Analyst Recommendations

and

Option Market Reactions

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Abstract

This paper examines the effect of analyst stock recommendations on equity option market activity in US over the 1996 to 2002 period. I find that the implied volatilities of recommended stocks gradually increase up to the recommendation revision date and stay at the increased level after the revision for both upgrades and downgrades. However, this pattern of implied volatility movement in option market is not justified by the *ex post* realized volatility in the stock market. Cumulative abnormal returns on both calls and puts also start to increase as far as 10 trading days before the revision date regardless of the direction of the revision, whereas underlying stocks exhibit little pre revision activity. The results are robust to exclusion of important corporate announcement dates. A delta hedged trading strategy that shorts call options on recommendation revision date yields significant positive profits before transaction costs. The evidences suggest there is more information trading option market than in stock market and volatility underlying the stock price process may not be constant. Overall, options do not seem to be redundant securities.

1. Introduction

The value of stock analysts' recommendations has been the subject of debate in the academics as well as the popular media. Although the press doesn't seem to be much favorable to stock analysts in the midst of recent law suits against major brokerages, empirical evidence from academic literature documents that analysts' recommendations do affect individual stock prices.[1] This is generally taken as evidence against market efficiency, although the magnitude of the mispricing detected by analysts may not be large enough to provide arbitrage opportunities after trading costs.

The evidence in the underlying stock market naturally leads us to question the extent to which the option market may be affected by such analyst recommendations. Traditional view that been that if markets are perfect, in terms of information and frictions, and the prices for the underlying stocks follow a constant or deterministic volatility process, then options are redundant assets whose payoffs can be replicated exactly by other fundamental securities. Under such circumstances, option prices are completely characterized by underlying stock prices and the effect of analyst recommendations on options would be determined only through changes in the stock prices.

However, a growing body of literature recognizes the possibility that options may not be redundant securities.[2] The theoretical background for the possible non-redundancy has been focused on information asymmetry, suggesting that informed traders may prefer

1 For example, see Stickel(1995) and Womack(1996). Barber, Lehavy, McNichols and Trueman(2001) tests a trading strategy based on recommendations, Boni and Womack(2003) analyzes the performance by industry, Jegadeesh, Kim, Krishe and Lee(2003) evaluates trading strategies based on both recommendations and other stock characteristics such as momentum , and Jegadeesh and Kim(2003) provides international evidence.

[2] For example, Back(1993), Sheihk and Ronn(1994), and Coval and Shumway(2000)

to trade in the options due to various reasons such as leverage effect[3]. Subsequent research has attempted to identify indications of informed trading in the option market, mainly through option volume. Empirical evidence is still somewhat mixed as to whether option or stock market leads information trading, although more recent works on this subject seem to provide evidence in favor of information trading in the options.[4] A more radical behavioral approach in support of non redundancy is that stock markets and option markets are segmented in terms of the type of investors that participate in each market.[5] Generally, option market participants are assumed to be more sophisticated than stock market participants in that they are less affected by investor sentiment. If so, option market should exhibit less overreaction or underreaction to a specific event, compared to the underlying stock market.

Another stream of research on non-redundancy investigates the existence of negative volatility risk premium under stochastic volatility.[6] If volatility is stochastic and there exists negative correlation between underlying returns and volatility, generally referred to as 'Black effect' or 'leverage effect', then volatility risk premium could be negative, since options have positive vega and therefore would function as a hedging instrument in down markets.

In this paper, I investigate the redundancy hypothesis by testing constant volatility assumptions and the presence of information trading in the options market around analyst recommendation revisions. Analyst recommendations are distinct from other major corporate announcements such as earnings announcements in that other corporate events

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[3] Black(1975) first suggested that options are levered position in the underlying security.
[4] For evidence on stock market leading options, see Stephen & Whaley(1990) and Chan, Chung and Fong(2002) . For evidence on option market leading stocks, see Sheikh and Ronn(1994), Easley, O'hara & Srinivas (1998), and Pan and Poteshman(2003).
[5] For example, Lamont and Thaler(2000), Ofek, Richardson and Whitelaw(2003).
[6] See Poteshman(2000,2001), Coval and Shumway(2001), and Bakshi and Kapadia(2003).

are generally scheduled in advance, whereas recommendations are not.[7] If announcement is scheduled in advance, uninformed traders can place bets on volatility even without substantial private information, adding noise to the pre announcement option market activity.[8] In contrast, market activity before an unscheduled event should provide a more clean measure of information trading, if there is any at all.[9] Among the unscheduled events, analyst recommendations are the most frequent and thus provide a much larger sample of events compared to other events.[10]

The following analysis is focused on comparing the extent to which the option market is affected by analyst recommendations with the level of reactions in the underlying stock market. If options are redundant securities so that the prices are completely characterized by the underlying securities' stochastic process, then option prices should only mechanically reflect the changes in the level of the underlying stock price following a recommendation. And if there is no information trading in the options market, we should not be able to observe unusual movements in the option market activity prior to a recommendation revision.

To measure the price reactions in the option market, I focus on the implied

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[7] A few papers have investigates option market activity around important corporate announcements. For example, Patell and Wolfson (1981), Donders and Vorst(1996), Amin and Lee(1997), Donders, Kouwenberg, Vorst(2000), Isakov and Perignon(2001), Acker(2002), and Mahani and Poteshman(2003). Most of these have focused on earnings announcements, but this paper is the first in the literature to investigate option market reactions to analyst recommendations, as far as I know.

[8] Interestingly, Mahani and Poteshman(2003) show that unsophisticated investors enter option positions that load up on growth stocks relative to value stocks in the days leading up to earnings announcements, mistakenly believing that mispriced stocks will move even further away from fundamentals at impending scheduled news releases.

[9] Ederington and Lee(1996) also point out that the two types of events should be distinguished. Their unscheduled event is however defined indirectly as the days without scheduled events, so it is not clear what event affected the implied volatility. Some other examples of studies on unscheduled events are French and Dubofsky(1986), Sheihk(1989), and Cao, Chen and Griffin(2002). The first 2 papers analyze stock splits and the last paper analyzes takeover announcements.

[10] For example, number of total events considered in this paper is over 60,000, whereas Sheikh(1989) examines 83 stock splits.

volatility of the option rather than option prices themselves.[11] There are 2 basic reasons for relying on the implied volatility. First, under the assumption that option pricing model is correctly specified, implied volatility can be thought of as an option's price measure, free of the level of the underlying stock price. Moreover, even if model is not correctly specified, as long as option traders employ the model in calculating their reference prices, implied volatility would be a fair proxy for the option price level, holding all other factors (price of the underlying, time to maturity, interest rate, strike price, etc) fixed.[12] By looking at implied volatility rather than option prices, we can get rid of the effect of large stock price changes immediately following a recommendation.[13] If redundancy hypothesis is correct, we should not be able to detect a systematic change in implied volatility around a recommendation.[14] And if there is no information trading in the options market, we should not be able to see systematic changes in the implied volatility prior to the recommendation. Second, since implied volatility is free of the dollar price level, it is easier to handle cross sectional aggregation with implied volatility than with option prices themselves in an event study framework.

I find that implied volatility gradually increases prior to recommendation revision, which provides an evidence for information trading in option market. This increased level of implied volatility does not drop after the recommendation revision both for

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[11] Sheikh(1989) also points out the relative advantage of using implied volatilities rather than option prices.

[12] Note we are not trying to test the forecasting performance of implied volatility for the future volatility level over the life of the option. We only need to capture the variation in option price, net of the variation in the underlying stock.

[13] Sheihk and Ronn(1994) measures the variation in option prices that is separate from the changes in the underlying stocks by subtracting off model prices from actual prices. Although their methodology allows different volatilities for each day of the week (or each hour during the day), these day of the week (or hour of the day) specific volatilities are assumed to be fixed during the whole sample period, which might not reflect possible changes in the distribution of the underlying asset over time.

