion dispersion would lead to lower future returns.

Summarizing, there are two main hypothesis derived from the model, which are tested in the empirical section that follows.

Hypothesis 1: In a market with short sale constraints, high opinion dispersion leads to positive deviations from the efficient price (overpricing).

Hypothesis 2: If the dispersion of opinion is very low, the overpricing effect will not be present.

IV. The Indian Markets: Background Info

The Indian equity market provides a natural environment for the predictions of the proposed model, as short sales were banned across the equity market from 2001 to 2008. This section provides an overview of the main characteristics of the S&P CNX Nifty index, the most prevalent Indian equity index. It also describes the operations of the Indian equity derivatives market.

S&P CNX Nifty: The Standard & Poor's CNX Nifty commenced trading in April 1996 and today it is the leading index on the National Stock Exchange of India, often used as a benchmark for the Indian market portfolio. It includes 50 of the approximately 935 companies listed on the NSE, many of which are blue chip companies. It accounts for 22 sectors of the Indian economy and it represents about 60% of the total market capitalization of the National Stock Exchange. It is highly liquid, as it only includes stocks with low impact cost. The S&P CNX Nifty index includes only the

capital gains and losses due to price movements. It does not include dividends. The daily movements of the total returns index, which includes both price movements and the dividend yield, are shown in Figure 1.

Equity Derivatives in India: Derivatives trading was initially introduced in India in June 2000, when trading in index futures commenced. Trading in index options commenced a year later in June 2001. Although the Indian options market in organized exchanges is relatively young, its size has been growing at a stunning pace (Table II). Options are traded in the National Stock Exchange and the Bombay Stock Exchange, whereas Futures are traded in the National Stock Exchange, the Bombay Stock Exchange and the Singapore Stock exchange. Both NSE and BSE have moved to an electronic platform, eliminating arbitrage opportunities from price differentials in the two exchanges. NSE has been accounting for the bulk of the total turnover in derivatives trading since 2002, rendering it the leading exchange for derivatives trading in India.[5] Table I describes the growth of NSE's derivatives market.

At any point in time there are only three contract months available for trading with one month, two months and three months to expiration. These contracts expire on the last Thursday of the expiry month. If the last Thursday is a holiday the derivative contracts expire the previous day. Also, there are long term options for three quarterly months of the cycle March/June/September/December and five months following semi-annual months of the cycle June/December. All derivatives are cash settled. The number of strikes provided on S&P CNX Nifty depends on the previous day's index closing price of the index.

[5] National Stock Exchange, Annual Report, 2008

In the period 2002-2007, most of the investors in the derivatives market are retail investors, since institutional investors are prohibited from investing in the derivatives market - except for those involved in hedging activities. In fact, even during the year of 2007-2008, 63% of the investors were retail investors whereas institutional investors accounted for only 12% of the NSE turnover on futures and options. Most of the institutional investors are foreign institutional investors.[6]

Jogani & Fernandes (2003) and Shah (2003) examine the efficiency of the derivatives market and show that in the period of 2001-2002 there were many arbitrage opportunities involving derivatives. In fact, they observe that during 2001-2002 the futures on S&P CNX index are selling at a discount to the actual index price level as opposed to the premium that one would expect. One of the main reasons cited is the restrictions in short sales and the high bid-ask spreads of options that made arbitrage difficult. The restrictions in short selling were effectively lifted in 2008. Also, many call-put parity violations are observed. Cited reasons for the persistence of those arbitrage opportunities are the restrictions on institutional investors, the lack of knowledge and expertise of the retail investors, and the high bid-ask spread of options.

V. Data

Since this paper examines the investors' behavior in a market with only one risky asset, I will assume that this one risky asset is represented by the S&P CNX NSE NIFTY index. The dataset employed includes daily closing prices for the S&P CNX NSE NIFTY and for all futures and options on the S&P CNX NSE NIFTY index. It also includes hourly intra-day snapshots of the trading book for all derivatives on S&P CNX NSE

[6]

NIFTY and all trades throughout the day on the underlying index and the corresponding derivatives. The data extends from 2002 to 2008 and it was obtained from the National Stock Exchange, the leader Indian exchange in trading derivatives. The highly liquid nature of these instruments guarantees a high level of market efficiency.

The derivatives chosen are the ones nearest to expiration, unless the time to expiration is a week or less. In that case, the derivatives of the following month are considered, so that the derivatives in the sample are always the most liquid possible. Dividend yield and interest rate data are required in order to estimate the deviations from the equilibrium prices and the arbitrage gaps. The dividend yield for the index is provided by India's National Stock Exchange (NSE). As for the interest rate, the one month interbank borrowing and lending rate (MIBOR, MIBID) is used. Both datasets are provided by NSE.

VI. Mispricing

Existing literature has used subsequent returns to measure mispricing. The rationale behind this measure is that if equity assets are overpriced, the prices will, at some point, correct, i.e. exhibiting negative subsequent returns. The size of the correction is a measure of mispricing. The length of the period considered for the estimation of subsequent returns varies from study to study. However, it is difficult to determine which would be the appropriate timeframe to consider, and most of the studies do not provide a theoretical justification for their timeframe choice.

Nevertheless, overpricing might not necessarily translate in future lower returns in the near future. In the proposed theoretical model, if opinion dispersion is high, there

will be a price correction since the true fair value of the risky asset is revealed during the second period in a two period model. However, when applying the model in an actual market, it is difficult to determine how long it would take for the fair price to be revealed. Moreover, a price correction would be more likely to happen if short sale restrictions are eliminated, which does not apply to the case of the Indian equity market during the period of 2002-2007.