[14] If volatility is stochastic, actual distribution of the underlying stock can also change after a recommendation over the life of the option, which may lead to changes in implied volatility. This issue is addressed in section 3.

upgrades and downgrades. Moreover, the increase is not justified by *ex post* realized volatility over the life of the option. These evidences suggest that options may not be redundant securities and there may be other factors affecting option prices, such as negative volatility risk premium. To explore this issue further, I examine the gains to a delta-hedging strategy following a recommendation revision.[15] I find that selling a call after a recommendation revision and delta hedging it with a long position in the underlying stock results in significant profits, confirming negative volatility risk premium. For large firms, this strategy yields positive profits even after trading costs.

The remainder of the paper is organized as follows. Section 2 briefly describes the data and the sample. Section 3 presents empirical evidence on changes in implied volatility around recommendation revision date. Section 4 presents additional evidence of information trading in option market using cumulative abnormal returns and abnormal trading volume. Section 5 presents a robustness check, excluding observations around important corporate announcements. Section 6 explores possible negative volatility risk premium and overpricing in the option market by implementing a delta hedged trading strategy based on recommendations. And finally, some concluding remarks are given.

2. Data and Sample

I obtain recommendations data from IBES Detailed file and options data from OptionMetrics. OptionMetrics is a comprehensive dataset that contains daily price (bid, ask quotes), volume and open interest information for the entire US listed index and equity option markets. OptionMetrics also contains pre-calculated implied volatilities, as well as other sensitivity values (commonly known as the "Greeks") for all equity and index options. It also provides daily closing prices and returns of the underlying asset

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[15] The strategy is based on Bakshi and Kapadia(2003)

and continuously compounded daily interest rates for various maturities. The implied volatilities American style equity options are calculated by iterating Cox, Ross, and Rubinstein(CRR) binomial model which rely on constant volatility assumptions. The sample period is from January 1996 to September 2002.[16]

On the recommendation data, I impose the following criterion.

(a) There should be at least one analyst who issues a recommendation for the stock and revises the recommendation during the sample period,

(b) The analyst code should be available on IBES,

I impose these criteria since my primary focus is on the option market reaction after recommendation revisions.[17] Therefore, I do not include recommendations in my sample if an analyst makes only one recommendation for the stock, or if IBES does not provide an analyst code since I need the code to identify revisions.

I match the above revisions dataset with the options data with the following filters.

(c) The implied volatility and vega from the option on the recommended stock as well as the stock price should be available on the revision date[18].

(d) The bid-ask midpoint of the option should be at least $0.05 and both the bid and the ask price should be greater than 0 on the revision date.

(e) Options should be closest to expiration with at least 20 trading days left until maturity on the recommendation date.

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[16] IBES recommendations data starts in 1993, but availability of OptionMetrics data restricts the sample period to starts from 1996.

[17] This restrictions are the same as in Jegadeesh and Kim(2003). Prior research reports that recommendation levels are generally biased upward, and the information content in changes in recommendations (upgrades or downgrades) is greater than the levels themselves. See Womack(1996) and Jegadeesh and Kim(2003)

[18] Sometimes deep in the money options violate lower boundary condition. In these cases, option prices are generally quite high and implied volatility cannot be calculated because it has to be negative to match the lower bound. See Canina and Figlewski(1993) for a detailed discussion.

Selecting only the options with the same maturity is to reflect the fact that implied volatilities represent volatility of the underlying asset over the life of the option. Mixing options with different maturities can add noise to the implied volatility since options with different maturities may contain different volatility forecasts for different time horizon.[19]

In addition to the above 2 databases, CRSP distributions data and Compustat quarterly data were used to obtain important corporate announcement dates such as earnings and dividend announcement dates to be used in robustness check.

Table 1 provides the descriptive statistics of the sample. For comparison, I also report the summary statistics for all IBES recommendations, without conditioning on being optioned. There are a total of 28,045 upgrades and 34,696 downgrades in the sample. The average number of stocks per year in the sample is 1,601. This is roughly 40% of all the stocks covered in IBES recommendation revisions. However, in terms of analysts and brokers, the coverage of optioned sample amounts up to 80% and 90%, respectively. We do not observe significant difference in the number of upgrades and downgrades between optioned revisions and all revisions, although the level of recommendation seems to be slightly higher for optioned stocks.[20] The average number of options traded per stock in the sample is 8.3, and the total number of distinct option series, identified by underlying security, put or call, strike, and expiration date is 411,672 over the whole sample period. We can verify that average options per stock increased up

[19] I also tried the subsequent analysis without imposing the same maturity constraint, but the results are qualitatively similar, although the magnitude is a bit smaller.

[20] Analyst recommendations are generally issued in 5 levels; ``strong buy,'' ``buy,'' ``hold,'' ``sell,'' and ``strong sell.'' Analysts do use other labels such as ``market underperform'' and ``market outperform,'' or ``underweight'' and ``overweight,'' to convey their opinions, but IBES standardizes the recommendations, and converts them to numerical scores where ``1'' is strong buy, ``2'' is buy, and so on. I reverse score these numbers so that higher numbers correspond to favorable recommendations. I categorize recommendation revisions as either upgrades or downgrades by comparing them with the previous recommendation for the stock by the same analyst.

to 11.8 in 2000 and then returned to pre bubble level by 2002. This seems to suggest that heterogeneity in the investor beliefs may have increased during the tech bubble. For both panels, the level of recommendations reaches its peak in 1999 and 2000, and then drops significantly.

3. Implied Volatility Changes around Recommendation Revision Date

(1) some notes on how to measure implied volatility

Since many option series – identified by different strikes and expiration dates - trade at the same time for one underlying stock, how to obtain a good estimate of a single implied volatility at a given point in time should be an issue. As an extreme example, 690 different options were trading for AOL on April 13th, 1999, at the very height of the tech bubble. One simple way would be to just take a simple average of all available implied volatilities on a given day.[21] But this would not reflect the relative information quality of each option on implied volatility. Previous research suggests weighting each implied volatility by option vega - first derivative of option price with respect to underlying volatility – under the assumption that high vega options should estimate the true volatility more accurately.[22] A variation of this weighting scheme is to use option price's elasticity with respect to the volatility.[23] But this measure has a tendency to give more weight to out of the money options that have low prices. Some studies suggest using a single implied volatility that minimizes a function of the squared difference of observed option price and model (BS) price[24], but Ederington and Guan(2002) find that the result of this procedure is very similar to simply using high powered(squared or raised

[21] The averages should be taken among options with the same maturity for reasons previously discussed.
[22] See Latane and Rendleman(1976). Actually, their average was weighted geometric average, so the weights do not sum to 1, and is biased toward zero as noted by Chiras and Manaster(1978) and Ederington and Guan(2002). In this paper, I use arithmetic average, following subsequent research on this topic.
[23] See Chiras and Manaster(1978)
[24] For example, Beckers(1981) and Whaley (1982)

to the 4th power) vega as weights. Moreover, there is also some evidence that weighting does not provide much additional information[25]. In this paper, I report the results based on vega-weighted averages of implied volatility from options that are closest to the next expiration date, but with at least 20 days to maturity on the recommendation revision date.[26] The implied volatilities are obtained separately for calls and puts. Combined implied volatility is also calculated using both puts and calls.

(2) Implied Volatility Changes: ±10 day Event Time Analysis around Revision Date

Implied volatility for recommended stock *i*(i = 1, 2, …28,045 for upgrades, i = 1, 2,...34,696 for downgrades) on event day *j* (j = -10, -9, …..9, 10) is calculated as follows;

$$\sigma_{ij,implied} = \sum_{x=1}^{n_{ij}} \frac{\dfrac{\partial p_{ijx}}{\partial \sigma_{ijx,implied}}}{\sum_{x=1}^{n_{ij}} \dfrac{\partial p_{ijx}}{\partial \sigma_{ijx,implied}}} \sigma_{ijx,implied}$$

where n_{ij} is the number of options traded on stock *i* on day *j* and p_{ijx} is the price of option *x* on stock *i* on day *j* and σ_{ijx} is the implied volatility from option *x* on stock *i* on day *j*, i.e. implied volatility is a vega - weighted average all available implied volatilities.[27] Only the options having shortest time to maturity with at least 20 days left until expiration as of the recommendations revision date (day 0) are selected.[28] Since changes in implied volatility may reflect changes in the actual distribution of returns, I also calculate annualized *ex post* realized volatility over the life of the option and past historical volatility for stock *i* on day *j* as follows;

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[25] See Ederington and Guan(2002) for a detailed discussion.

[26] I have also tried selecting a single implied volatility from the at the money option with the shortest time to maturity with at least 20 days left until the expiration. The results are qualitatively the same.

[27] If multiple revision is made on the same stock on the same day, they are treated as distinct observations, i.e. *i*'s index each recommendation revision rather than stocks themselves, to be exact.

[28] Options that violate the lower and upper boundaries on a given day during the event period as well as options with bid ask mid point less than \$0.05 or either bid or ask price equal to \$0.00 are excluded from the calculation of average implied volatility on that day.

$$\sigma_{ij,realized} = \sqrt{\frac{252}{\tau_{ij}-1}\sum_{k=0}^{\tau_{ij}}(r_{ij,k}-\bar{r}_i)^2} \quad \text{and} \quad \bar{r}_i = \sum_{k=0}^{\tau_{ij}} r_{ij,k} \Big/ \tau_{ij}$$

where τ_{ij} is the number of days until expiration on day *j* for stock *i*, and $r_{ij,k}$ is the return on k^{th} day from day *j*.

$$\sigma_{ij,past44} = \sqrt{\frac{252}{44}\sum_{k=j-44}^{j}(r_{ij,k}-\bar{r}_i)^2} \quad \text{and} \quad \bar{r}_i = \sum_{k=j-44}^{j} r_k \Big/ 44$$

Past 44 trading days were selected to calculate historical volatility because average time to maturity on day –10 was 41.5 days in the sample.

Figure 1 presents average implied volatilities from calls, puts and all options for each event day *j*, as well as *ex post* realized volatility and past historical volatility. Overall, implied volatility gradually increases prior to recommendation revision date, reaches its local peak on day 0 for downgrades and day –1 for upgrades, and then stays around the increased level after the revision date. The magnitude of average pre revision increase in implied volatility is 5.6% point for downgrades and 2.2% point for upgrades, showing larger changes for downgraded stocks. This is in contrast to previous studies on stock splits, where the announcement is not anticipated by implied volatilities.[29] To formally test whether gradual increase and persistence of the implied volatility around recommendation revision is significant, I estimate the following dummy variable regression model[30];

$$(\sigma_{ij,implied} - \bar{\sigma}_{ij,implied}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$$

where *i* indexes each recommendation and *j* indexes each event date. $\bar{\sigma}_{ij,implied}$ is the

[29] See French and Dubofsky(1986) and Sheihk(1989). They also report that implied volatility is higher after the split announcement, similar to the results in this paper.
[30] This specification is similar to Ederington and Lee(1996), Donders and Vorst(1996) and Donders, Kouwenberg, Vorst(2000), where they test the implied volatility changes around earnings announcement dates.

average implied volatility for the whole event period, and D_{ij} is a dummy variable set to 1 if the observation is for day j and 0 otherwise. If there is no significant change in the implied volatility around recommendation revision date, all α_j's should not be significantly different from zero, and $\sigma_{ij,implied}$ should be modeled as a sum of $\bar{\sigma}_{ij,implied}$ and a random error. Note that the coefficient for each dummy variable measures average deviation from $\bar{\sigma}_{ij,implied}$ for each event day *j*. To test whether the implied volatilities *after* the revision date is different among each event day, I estimate the following dummy variable regression;

$$(\sigma_{ij,implied} - \bar{\sigma}_{ij,implied(j=0,1..10)}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$$

where $\bar{\sigma}_{ij,implied(j=0,1..10)}$ is now the average implied volatility obtained from days 0 to 10 only. Table 2 presents the results from these regressions. The last 4 columns present results based on the second model, where the deviations are from the average of the implied volatilities after the revision date. For upgrades, the combined implied volatilities from both calls and puts are significantly different from the average implied volatility for days –10 to –4 and days +3 to +10. Moreover, the coefficients are monotonically increasing. From days –3 to +2, the deviations from the averages are not significantly different from zero, except on day –1 where implied volatility shows a significant jump. For downgrades, the coefficients are generally larger and more significant, consistent with figure 1, and only day –1 has insignificant deviation from zero. The last 4 columns show the results of the test whether implied volatilities are different from the average implied volatility calculated using only the implied volatilities after the revision date. For upgrades, days –2 to +8 are not significantly different from after revision average implied volatility, except for day +1. For downgrades, days 1 to 10 are not significantly different. The results also provide support that implied volatility reaches its local peak on day –1 for upgrades and day 0 for downgrades, with the magnitude for upgrades being smaller than for downgrades.

Having established that implied volatility after the revision is significantly larger than the pre revision period, I then investigate the possibility that this change might just reflect the actual changes in the underlying distribution, by comparing implied volatility with the past historical volatility and *ex post* realized volatility over the remaining life of the option. First, implied volatility changes seem to roughly reflect the changes in the past historical volatility. From figure 1, we can verify that implied volatility moves very closely with the historical volatility using past 44 trading days.[31] Historical volatility is slightly flatter than implied volatility until day –2, and then jumps on day –1 and day –2 to reflect large changes in underlying stock returns on day 0. This similarity between implied volatility and past historical volatility suggests that option traders may be taking past historical volatility as an important input in their option pricing formulas.

However, this increase in implied volatility is not justified in terms of the *ex post* realized volatility over the remaining life of the option. Figure 1 shows that *ex post* realized volatility remains fairly stable until the revision date[32] and then actually drops after the revision for both upgrades and downgrades. The magnitude of the decrease in *ex post* volatility is similar to the magnitude of increase in implied volatility. The mechanical reason behind this drop is that the large change in underlying stock prices on

[31] I also compared implied volatilities with historical volatilities calculated from past 66 and 132 trading days. The results are qualitatively similar, although the longer time periods tends to smooth out historical volatilities.

[32] The pre revision ex post volatility for each day j (j = -10 to 0) is not significantly different from the average implied volatility over this event period, except for day –1 and day 0 for upgrades and day 0 for downgrades , according to the dummy regressions in a similar fashion as is done for implied volatility.

day 0 is not included in the *ex post* volatility calculation, starting from day 1.