In order to avoid these shortfalls, an alternative measure is used in this paper: a futures-based measure of overpricing. Overpricing is estimated as the logarithmic difference between the index price and the discounted futures price. Since there are no short sale constraints in the *derivatives* market, taking both a long and a short position in the futures market is feasible, even when there are short sale constraints in the *equity* market. An arbitrage argument could be used to explain the proposed proxy. In perfect markets with no short sale constraints the relationship between the futures price and the underlying price will be described by:

$$F_{0,t} = S_0 e^{(r-\delta)T}$$

where $F_{0,t}$ = today's price of the futures contract expiring at time t,
S_0 = the price of the underlying today,
r = interest rate
δ = dividend yield
T = time to expiration

In perfect markets, if the futures price is *below* the price of the underlying with the accumulated net interest – (r-δ) – arbitrageurs will engage in cash and carry arbitrage.[7] The arbitrage will bring the price back to equilibrium so that the equality will

[7]Cash and carry involves the following steps:
T=0 : borrow funds, buy the underlying, short a futures contract

still hold. If the futures price increases *above* the price of the underlying with the accumulated net interest, arbitrageurs will engage in reverse cash and carry,[8] which will bring the price back to equilibrium, so that the equality will still hold.

In imperfect markets, with short sale constraints, however, if the futures price deviates from the futures price determined by the above equality, arbitrageurs might not be able to reverse the deviation. More specifically, cash and carry will still be feasible, since it involves buying a futures contract and buying the underlying. However, if the futures price moves towards the opposite direction, arbitrageurs will not be able to engage in *reverse* cash and carry since they will not be able to short the underlying. The result will be that in an equity market with short sale constraints the following inequality will hold:

$$F_{0,t} \leq S_0 e^{(r-\delta)T}$$

which can also be expressed as:

$$S_0 - F_{0,t} e^{-(r-\delta)T} \geq 0$$

This positive difference is a measure of overpricing. The higher the deviation of the underlying to the discounted futures price, the higher the overpricing will be. Therefore, the logarithmic difference of the underlying from the discounted futures price will be a measure of overpricing in percentage terms.

T=1: repay loan with interest, deliver asset

[8] Reverse cash and carry involves the following steps:
T=0: short underlying, lend proceeds, buy a futures contract
T=1: collect proceeds from loan, accept delivery, repay short sale with the underlying from the futures contract

More specifically: $\text{Overpricing} = Log(S_0 / F_{0,t} e^{-(r-\delta)T})$

In order to apply this measure of overpricing, I use all intra-day data. I match every futures trade with the value of the underlying index at the exact time of the trade and I estimate overpricing as defined by the equation above. Then I estimate daily overpricing as the average overpricing across all trades throughout the day. When there are many trades at exactly the same second, I average the trade quotes. I choose the futures with the nearest expiration date, unless the expiration is less than a week away. If it is less than a week long, the following month is chosen as an expiration month. Therefore, at all times the most liquid futures contract is used.

Figure 2 describes the average daily overpricing during the period 2002-2007. The futures-based overpricing behaves differently in the first half of the sample (January 2002- April 2004) than the latter half (May 2004-October 2007). In the first half, mispricing fluctuates between positive and negative, whereas in the second half of the sample overpricing is consistently above zero.

Therefore, it appears that overpricing is mostly present in the second half of the sample (May 2004-October 2007). This period coincides with the time the Indian equity index was booming (Figure 1). Based on the model, we expect that high level of disagreement in the market would be a leading reason for the overpricing observed. It is observed that overpricing demonstrates a series of spikes, almost all of them about a year apart from each other. Based on the model, it is expected that opinion dispersion will be higher in the second half of the sample and then it will have a positive effect on overpricing. In the first half of the sample, we do not observe consistent overpricing, maybe because the dispersion of opinion is relatively low. Therefore, we would expect

opinion dispersion to be lower in that part of the sample, and, thus, not to have an effect on overpricing.

V. Opinion Dispersion

A series of proxies for opinion dispersion are used in this study, such as standard deviation of daily returns, historical, intra-day volatility, implied volatility, daily price range and market turnover. Each proxy is first described, and then applied to the data.

Historical volatility: Historical volatility is estimated as standard deviation of daily index returns over the previous month (Figure 3). As predicted, the historical one month volatility seems to be lower during the first half of the sample compared to the latter. More importantly, the spikes in the historical one month volatility coincide to the most pronounced spikes of overpricing.

Intra-day variance and intra-day volatility: Another proxy is the intra-day variance and the intra-day volatility. Intra-day variance is estimated using the Andersen and Bollerslev (1998) intra-day measure. The intra-day variance is estimated as the sum of the squared five minute returns. The intra-day volatility is the square root of the intra-day variance. The same measure has been estimated excluding the first and the last half an hour of trading. The exclusion of the first and last half an hour does not seem to affect the pattern of intra-day volatility. In the case of intra-day variance, we observe very pronounced spikes, coinciding with spikes in overpricing is higher, but the difference in the level of opinion dispersion between the two halves of the sample is not as noticeable (Figure 4). This is more noticeable in Figure 5 that depicts intra-day volatility. The spikes persist at the same time periods.

Implied Volatility: The benefit of this measure is that in contrast to the previous volatility estimates, it is forward looking and, thus, a better predictor of the investors' current views. Implied volatility is estimated using the Black Scholes formula adjusted for the dividend yield. The implied volatility in Figure 6 is the average of the implied volatility from calls and the implied volatility from puts. Just like the previous measures, implied volatility seems to be higher in the second half of the sample and it seems to exhibit spikes at about the same times the observed futures-based overpricing is highest.

The *daily price range* is measured by the logarithmic (percentage) difference between the highest and the lowest index price throughout the day. This measure is the closest to our theoretical definition of heterogeneity of opinions for the terminal value in the market as measured by parameter H. In our theoretical model, opinions are uniformly distributed between (F-H, F+H) and the price range is therefore 2H. Figure 7 shows the pattern followed by the daily price range during the period of 2002-2007. The spikes seem to follow a similar pattern to the spikes of the overpricing measure.

The *market turnover* is measured by volume over the number of outstanding shares in the market. The pattern of the index turnover appearing in Figure 8 is puzzling. It appears that turnover is higher in the first half of the sample and much lower in the second half of the sample, which is exactly opposite to what was expected. Moreover there do not appear to be any obviously noticeable spikes in the second part of the sample.

VIII. Empirical Results

The model predicts that in an equity market with short sale constraints there will be overpricing when there is considerable disagreement. That is because, as noted earlier, the pessimist investors will be forced to stay out of the market and the price of the risky asset will be primarily driven by the optimists. Conveniently, the proposed measure of overpricing demonstrates consistent overpricing only in half of the sample. If the predictions of the theoretical model hold, a reason for not observing consistent overpricing in the first half of the sample would be low dispersion of opinion. If that is the case it would be expected that there will be no effect of dispersion of opinion on overpricing in the first half of the sample. Therefore the effect of opinion dispersion on overpricing should be positive and statistically significant during the second half of the sample. In the first half of the sample, no significant effect is expected.

In order to test the predictions of the model, we split our sample in two time periods: the first one covering the period January 2002-April 2004 and the second one covering the period of May 2004-September 2007. A test of equality of means for the opinion dispersion proxies is performed. The means and standard errors are reported in Table II. The means of all opinion dispersion proxies other than the turnover are higher in the second half of the sample than in the first half of the sample, providing supportive evidence for our hypotheses.

In order to test the effect of opinion dispersion on overpricing, a regression analysis is performed. Each of the proxies of opinion dispersion is regressed on the futures-based overpricing. The regressions are run both for the full sample and the two subsamples. As predicted all proxies of opinion dispersion seem to have a positive and significant effect on the futures based overpricing at the 1% level in the second

subsample (Table III). Moreover, the R-squared is high, ranging from 8% to 20%. During the first half of the sample many of the proxies, primarily the volatility proxies, seem to have no significant effect on overpricing, which was also predicted by the model. Turnover, which is very high during the first subsample, has a positive and significant effect on overpricing. However, R-squared in the first half of the sample is considerably lower indicating that turnover has higher explanatory power at the second subsample. When one looks at the full sample, most proxies of opinion dispersion have a positive and significant effect on overpricing, but this result seems to be primarily driven by the second half of the sample, where overpricing is consistently present.

Additionally, Granger causality tests are performed to determine the direction of the positive relationship between the futures-based overpricing and the proxies for opinion dispersion. Most of the proxies of dispersion of opinion seem to cause the futures based overpricing (Table IV), which is consistent with the setup of the proposed model and its predictions.

Also, it is interesting to test whether the futures-based overpricing measure is followed by subsequent negative returns, which will happen as overpricing is corrected in the market. The appropriate timeframe for this correction is unknown. In this study, a daily, monthly, quarterly and annual time frame is employed. Since results are similar for all timeframes, I only report the results that test the subsequent correction in the returns in the month following the observed futures-based overpricing (Table V). The results indicate that there is no significant effect of the futures-based overpricing on one month subsequent returns, which means that overpricing is not followed by a price correction.

The reason for this could be that the time period examined coincides with the great boom in the Indian equity market.

Finally, a regression analysis of different opinion dispersion proxies on subsequent returns has been performed. The results indicate no significant effect of opinion dispersion on subsequent returns (Table VI). This is consistent with the effect of overpricing on subsequent returns (Table V).

IX. Future Research: Two Asset Model and Empirical Robustness Tests

On the theoretical front, I intend to extend the two period model of this paper to include two equity assets with correlated returns. In this extension, similarly to the current model, investors have uniformly distributed beliefs for each ith asset {i, 1, 2}. More specifically, the views for terminal value of every asset i are uniformly distributed between $[F_i-H_i, F_i+H_i]$, but the two assets' opinion dispersion, H_i is independent. The pricing implications of short sale constraints for each asset and the market as a whole are observed. The market is represented by the investors' portfolio choice, which contains both assets in some proportions, determined by the investors' utility optimization under a budget constraint. Empirically, the investors' portfolio of the two risky assets is approximated by the most prevalent equity index.

To better corroborate the existing results, robustness tests could be helpful. First, overpricing does not seem to be corrected in the near term future. One explanation for this finding could be that since the time with high overpricing coincides with the "big boom" in the Indian Equity Market, subsequent returns could be primarily driven by the growth in the market. So, even if the returns are relatively lower because of the price

correction they will still appear positive. In order to disentangle the price correction from the general upward movement of equity prices in India during that period, it would be prudent to control the regressions for different macroeconomic variables, such as economic growth. Macroeconomic variables, nevertheless, are reported in quarterly frequency whereas the data used in this study have a daily frequency. One way circumvent this problem, is to create regime dummies and use them to control for macroeconomic factors. Finally, another way of controlling for the equity growth is to use an international index as a control in the regressions performed in this paper. Possible choices are the MSCI Barra international index for all countries, and the MSCI Barra international index for emerging markets. Daily data are available for both indices during the 2004-2007 period.

Another empirical extension would be to expand the employed dataset after April 2008, when the short sale constraints were lifted, and test the predictions of the model in the context of an event study. Figure 1 shows that the index value drops during that period. Without further testing, it would be arbitrary to assume that this price decline is due to the elimination of short sale constraints, especially since this period coincides with the beginning of the current economic crisis. In the proposed analysis control variable for the current global economic crisis should be included.

X. Conclusion

Short sale constraints is a controversial issue that has recently been brought to the spotlight after the recent regulatory developments on short sale restrictions in the US market: the elimination of the uptick rule, the consideration of reinstatement of a

modified uptick rule and the three week short sale ban of the stocks of 799 financial institutions. The effectiveness of these specific restrictions and other short sale constraints has long been debated. Their supporters argue that unrestricted short sales can exacerbate market panic and drive prices below fair value, whereas those with the opposing view counterargue that short sale constraints impede the efficient price discover by prohibiting pessimists from participating actively in the market.

This paper aims at providing some evidence on the pricing implications of short sale constraints. It presents a model that describes and equity market under short sale restrictions. It predicts that if the opinion dispersion is above some minimum level, there will be overpricing in the market, as the pessimists will not be able to actively express their opinions in the market and thus the price will be driven by the optimists' long positions. Moreover, when this overpricing exists, it will be positively affected by opinion dispersion.