According to Black's leverage effect, volatility should increase following negative returns and decrease after positive returns. The decrease in *ex post* volatility for upgrades seems to be consistent with leverage effect, since upgrades are generally related with positive returns. However, decrease in *ex post* volatility for downgrades may seem as a contradiction to leverage effect, since downgraded stocks exhibit a large price drop following a revision. I conjecture that this seemingly inconsistent results for downgrades stocks is from the fact that sample standard deviation used to estimate *ex post* volatility depends on relatively short time to maturity, around 30.5 trading days on average from day 0 in my sample. Under such short time horizon, recommendation revision may have been the biggest event that affected underlying stock returns, so the returns could have remained relatively stable once revision is made, at least until expiration.[33]

Two other points may be of interest from figure 1. First, implied volatility for downgraded stocks is generally higher than upgraded stocks. This suggests that analysts may not like stocks with high volatility. Assuming negative correlation between volatility and past returns, downgraded stocks could potentially be past losers, or at least has lower return ranking than upgraded stocks.[34] Second, average implied volatilities calculated from puts are always greater than average implied volatilities from calls for each event day *j*. Previous research also documents this phenomenon but the explanation is not perfectly satisfactory [35]

To examine the degree of deviation of implied volatility from ex post realized

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[33] Sheik(1989) finds that standard deviations estimated from post split announcement(31 trading days) is higher compared to pre announcement(30 trading days). In contrast, past 44 days historical volatility on day –1 is significantly greater than *ex post* realized volatility on day + 1 in my sample.
[34] See Jegadeesh, Kim, Krishe, and Lee (2003) and Jegadeesh and Kim(2003)
[35] See Whaley (1986) and Harvey and Whaley (1992). Whaley points out portfolio insurance aspect of put options.

volatility and also from past historical volatility, figure 2 presents the average difference between implied volatility and ex post volatility over the life of the option on day *j* as well as the average difference between implied volatility and historical volatility calculated using past 44 trading days. For both upgrades and downgrades, implied volatility is less than *ex post* volatility prior to the revision date, but becomes greater after the revision date. From this, we can see that changes in implied volatility net of the changes in *ex post* realized volatility is even greater than raw changes. The deviation of implied volatility from past historical volatility is smaller compared to the deviation from *ex post* volatility. The differences between implied volatilities and *ex post* realized volatilities are statistically different from zero for most cases.[36]

Finally, to measure the changes in implied volatility net of the effect of changes in the past historical volatility and ex post realized volatility, I implement a two step dummy regression. First, I regress implied volatility on past historical volatility and/or ex post realized volatility. I then obtain the residuals from these regressions, and regress the residuals on the 21 event day dummies. To be specific, the following 3 models are estimated separately in the first step.

$$\sigma_{ij,implied} = \beta_0 + \beta_{past}\sigma_{ij,past44} + \varepsilon_{ij}$$

$$\sigma_{ij,implied} = \beta_0 + \beta_{realized}\sigma_{ij,realized} + \varepsilon_{ij}$$

$$\sigma_{ij,implied} = \beta_0 + \beta_{past}\sigma_{ij,past44} + \beta_{realized}\sigma_{ij,realized} + \varepsilon_{ij}$$

The following dummy regression model is estimated for each of the 3 residual series obtained from the first step.

$$\hat{\varepsilon}_{ij} = \sum_{j=-10}^{10}\alpha_j D_{ij} + \nu_{ij}$$

[36] The exceptions are day –4, –3 combined implied volatility, day –1 call implied volatility, and day –6, -5, -4 put implied volatility for upgrades.

where D_{ij} is a dummy variable for each event day as defined before. $\hat{\varepsilon}_{ij}$ will be referred to as the 'net implied volatility' in the subsequent discussions.

The adjusted R^2's for the 3 models in the first step are 70.8, 57.9, and 76.8 respectively. This suggests that implied volatility is largely determined by past volatility, although *ex post* realized volatility also has some incremental effect.[37] Table 3 presents the results for the second step regressions. Overall, we can verify that implied volatility still increases gradually before the recommendation revision date even after taking out the effect of past historical volatility and ex post realized volatility on implied volatility. Controlling for past volatility and realized volatility separately yield coefficients that are reminiscent of figure 2. Net implied volatility after controlling for both past volatility and ex post realized volatility still shows similar patterns as depicted in figure 1, except that it continues to increase after the revision. We can also verify that net implied volatility for up revisions decrease substantially on day 0. The drift of net implied volatility after the revision date suggests that option market investors may not be more sophisticated in general as is suggested by recent behavioral models.

In summary, implied volatility gradually increases before the recommendation revision date and then stays at the increased level for the rest of the event period. This suggests that there may be information trading in the option market. Moreover, the increase in implied volatility cannot be justified by *ex post* realized volatility. This suggest that constant volatility option pricing model may be misspecified, resulting in overpricing of option prices compared to constant volatility model prices. Or, option market may be overreacting to recommendation revision, as is implied by the patterns in

[37] I also examined another specification with daily stock return volatility defined by $\sigma_{ij.daily} = |r_{ij}|\sqrt{252}$ as additional control variable, but this had almost no effect on the results.

net implied volatility. Information trading in option markets and violation of constant volatility assumptions both imply that options are not just redundant assets. I now explore the above two implications in the section 4 and section 6, respectively.

4. Information Trading in Option Market[38]

The previous literature on implied volatility in an event study framework is not quite extant, and most of them were focused on earnings announcements.[39] These studies document that implied volatility increases substantially before the earnings announcement and then reverts back to the long run average level after the announcement, although there is some variation on the timing of the reversion. In contrast, the results presented in this paper suggest that implied volatility does not drop after a recommendation revision. However, the two events are basically different in that earnings announcement is a scheduled event, in which the content of the news is private information, but the date of the release is public information[40]. Consequently, it should not be difficult to verify that implied volatility increases before the announcement - since everyone is expecting something to happen, but does not know the direction - and this uncertainty is resolved after the announcement, leading to a mean reversion in implied volatility. But in recommendation revisions, the date of the revision is not publicly known until the revision is actually issued. Therefore, there is no theoretical reason to

[38] The results in this section are based on options within ±10% moneyness range since deep in or out of the money options are relatively insensitive volatility and tend to be fairly illiquid; moneyness is defined as y = $(S_t - PVD)\, e^{r(\tau/252)}/K$, where S_t is the underlying stock price on day t, PVD is the present value of the dividends paid over the life of the option, r is the continuously compounded zero coupon interest rate until maturity, τ is the time to maturity in trading days and K is the strike price. I also tried the same analysis without any moneyness restrictions. The results are qualitatively the same.

[39] For example, Patel and Wolfson (1981), Donders and Vorst(1996), Donders, Kouwenberg, Vorst(2000), Isakov and Perignon(2001), and Acker(2002). The first paper uses US data from 08/1976 to 10/1977, the next 2 papers use Dutch data, the 4th paper uses Swiss data, and the last paper uses data from UK.

[40] There can be cases when a recommendation revision is issued very close to an important corporate announcement. This issue will be dealt with in section 5.

expect that implied volatility would increase prior to recommendation revision date, unless there is a change in the actual distribution of the underlying asset before the revision date and the market somehow captures this change or, some analysts provide private information to their client option investors prior to issuing a public recommendation revision. But, as we have seen from figure 1, ex post realized volatility is relatively stable in pre revision period, whereas implied volatility gradually increases, which leaves us with more emphasis on information trading in option market as a possible explanation for gradual increase in implied volatility.[41]

Another possibility is that informed option investors are providing private information to stock analysts, and analysts are revising their recommendations according to these private information from option investors. If so, then the value that analysts add to stock prices may just reflect information transmission from option market to stock market, and the previous research on stock market reactions may have been overestimating analysts' skill. I do not pursue causality of information transmission between stock analysts and option investors in this paper, since information trading in option market is supported in either case.

(1) Cumulative Abnormal Returns around Recommendation Revision Date

To explore the possibility of information trading in option market in more detail, I examine the magnitude and significance of cumulative abnormal returns for underlying stocks, calls and puts, following an upgrade or a downgrade, over the 21 day event window. j-day cumulative abnormal return for stock i is obtained as;

[41] Pan and Poteshman (2002) report that roughly 70% of option trading is from public customers of full service brokerages. This suggests that option investors may have better access to analyst's information prior to recommendation revision compared to stock investors.

$$CAR_i(J) = \prod_{t=-10}^{j}(1+r_{it}) - \prod_{t=-10}^{j}(1+r_{mt})$$

where r_{it} and r_{mt} are the day *t* return for stock *i* and CRSP value weighted index return.[42] The results are presented in table 4 and figure 3. First, cumulative returns for underlying stocks exhibit patterns that are consistent with the previous research.[43] That is, upgraded stocks exhibit a jump on day 0 without a significant trend prior to a revision, downgraded stocks show a drop on day 0 with mild gradual decrease prior to a revision, and the magnitude of the drop for downgrades is larger than the jump for upgrades. For example, the cumulative returns to upgrades are not statistically different from zero until day –2.