The model is empirically tested in the Indian equity market, where short sales were prohibited during the period of 2001-2008. The Indian equity market serves as a natural environment for testing the predictions of the proposed model. Overpricing is measured by the logarithmic (percentage) difference between the index value and the discounted futures price on the index. Opinion dispersion is approximated by a series of measures such as historical volatility, intra-day volatility, implied volatility, price range, turnover, average turnover. Preliminary results indicate that in periods characterized by consistent overpricing, opinion dispersion is a contributing factor to this overpricing. On the contrary, when overpricing is not consistent opinion dispersion is on average lower and does not seem to have any effect on mispricing.

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	Table I	
	Total Settlement for Index/Stock Derivatives	
Years	**(Rs.cr)**	**(US $mn)**
2000-2001	860.1	18.44
2001-2002	7858.8	161.04
2002-2003	23107.6	486.4.7
2003-2004	122,959.80	2833.3
2004-2005	146,486.20	3348.25
2005-2006	285,218.00	6393.59
2006-2007	664,944.70	15254.52
2007-2008	1,565,192.30	39,227.88

Table II			
Means of proxies of opinion dispersion			
	Jan 2002- April 2004	May 2004 - Oct 2007	Full Sample
Implied volatility			
Mean	0.1909	0.2440	0.2235
Standard deviation	0.0548	0.0757	0.0731
St. error of mean	0.0025	0.0027	0.0020
Past Stdev			
Mean	0.0377	0.0781	0.0628
Standard deviation	0.0294	0.0487	0.0467
St. error of mean	0.0013	0.0017	0.0013
Intra-day volatility			
Mean	0.3766	0.7815	0.6285
Standard deviation	0.2941	0.4865	0.4673
St. error of mean	0.0135	0.0173	0.0131
Price range			
Mean	0.0167	0.0186	0.0179
Standard deviation	0.0083	0.0137	0.0119
St. error of mean	0.0004	0.0005	0.0003
Turnover			
Mean	0.0087	0.0031	0.0053
Standard deviation	0.0126	0.0069	0.0099
St. error of mean	0.0006	0.0002	0.0003
Average past turnover			
Mean	0.0088	0.0032	0.0053
Standard deviation	0.0093	0.0045	0.0072
St. error of mean	0.0004	0.0002	0.0002

Table III			
Panel A: Dependent Variable = Percentage mispricing			
Measures of dispersion of opinion	Jan 2002- April 2004	May 2004 - Oct 2007	Full Sample
Implied volatility	-0.431	3.237***	3.264***
R-squared	0.003	0.227	0.187
Past Stdev	-0.001	0.003***	0.004***
R-squared	0.005	0.085	0.132
Intra-day variance	-0.778	0.553***	0.549***
R-squared	0.026	0.0869	0.048
Price range	-8.769***	16.138***	12.364***
R-squared	0.027	0.148	0.059
Turnover	4.653***	27.753***	3.576***
R-squared	0.018	0.132	0.004
Average past turnover	3.165	38.226***	-2.627
R-squared	0.004	0.111	0.001

*** significant at 1% level

** significant at 5% level

* significant at 10% level

Table IV			
Granger Causality Tests			
	Jan 2002- April 2004	May 2004 - Oct 2007	Full Sample
Implied volatility			
Mispricing is the cause	0.852	0.149	0.187
IV is the cause	0.966	0.01217***	0.00521***
Past Stdev			
Mispricing is the cause	0.000	0.00139***	0.00118***
Past Stdev is the cause	0.571	0.483	0.143
Intra-day volatility			
Mispricing is the cause	0.211	0.00026***	0.000051***
Intra day vol is the cause	0.374	0.000000025***	0.000011***
Price range			
Mispricing is the cause	0.873	0.476	0.333
Price range is the cause	0.323	0.00000053***	0.000021***
Turnover			
Mispricing is the cause	0.680	0.015**	0.201
Turnover is the cause	0.06009*	0.00142***	0.00178***

*** significant at 1% level

** significant at 5% level

* significant at 10% level

Table V			
Dependent Variable = Subsequent logarithmic one month returns			
	Jan 2002- April 2004	May 2004 - Oct 2007	Full Sample
Futures-based Overpricing	0.033	0.005	0.013
R-squared	0.029	0.002	0.009

*** significant at 1% level
** significant at 5% level
* significant at 10% level

Table VI			
Dependent Variable = Subsequent 1 month returns			
dispersion of opinion			
	Jan 2002- April 2004	May 2004 - Oct 2007	Full Sample
Implied volatility	0.275387**	-0.032	0.044
R-squared	0.034	0.001	0.002
Past Stdev	0.057	-0.002	0.009
R-squared	0.041419**	0.000	0.003
volatility	0.224	-0.105	-0.022
R-squared	0.011	0.006	0.000
Price range	0.640	-0.319	-0.135
R-squared	0.004	0.004	0.000
Turnover	0.580	-0.384	0.213
R-squared	0.008	0.001	0.001
Average past turnover	0.783	-0.777	0.197
R-squared	0.008	0.002	0.000

*** significant at 1% level

** significant at 5% level

* significant at 10% level

Figures

Figure 1

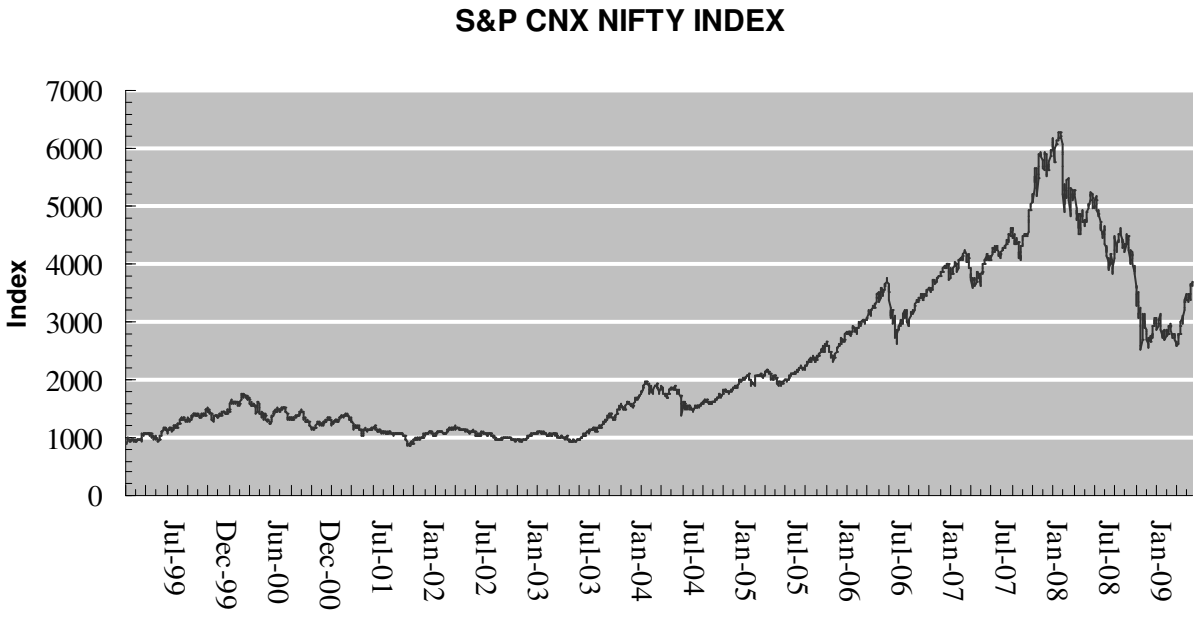


Figure 2

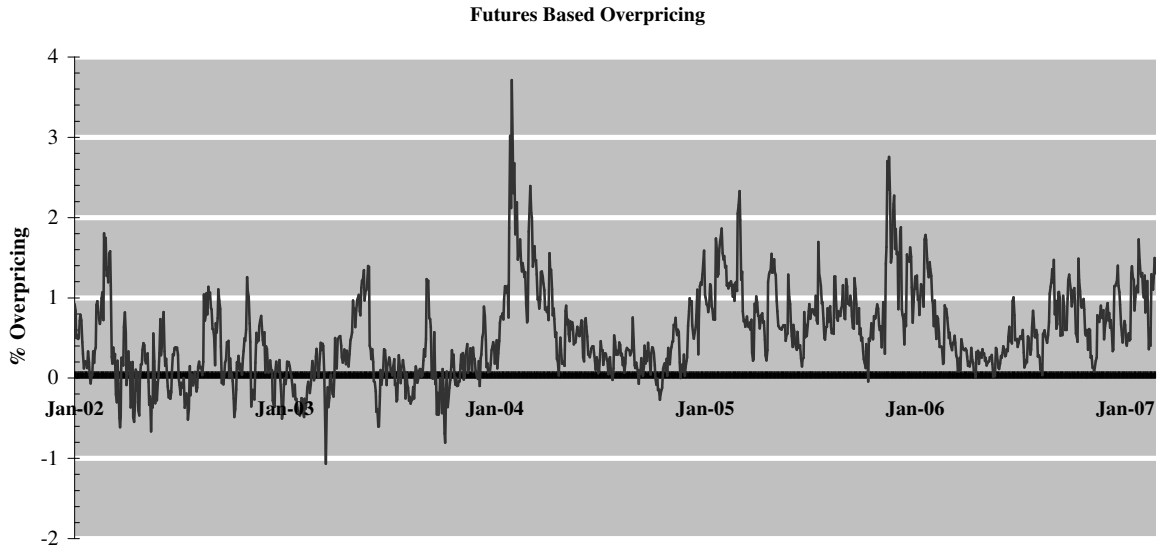
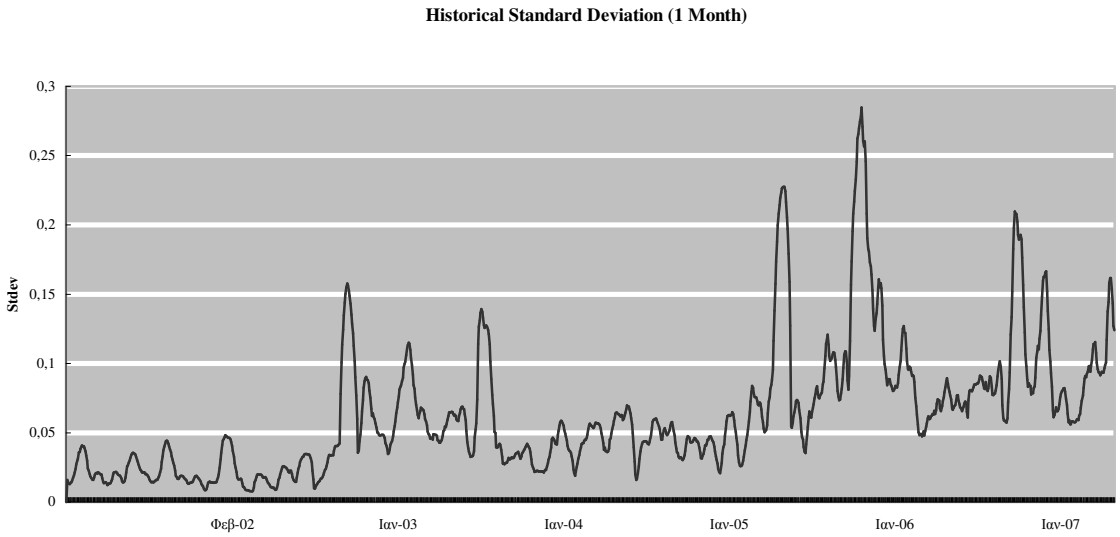