In contrast, cumulative option returns increase substantially prior to a revision date. Once a revision is made, option returns exhibit a much larger jump or a drop compared to the underlying stock, according to the direction of the revision (up or down) and type of the option (call or put), reflecting the fact that options are levered position in the underlying stock. What is more interesting is that options show a gradual increase in cumulative returns regardless of the direction of the revision and the type of the option prior to the revision date. All pre revision option returns are significantly different from zero except for day –9 put returns for down revisions. This seems to suggest that option investors may have some private information prior to actual issue of a recommendation revision.

We should also note that upward drift for calls on upgrades stocks and puts on downgrades stocks reverse their courses as early as day 5, whereas upgraded stocks

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[42] If the daily returns used to calculate cumulative returns for the same event period overlap in calendar time, the cumulative returns for this event window will be correlated. Since the maximum number of days in cumulative return calculations is 21 days, I assume that the cumulative returns are not correlated in when I calculate the standard errors. For standard errors that takes correlation structure explicitly into account, see Jegadeesh(2000) and Jegadeesh and Kim(2003).

[43] For example, Womack(1996)

exhibit a mild upward drift throughout the event period.[44] Downward drift for downgraded calls and upgraded puts show a similar pattern as in stocks, although the magnitude is larger, reflecting leverage effect. This large downward drift leads us to question the behavioral assumptions that option market investors may be more sophisticated than stock market participants, since we should observe smaller drift if the option market participants are more sophisticated.

(2) Trading Volume and Open Interest around Recommendation Revision

To further investigate possible information leakage in option market, I examine trading volume and open interest around recommendation revision date. Since trading volume and open interests vary across stocks, I compute a measure of standardized volume and open interest during an event window covering 20 days before and 20 days after the recommendation. I define standardized volume (SV_{ij}) for stock *i* on day *j* as:

$$SV_{ij} = \frac{Volume_j^i}{\left(\sum_{\tau=-20}^{20} Volume_j^i\right) \times \frac{1}{41}},$$

Where $Volume_j^i$ is the number of shares traded on day *j*, suitably adjusted for any splits within this window.[45] Standardized volume and open interest for calls and puts are defined in the same manner. Figure 4 plots the average standardized volumes for underlying stocks, calls and puts as well as standardized open interests for calls and puts. Standardized volume for underlying stocks exhibit a familiar pattern as is documented in

[44] Previous research documents that this upward drift can be persistent up to 6 months. See Womack(1996) and Jegadeesh and Kim(2003).
[45] If the number of days within an event window for which volume data are available is less than 41, I divide by that number, instead of 41.

the previous research.[46] Stock trading volume starts to pick up around day –3 to –2, reaches its peak on day 0, and then returns to normal level over the next 3 to 4 days. The peak is higher for downgrades than for upgrades. Option trading volume shows similar pattern as stock volume after the recommendation revision date. However, in contrast to stock volumes, option volumes start to pick up from the very beginning of the event period and gradually increases until day 0. This pattern is similar to implied volatility depicted in figure 1. Again, this suggests that there may be more information trading in option market than in stock market. Table 5 reports the dummy regression results for stocks, calls and puts, according to the following specification.

$$(S_{ij} - \bar{S}_{ij,(j \neq -1,0,1)}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$$

Days –1, 0, and 1 are excluded in obtaining $\bar{S}_{ij,(j \neq -1,0,1)}$ in order to eliminate the effect of large abnormal trading volume on these days. The coefficients are generally significantly different from zero for calls and puts as well as for stocks. However, the magnitudes of the coefficients for options are 8 to 10 times larger than stocks for up to day –4, confirming the results from figure 4.

Standardized open interest exhibits slight convexity before revision date and close to a linear relationship or slight concavity after the revision date. This suggests that much of the large trading volume just around day 0 may be involved with closing out existing positions, rather than opening up new positions. The investors closing out existing positions may be realizing gains depicted in figure 3.

We should be careful that the large trading volume around day 0 does not tell us much about the direction of trades. The phenomenon is consistent with either larger net

[46] For example, Womack(1996)

buys or larger net sells. A recent paper by Lakonishok, Lee, and Poteshman (2003) finds that option investors have larger short positions than long positions in general, which is quite contrary to casual intuition. They argue that this larger short position in calls may be related with writing covered calls, which in practice is considered as reflecting a mildly bullish belief. Under such circumstances, short position or net sells of calls should not necessarily reflect pessimistic beliefs. Consequently, it is not clear that high trading volume for upgrades on day 0 are from net buys or net sells. For example, higher net sells on upgraded calls could results from uninformed investors obtaining a long position in the stock and writing a fresh new covered call on day 0 or informed investors closing out their existing long positions after reaping high gains up until day 0.

(3) Bid-Ask Spread Changes around Recommendation Revision Date

Microstructure literature on information asymmetry predicts that the market maker may increase bid ask spread when faced with informed traders, not to be taken advantage of.[47] To explore this issue, I examine the changes in the bid ask spread, defined as (ask – bid)/(ask + bid)0.5, around the recommendation revision date. Figure 5 presents the average bid ask spread over the 21 day event period. We can see that the average bid ask spread decreases monotonically before the revision date, reaches bottom on day 0, and then increases monotonically after the revision date. This is consistent with the previous literature that documents negative relationship between bid-ask spread and trading volume.[48] To eliminate the effect of trading volume as well as the possible effect of option price level on bid-ask spreads[49], I employ a 2 step regression approach similar

[47] For example, Kyle(1985)

[48] See Donders, Kouwenberg and Vorst(2000) for a detailed discussion.

[49] Bid-ask spreads tend to be large when prices are low. The correlation between spread and bid ask mid point is –0.26 for calls and –0.23 for puts, which is actually much larger in magnitude than correlation between spread and abnormal volume (-0.03 for both calls and puts.) For example, when bid price is zero,

to the one taken for implied volatilities. To maintain tractability, only the options that are closest to money on day 0 are included in this analysis. The first step regression is ran separately for calls and puts as follows.

$$spread_{ij}^{bid,ask} = \beta_0 + \beta_{past} SV_{ij} + \beta_{realized} mid_{ij}^{bid,ask} + \varepsilon_{ij}$$

The second step the same as described in section 3, where the residuals of the first regression is regressed on the event day dummies. Table 6 reports the results for the second step regression. The spread tends to decrease up to day 0 and then increase, even after taking out the effect of abnormal trading volume and price level. This suggests that market makers were not anticipating informed trading in option market in the sense of microstructure theory. Interestingly, the coefficients for upgraded calls and downgrades puts show very similar pattern. This is also true for downgraded calls and upgraded puts.

5. Robustness Check: Excluding Corporate Announcement Dates

One may argue that recommendation revisions usually occur right before or after an important corporate announcement such as earnings or dividend announcement, and therefore the previous results may reflect the impact of other original corporate announcements rather than recommendation revisions themselves. To explore the extent to which the impact on implied volatility is affected by corporate announcements, I analyze the subsample in which those revisions with the earnings announcement or any distribution (dividends, splits, etc.) related announcement within the 21 day event period are excluded from the sample.

Out of 81,666 recommendation revisions in the sample, 33,193 (40.1%) had an earnings announcement, 12,637 (15.5%) had a distribution announcement and 7,347

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the spread is automatically 2, the maximum available value.

(9.0%) had both earnings and distribution announcement within 21 day event period. Excluding these observation results in a subsample of 43,183 recommendation revisions, which reduces the sample size to almost a half of the original sample. This reduction verifies that revisions are quite contemporaneous with corporate announcements.