Figure 3



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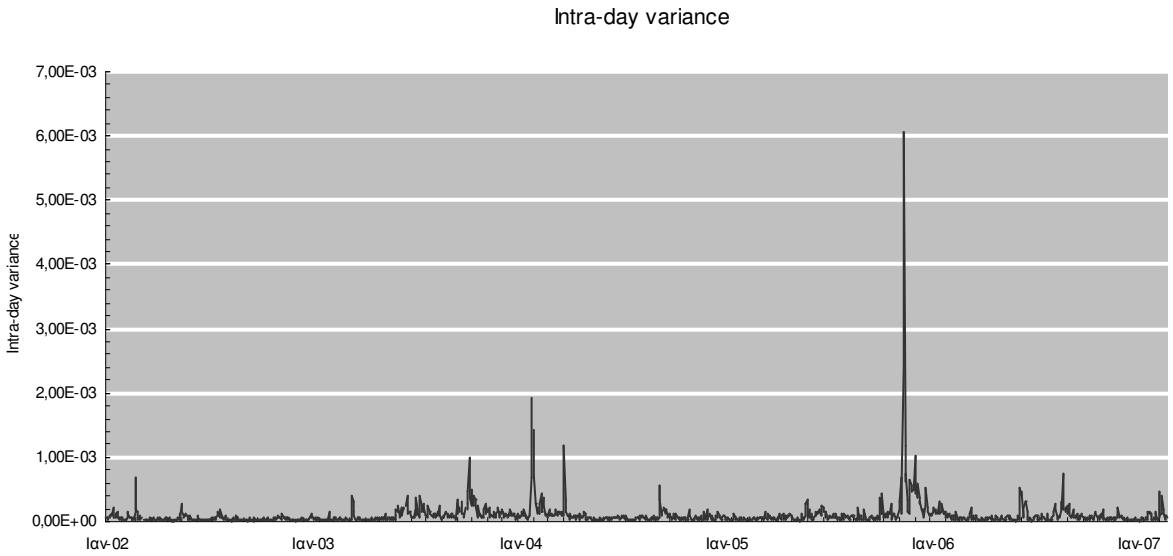
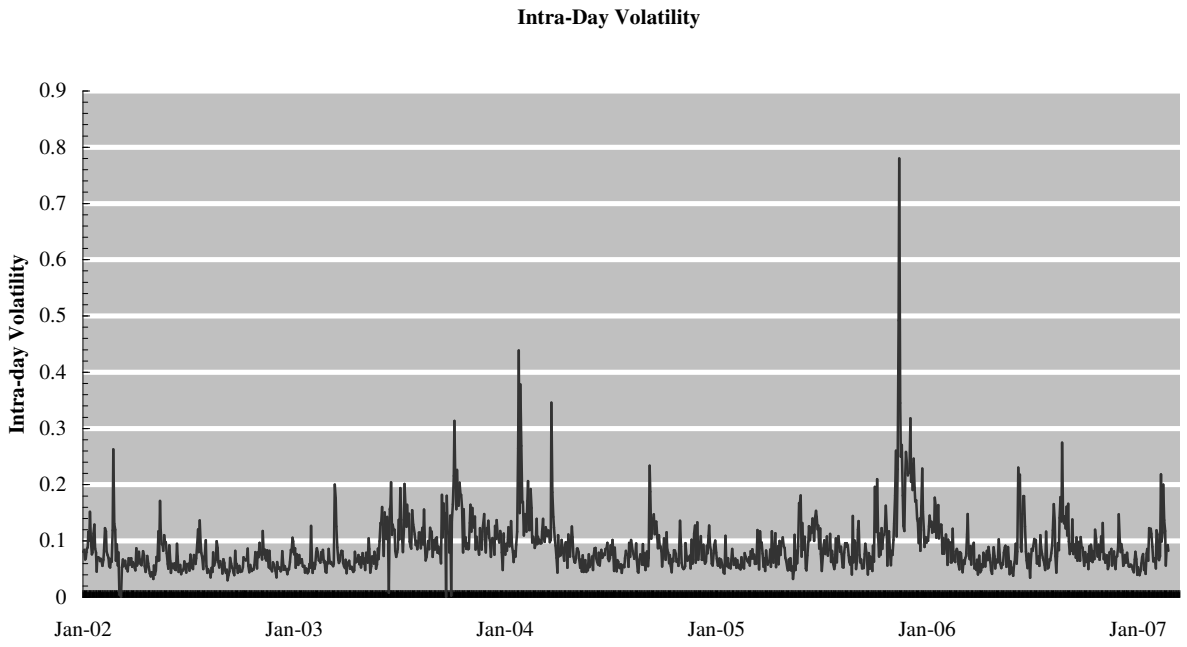


Figure 5



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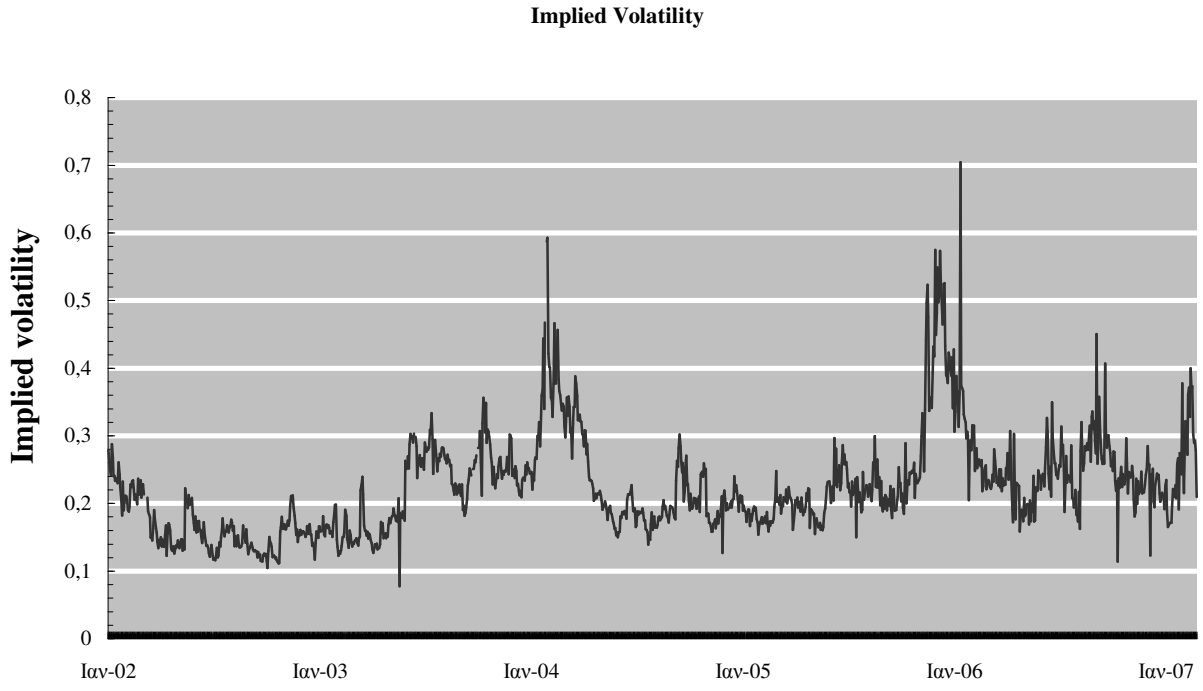


Figure 7

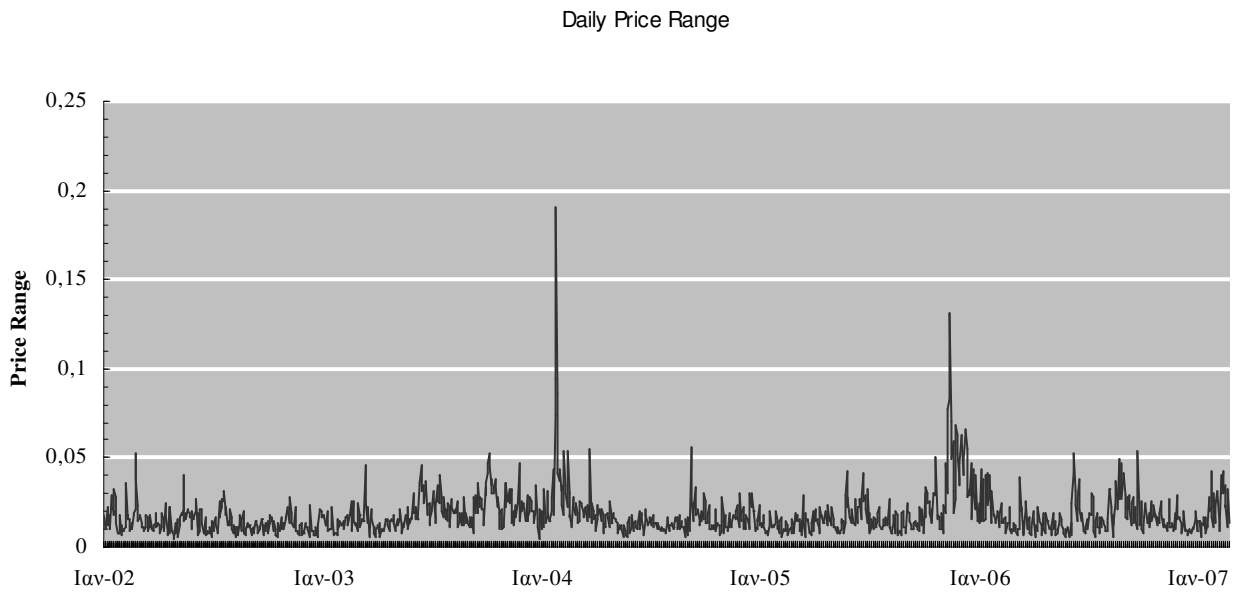
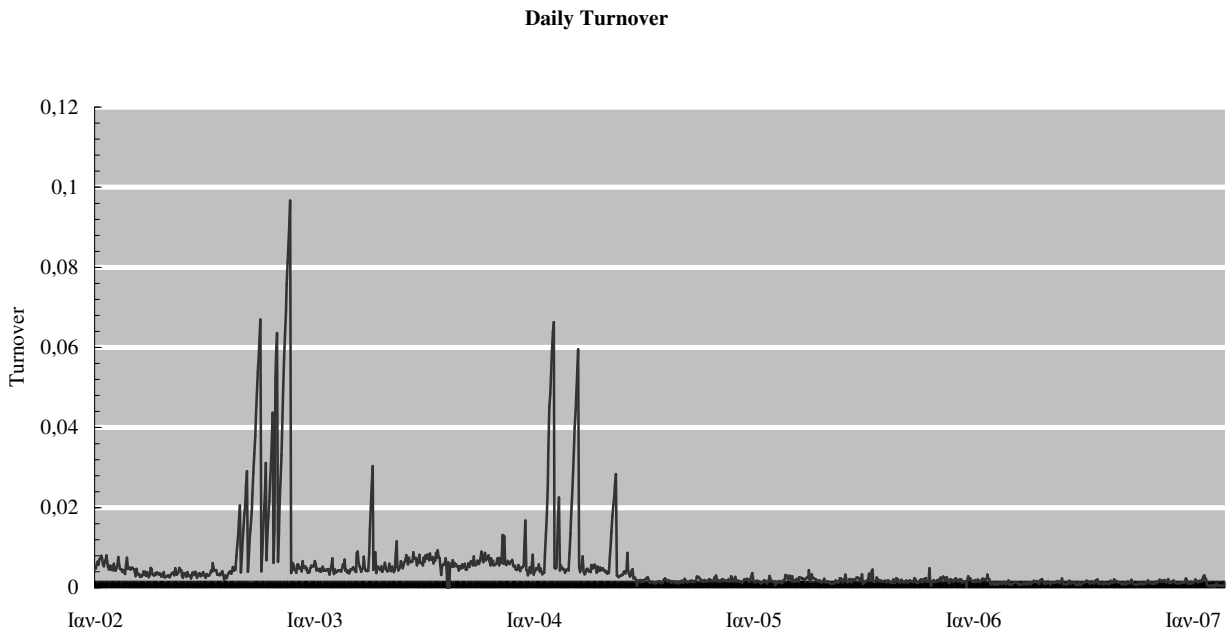