Figures 6 and 7 presents the implied volatilities and cumulative abnormal returns for this subsample in the same manner as in figures 1 and 3 for the whole sample. Figure 6 is shows the same characteristics as in figure 1, except that implied volatility for upgraded stocks start to drift up just after a recommendation revision and that implied volatilities are slightly higher than the whole sample. Cumulative abnormal returns in figure 7 are shows almost the same pattern as in figure 3. In short, gradual increase in implied volatility and cumulative abnormal returns for options prior to the revision date still exists even after excluding corporate announcement related observations.

6. Gains to Delta Hedged Trading Strategy

The large positive difference between implied volatility and *ex post* realized volatility after day 0 suggests that options may be overvalued for the remaining life of the option. To investigate the extent of this potential mispricing, I calculate the gains to a delta hedged trading strategy, described as follows. On each recommendation revision date, I locate all call options having shortest time to maturity but with at least 20 trading days left until expiration. These options are shorted as long as bid price is greater than 0. The proceeds from this short position are invested in the underlying at the rate of delta. Whatever remaining is invested in the riskfree asset and the position is rebalanced daily.[50] To be specific, for each recommendation *i*, the total delta hedged gain up to the expiration

[50] Options that violate the lower and upper bounds on day zero are excluded from this analysis.

date is calculated as follows.[51]

$$\pi^{i}_{t,t+\tau} = C_t - \max(S_{t+\tau} - K, 0) + \sum_{k=1}^{\tau} \Delta_{t+(k-1)} (S_{t+k} - S_{t+(k-1)}) + \sum_{k=1}^{\tau} r_{t+(k-1)} (C_t - \Delta_{t+(k-1)} S_{t+(k-1)}) \frac{1}{365}$$

where τ is the time to maturity from date t, Ct is the option price date t, S_{t+k} is the stock price on date $t+k$, K is the strike price, Δ_{t+k} is the delta hedge ration on date $t+k$, and r_{t+k} is the riskfree rate with maturity (τ-($t+k$)) on date $t+k$. The daily deltas and riskfree rates are obtained from OptionMetrics.[52] The first 2 terms measures the gains from being short in the call. If the call matures out of the money, the investor gets to keep the initial premium taken at day t, but if it matures in the money, the investor loses by the amount of the maturity value of the call. The second component captures the gains from price changes for being long in the stock, which basically hedges short position in calls. The last term measures the gains from risk free investment using whatever is left from the first 2 positions.[53]

Since many of the options pay dividends over the remaining life of the option, early exercise can be an issue in calculating the gains to delta hedged position. To address this issue, call options are assumed to be exercised on day $t+k$ if $D_{t+k+1} > K(1-e^{-r(\tau-(t+k))/365})$, where D_{t+k+1} is the dividend to be paid on day $t + k + 1$. In such cases, the delta hedged position is closed out on day $t + k$ and the gains to this position is calculated as of this day.

[51] This calculation basically follows Bakshi and Kapadia(2003). Bakshi and Kapadia consider a long position in the option with a short position in the underlying, whereas the opposite position is considered in this paper. The difference results in only opposite sign if bid ask midpoint is used, but gains considering transaction cost can be different because bid price is used for short option positions and offer price should be used for long option positions.

[52] Delta can be missing from OptionMetrics if the option is deep in or out of the money so that implied volatility cannot be calculated. In this case, I replace delta with 1 if the option is in the money on that day and with 0 if the option is out of the money.

[53] The last term is generally very small compared to the first 2 components, due to relatively short time to maturity exhibited in the sample.

To allow for delays in forming the hedged position after each recommendation revision is made, t is set to 0, 1, and 5. t = 0 implies that the hedge portfolio is formed on the revision date without any delay, and t = 5 implies that hedge portfolio formed on 5th day after the revision is made. Table 7 presents the average gains to above strategy. Panel A presents results with C_t set to bid ask midpoint, and panel B presents results assuming that the short option position was established at bid price. I subdivide the sample into large and small stocks to see if there is any size effect.[54]

Overall, delta hedged trading strategy with short position in the call option yields significant positive gains when bid ask midpoint is used to calculate the gains. For example, average gain for all stocks and all revisions is $0.13 and is statistically different from 0.[55] This is consistent with the previous research by Bakshi and Kapadia(2003a,b).[56] The dollar amount of gain is smaller compared to average gain of $0.43 reported in Bakshi and Kapadia (2003a) using S&P500 index options. However, in terms of π/S, the numbers reported here are close to 10 times larger than theirs. For example, gains relative to underlying stock price is 0.51% for all firms and all revisions in table 4, but Bakshi and Kapadia's index hedge positions lose about 0.05% of the index level[57].

We can also verify that the magnitude of the gains decrease monotonically as we

[54] Since the stocks in the sample are generally large, I classified stocks that fall in decile 9 and 10 of NYSE size decile as of the end of the previous year of the recommendation as large firms to split the sample into subsamples of about equal size.
[55] Since time to maturity is relatively short for each position, I assume that each delta hedged gains are independent observations in estimating standard errors.
[56] Their trading strategy is does not employ any conditional information such as recommendation revision.
[57] Their position involves buying options and shorting stocks, which is exactly the opposite of the position considered here, resulting in a loss instead of a gain. In another study, Bakshi and Kapadia(2003b) analyze unconditioned delta hedged gains to 25 individual stocks. The gains (π/S) are generally smaller than reported in this paper. For example, the largest π/S reported is 0.26% of Walt Disney.

increase the delay in hedge portfolio formation.[58] There is virtually no difference in delta hedged gains between upgrades and downgrades. This is probably due to the offsetting position in the underlying asset. In contrast, gains in dollar terms are much larger and more significant for large firms. This difference is more evident in panel B. Large firms still exhibit significant positive returns when bid price is used as the selling price of the call option, whereas gains to small firms are significantly negative. But overall, delta hedged gains incorporating trading costs are generally negative or not significantly different from zero. This might be taken as evidence that option market is fairly efficient considering all trading costs. On the other hand, this may reflect the illiquidity of option market rather than market efficiency. For example, average bid-ask spread in the sample as measure by (ask-bid)/ 0.5 (ask+bid) on the revision date is 22%.

Table 8 presents summary of delta hedged gains for each year in the sample period. The dollar amount gains show some variation over the years. For example in 2000, average delta hedged gains is negative. This is mainly due to sharp increases in stock prices during the height of the tech bubble. In times of extreme price increases, the delta's obtained from CRR binomial model were not large enough to fully hedge the changes in the prices of the call options written, resulting in a loss. We can also see that the standard deviation of the gains more than doubled during the bubble, suggesting that delta hedged strategies are more variable when there are large price changes. However, median dollar amount gains and gains relative to the underlying stock's price have been more stable over time, confirming that positive delta hedged gains is a general phenomenon rather than a time specific one.

[58] This is similar to what Jegadeesh and Kim(2003) report for a trading strategy using recommendation revisions to form a zero cost portfolio composed of long position in upgraded stocks and short position in downgraded stocks.

Figure 8 presents month by month average relative gains (π/S) to delta hedged strategy with no delay using bid ask midpoint. Gains following upgrade revisions are negative for 24 months and the same for downgrades are 15 months out of 80 months. The largest loss on upgraded strategy is on March 2000, at the very height of the bubble. Figure 9 presents sample distributions of the above statistic for the whole sample period for upgrades and downgrades separately. We can verify that mean, median and mode are all well above zero.[59]

7. Conclusion.

Although Black Scholes option pricing formula and CRR binomial model may still be widely used by practitioners, growing empirical evidence suggests that their assumptions may be misspecified. This paper examines the traditional redundancy hypothesis by providing evidences of information trading in option market as well as evaluating the validity of constant volatility assumption. Analysts recommendations provide an interesting setting for exploring information trading because they are unanticipated events.