Figure 8



Appendix 1.1

Every investor i faces the following optimization problem:

$$Max\{E(U(\tilde{W})) = E(-e^{-b*\tilde{W}})\}$$

$$s.t.$$

$$\tilde{W} = W_0 * \tilde{R}_p$$

$$\tilde{R}_p = R_f + w*(\tilde{R} - R_f)$$

where b = absolute risk aversion
W_0= initial wealth
$\tilde{W}$ = expected wealth
R_p = expected cumulative portfolio return
R_f = cumulative risk free rate, which in this model is assumed to be equal to 1.
$\tilde{R}$ = cumulative return for the risky asset
w = proportion invested in the risky asset

The above optimization problem can be re-written as:

$$\underset{w}{Max}\{E(U(\tilde{R})) = E(-e^{-b*W_0*(R_f + w*(\tilde{R} - R_f) + \frac{1}{2}b^2 w^2 \sigma^2 W_0^2})\}$$

Since $U(w)$ is monotonic the investor's optimization problem can be expressed as follows:

$$\underset{w}{Max}\{w(\bar{R} - R_f) - \frac{1}{2}bW_0 w^2 \sigma^2\}$$

First order condition:

$$\bar{R} - R_f - bW_0 w\sigma^2 = 0 \longrightarrow w = \frac{\bar{R} - R_f}{b\sigma^2}$$

Since $U(w)$ is monotonic the investor's optimization problem can be expressed as follows:

$$\underset{w}{Max}\{w(\bar{R}-R_f)-\frac{1}{2}bW_0w^2\sigma^2\}$$

First order condition:

$$\bar{R}-R_f-bW_0w\sigma^2=0\longrightarrow w=\frac{\bar{R}-R_f}{b\sigma^2W_0}$$

and if $R_f=1$:

$$w=\frac{\bar{R}-1}{b\sigma^2W_0} \qquad \text{(A1)}$$

Therefore, the dollar demand for the risky asset will be determined by the following equation:

$$\$D=W_0w=\frac{\bar{R}-1}{b\sigma^2} \qquad \text{(A2)}$$

Now let's estimate $\bar{R}$ and σ^2:

The return for every investor i will be $\tilde{R}_i=\frac{(F_i+\varepsilon)-P}{P}+1, \varepsilon\sim N(0,1)$

Then,

$$\bar{R}_i=\frac{F_i-P}{P}+1 \qquad \text{(A3)}$$

and

$$\sigma^2=Var(R_i)=\frac{1}{P^2}Var(F_i+\varepsilon)=\frac{1}{P^2}*1\longrightarrow\sigma^2=\frac{1}{P^2} \qquad \text{(A4)}$$

$$\text{(A2), (A3), (A4)}\longrightarrow Q^D=\frac{wW_0}{P}=\frac{1}{b}(F_i-P)\longrightarrow Q_i^D=\frac{wW_0}{P}=\frac{1}{b}(F_i-P)$$

Therefore the demand function for every unconstrained investor would be :

$$Q_i^{DU} = \frac{1}{b}\ (F_i\text{-}P)$$

But, since we have assumed that short sale constraints bind every investor, the demanded quantity cannot be negative. Therefore, the demand for every short sale constrained investor is :

$$Q_i^{DC} = Max\{\ \frac{1}{b}\ (F_i\text{-}P),0\ \}$$

Appendix 1.2

Since investors opinions are uniformly distributed between (F-H, F+H) the aggregate demand should be the sum of the individual demands. Therefore there are two cases:

$$\text{CASE 1: P < F - H}$$

$$Q^{DC1} = \frac{1}{2H}\int_{F-H}^{F+H}\frac{1}{b}(F_i - P^{C1})dF_i = Q^{DU} \longrightarrow P = F - Q^{DU}b = P^C = P^U$$

$$\text{CASE 2: P > F - H}$$

$$Q^{DC2} = \frac{1}{2H}\int_{P}^{F+H}\frac{1}{b}(F_i - P)dF_i \longrightarrow P = F + H - 2\sqrt{HQ^{DC2}b} = P^C > P^U$$

Substituting P in the conditions and solving for P leads to some interesting pricing implications:

$$\text{CASE1}: H < \frac{Q^D}{\gamma_b} : P^C = F - \frac{Q^D}{\gamma_b} = P^U$$

and

$$\text{CASE2}: H \geq \frac{Q^D}{\gamma_b} : P^C = F + H - 2*\sqrt{\frac{H*Q^D}{\gamma_b}} \geq P^U$$

where $\gamma_b = \frac{1}{b}$ called risk tolerance

$P^c - P^U$ = overpricing

$F - P^c$ = the return

Overpricing will be equal to zero in the first case and positive in the second case. The return will be positive in the first case. In the second case,

$$F - P^c > 0 \text{ if } \frac{Q^D}{\gamma_B} < H < \frac{2Q^D}{\gamma_B}$$

$$F - P^c < 0 \text{ if } H > \frac{2Q^D}{\gamma_B}$$

In order to determine the predicted effect of dispersion of opinion on prices, overpricing and future returns we need to take the first derivative of each one towards the opinion dispersion parameter H.

In Case 1, the constrained price is not a function of opinion dispersion. Therefore,

In Case 1:

$$\frac{\partial P^c}{\partial H} = 0$$

$$\frac{\partial (P^c - P^U)}{\partial H} = 0$$

$$\frac{\partial (F - P^c)}{\partial H} = 0$$

In Case 2:

$$\frac{\partial P^c}{\partial H} = 1 - 2\sqrt{\frac{Q^D}{\gamma_B}}\frac{1}{2\sqrt{H}} \geq 0, \text{since in Case 2 H} \geq \frac{\mathrm{Q^D}}{\gamma_{\mathrm{B}}}$$

$$\frac{\partial (P^c - P^U)}{\partial H} = 1 - \sqrt{\frac{Q^D}{\gamma_B}}\frac{1}{\sqrt{H}} \geq 0$$

$$\frac{\partial (F - P^c)}{\partial H} = -1 + \sqrt{\frac{Q^D}{\gamma_B}}\frac{1}{\sqrt{H}} < 0$$