I find that the implied volatilities of recommended stocks gradually increase up to the recommendation revision date and stay at the increased level after the revision for both upgrades and downgrades, but this increased level is not justified by the *ex post* realized volatility. Cumulative abnormal returns on both calls and puts also increase well before the revision date regardless of the direction of the revision, whereas underlying stocks exhibit little pre revision activity. Abnormal trading volume shows similar patterns. These findings suggests that information trading is more prevalent in option market than in the stock market. I also examine gains to a delta hedged strategy in order

[59] Actually, Prob($\pi/S>0|\text{up}$) = 65.3% and Prob($\pi/S>0|\text{down}$) = 67.3% for the whole sample period.

to explore the possibility of overpricing and negative volatility risk premium in options. These gains yield significant positive profits before transaction costs. For large firms, positive profits are possible even after trading costs, suggesting constant volatility assumptions may be misspecified. Information trading in option market and the breakdown of constant volatility provides further evidences that options may not be simple redundant assets.

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Table I: Descriptive Statistics of the Sample

This table presents the descriptive statistics of the sample. Panel A presents the summary statistics for the sample as described in sections 2, and panel B presents the summaries for all recommendations revisions from IBES. The last row in each panel present sum of all years for number of recommendation revisions and averages for other columns. The sample period is from January 1996 to September 2002.

Panel A: Sample (Optioned stocks only)

						Recommendations Revisions					
	All optioned stocks	Stocks	Options/stock	Analysts	Brokers	Upgrades	%	Downgrades	%	Total	Avg. Recomm.
1996	2,207	970	5.35	1,422	150	2,869	40.68%	2,773	39.32%	7,053	3.83
1997	2,680	1,240	6.94	1,705	174	2,872	37.07%	3,155	40.73%	7,747	3.85
1998	2,983	1,486	7.53	2,074	203	3,802	37.39%	4,430	43.57%	10,168	3.86
1999	3,104	1,678	8.61	2,480	197	5,100	41.29%	4,622	37.42%	12,351	3.95
2000	3,036	1,893	11.79	2,510	198	4,506	34.71%	5,849	45.06%	12,981	3.93
2001	2,672	1,940	10.13	2,477	174	4,601	32.25%	6,581	46.13%	14,265	3.83
2002.9	2,499	1,997	7.83	2,448	160	4,295	25.12%	7,286	42.61%	17,101	3.69
Avg/sum	2,740	1,601	8.31	2,159	179	28,045	34.34%	34,696	42.49%	81,666	3.85

Panel B: All Recommendation Revisions (including non optioned stocks)

	All optioned stocks	Stocks	Options/stock	Analysts	Brokers	Upgrades	%	Downgrades	%	Total	Avg. Recomm.
1996	-	3,977	-	2,020	177	6,484	37.33%	7,110	40.93%	17,369	3.79
1997	-	4,219	-	2,315	211	5,859	34.31%	7,417	43.44%	17,075	3.83
1998	-	4,437	-	2,700	230	6,791	34.40%	9,249	46.85%	19,742	3.81
1999	-	4,350	-	3,015	217	7,784	38.03%	8,286	40.48%	20,468	3.88
2000	-	4,020	-	2,950	212	6,407	33.27%	8,871	46.07%	19,255	3.89
2001	-	3,651	-	2,862	186	6,003	30.57%	9,265	47.18%	19,637	3.79
2002.9	-	3,680	-	2,800	169	5,559	24.00%	10,099	43.60%	23,164	3.63
Avg/sum	-	4,048	-	2,666	200	44,887	32.83%	60,297	44.11%	136,710	3.80

Table II: Dummy Variable Regression Results for Implied Volatility around Recommendation Revision

This table presents results for model $(\sigma_{ij,implied} - \overline{\sigma}_{ij,implied}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$ as described in section 3. The last 4 columns presents results for $(\sigma_{ij,implied} - \overline{\sigma}_{ij,implied(j=0,1..10)}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$. The sample period is from January 1996 to September 2002.

	Combined				Calls				Puts				Combined(base: day0 to day10)			
	Up		Down		Up		Down		Up		Down		Up		Down	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
D_{-10}	-0.0159	-8.76	-0.0350	-17.81	-0.0150	-8.31	-0.0310	-16.09	-0.0155	-8.47	-0.0352	-17.56	-0.0209	-11.53	-0.0513	-26.10
D_{-9}	-0.0148	-8.33	-0.0332	-17.30	-0.0138	-7.82	-0.0299	-15.91	-0.0143	-7.94	-0.0331	-16.92	-0.0198	-11.16	-0.0494	-25.78
D_{-8}	-0.0127	-7.31	-0.0312	-16.58	-0.0114	-6.63	-0.0279	-15.16	-0.0127	-7.21	-0.0313	-16.33	-0.0177	-10.20	-0.0474	-25.24
D_{-7}	-0.0112	-6.57	-0.0289	-15.67	-0.0096	-5.67	-0.0257	-14.26	-0.0112	-6.52	-0.0293	-15.58	-0.0162	-9.52	-0.0451	-24.50
D_{-6}	-0.0097	-5.80	-0.0256	-14.16	-0.0079	-4.79	-0.0237	-13.34	-0.0095	-5.61	-0.0252	-13.66	-0.0147	-8.81	-0.0419	-23.14
D_{-5}	-0.0084	-5.17	-0.0241	-13.57	-0.0067	-4.15	-0.0218	-12.51	-0.0086	-5.17	-0.0241	-13.29	-0.0134	-8.24	-0.0404	-22.73
D_{-4}	-0.0064	-4.02	-0.0203	-11.65	-0.0042	-2.66	-0.0181	-10.60	-0.0069	-4.27	-0.0202	-11.37	-0.0115	-7.14	-0.0366	-20.98
D_{-3}	-0.0025	-1.62	-0.0163	-9.50	-0.0012	-0.78	-0.0144	-8.55	-0.0023	-1.44	-0.0163	-9.33	-0.0076	-4.79	-0.0326	-18.96
D_{-2}	0.0026	1.66	-0.0099	-5.82	0.0033	2.12	-0.0073	-4.43	0.0023	1.44	-0.0108	-6.29	-0.0024	-1.57	-0.0261	-15.44
D_{-1}	0.0060	3.93	0.0004	0.22	0.0059	3.86	0.0019	1.14	0.0059	3.79	-0.0013	-0.78	0.0010	0.64	-0.0159	-9.59
D_{0}	0.0023	1.55	0.0213	13.32	0.0033	2.24	0.0226	14.41	0.0021	1.39	0.0197	12.02	-0.0027	-1.80	0.0051	3.17
D_{1}	0.0020	1.36	0.0170	10.58	0.0029	1.91	0.0182	11.57	0.0019	1.24	0.0158	9.66	-0.0030	-1.99	0.0008	0.47
D_{2}	0.0028	1.83	0.0164	10.20	0.0034	2.25	0.0163	10.33	0.0026	1.74	0.0163	9.95	-0.0023	-1.51	0.0002	0.11
D_{3}	0.0031	2.05	0.0154	9.55	0.0033	2.20	0.0144	9.11	0.0027	1.80	0.0157	9.51	-0.0019	-1.28	-0.0008	-0.52
D_{4}	0.0032	2.15	0.0140	8.64	0.0031	2.05	0.0133	8.38	0.0031	2.05	0.0142	8.58	-0.0018	-1.18	-0.0023	-1.41
D_{5}	0.0039	2.56	0.0153	9.22	0.0035	2.31	0.0134	8.25	0.0038	2.49	0.0158	9.36	-0.0011	-0.75	-0.0010	-0.60
D_{6}	0.0051	3.39	0.0147	8.84	0.0037	2.43	0.0123	7.53	0.0055	3.56	0.0155	9.15	0.0001	0.09	-0.0016	-0.95
D_{7}	0.0063	4.18	0.0156	9.39	0.0048	3.14	0.0118	7.23	0.0062	4.05	0.0167	9.80	0.0013	0.88	-0.0006	-0.38
D_{8}	0.0079	5.19	0.0163	9.79	0.0052	3.43	0.0125	7.60	0.0079	5.10	0.0168	9.85	0.0029	1.89	0.0001	0.04
D_{9}	0.0086	5.63	0.0165	9.83	0.0054	3.58	0.0112	6.82	0.0091	5.90	0.0181	10.56	0.0035	2.33	0.0002	0.11
D_{10}	0.0102	6.71	0.0161	9.56	0.0069	4.52	0.0108	6.52	0.0106	6.84	0.0174	10.12	0.0052	3.42	-0.0002	-0.13

Table III: 2nd Step Regression Results for Residuals of Implied Volatility on Past and/or Ex Post Volatility

This table presents results for the 2nd step dummy regression of residuals on 21 event day dummies; $\hat{\varepsilon}_{ij} = \sum_{j=-10}^{10} \alpha_j D_{ij} + \nu_{ij}$. The residuals are obtained by regressing implied volatility on past and/or ex post volatility. The first row in each column presents the regression model used in the first step. The sample period is from January 1996 to September 2002.

	$\sigma_{ij,implied} = \beta_0 + \beta_{past}\sigma_{ij,past44} + \varepsilon_{ij}$				$\sigma_{ij,implied} = \beta_0 + \beta_{realized}\sigma_{ij,realized} + \varepsilon_{ij}$				$\sigma_{ij,implied} = \beta_0 + \beta_{past}\sigma_{ij,past44} + \beta_{realized}\sigma_{ij,realized} + \varepsilon_{ij}$			
	Up		Down		Up		Down		Up		Down	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
D_{-10}	-0.0067	-6.72	-0.0065	-5.99	-0.0333	-28.05	-0.0363	-27.10	-0.0133	-14.76	-0.0177	-17.72
D_{-9}	-0.0062	-6.44	-0.0039	-3.67	-0.0331	-28.57	-0.0349	-26.69	-0.0132	-14.96	-0.0155	-15.89
D_{-8}	-0.0046	-4.86	-0.0025	-2.38	-0.0318	-28.04	-0.0338	-26.39	-0.0118	-13.60	-0.0146	-15.29
D_{-7}	-0.0033	-3.51	-0.0006	-0.57	-0.0303	-27.25	-0.0324	-25.83	-0.0105	-12.35	-0.0133	-14.21
D_{-6}	-0.0021	-2.32	0.0018	1.79	-0.0290	-26.61	-0.0302	-24.60	-0.0094	-11.28	-0.0112	-12.21
D_{-5}	-0.0011	-1.25	0.0029	2.99	-0.0273	-25.58	-0.0293	-24.32	-0.0081	-10.00	-0.0104	-11.57
D_{-4}	0.0003	0.32	0.0054	5.65	-0.0256	-24.45	-0.0272	-23.01	-0.0068	-8.48	-0.0088	-9.97
D_{-3}	0.0028	3.21	0.0075	7.95	-0.0221	-21.40	-0.0244	-20.97	-0.0040	-5.05	-0.0068	-7.78
D_{-2}	0.0048	5.67	0.0108	11.54	-0.0175	-17.29	-0.0193	-16.86	-0.0015	-1.90	-0.0036	-4.18
D_{-1}	0.0020	2.41	0.0114	12.44	-0.0137	-13.71	-0.0105	-9.32	-0.0023	-3.04	-0.0009	-1.04
D_{0}	-0.0095	-11.54	0.0086	9.73	-0.0119	-12.17	0.0100	9.23	-0.0093	-12.45	0.0020	2.49
D_{1}	-0.0104	-12.67	0.0049	5.54	-0.0014	-1.48	0.0331	30.50	-0.0053	-7.12	0.0103	12.70
D_{2}	-0.0098	-11.85	0.0047	5.24	0.0009	0.89	0.0353	32.50	-0.0040	-5.31	0.0111	13.67
D_{3}	-0.0095	-11.53	0.0042	4.71	0.0019	1.89	0.0360	33.01	-0.0035	-4.65	0.0110	13.43
D_{4}	-0.0091	-10.99	0.0035	3.95	0.0028	2.86	0.0366	33.51	-0.0028	-3.78	0.0109	13.32
D_{5}	-0.0083	-9.95	0.0052	5.68	0.0041	4.17	0.0383	35.04	-0.0019	-2.56	0.0121	14.76
D_{6}	-0.0073	-8.77	0.0054	5.86	0.0055	5.56	0.0392	35.74	-0.0009	-1.19	0.0127	15.46
D_{7}	-0.0059	-7.15	0.0065	7.11	0.0072	7.30	0.0408	37.15	0.0006	0.76	0.0140	17.00
D_{8}	-0.0040	-4.82	0.0078	8.51	0.0096	9.76	0.0427	38.83	0.0028	3.67	0.0157	19.03
D_{9}	-0.0028	-3.41	0.0089	9.61	0.0112	11.35	0.0443	40.19	0.0042	5.56	0.0171	20.75
D_{10}	-0.0012	-1.43	0.0095	10.24	0.0136	13.79	0.0455	41.18	0.0062	8.15	0.0181	21.85

Table IV: Cumulative abnormal returns for underlying stocks, calls and puts around recommendation revision date.

This table presents cumulative abnormal returns for underlying stocks, calls and puts around recommendation revision date. The abnormal returns are obtained by subtracting off cumulative market returns on each date *j*. The sample period is from January 1996 to September 2002.

	Stocks				Calls				Puts			
	Up		Down		Up		Down		Up		Down	
	CAR(%)	t	CAR(%)	t	CAR(%)	t	CAR(%)	t	CAR(%)	t	CAR(%)	t
D_{-10}	-0.02	-1.28	-0.10	-5.34	1.93	12.22	1.92	12.47	0.79	5.81	0.69	5.00
D_{-9}	0.01	0.42	-0.16	-5.22	4.12	16.18	4.36	19.89	1.39	6.19	0.14	0.75
D_{-8}	-0.01	-0.16	-0.28	-8.85	5.10	16.36	5.58	20.24	2.53	10.00	1.22	4.94
D_{-7}	-0.03	-0.87	-0.39	-10.35	5.46	15.30	6.61	20.72	3.78	12.76	2.60	8.94
D_{-6}	-0.01	-0.24	-0.47	-11.12	6.04	14.21	8.84	23.82	5.84	15.99	2.65	8.16
D_{-5}	0.00	-0.07	-0.58	-12.67	7.06	14.96	11.13	25.72	7.95	14.38	2.72	7.61
D_{-4}	-0.01	-0.28	-0.71	-14.31	7.03	13.79	12.00	25.15	11.01	19.62	5.77	13.62
D_{-3}	0.01	0.16	-0.90	-16.78	8.27	14.86	14.81	27.74	13.77	21.02	4.55	9.20
D_{-2}	0.12	2.00	-1.17	-19.36	10.00	16.32	17.01	29.09	16.66	24.51	6.78	13.88
D_{-1}	0.69	10.36	-2.53	-35.40	16.82	22.37	18.91	27.13	18.74	24.84	14.13	21.51
D_{0}	2.68	35.81	-5.90	-72.17	34.67	37.13	7.40	11.03	9.67	12.58	33.80	38.22
D_{1}	3.06	39.62	-6.15	-72.16	36.29	38.21	4.85	7.16	7.10	8.59	35.29	37.00
D_{2}	3.18	40.55	-6.30	-73.93	37.07	37.07	3.04	4.41	5.81	6.63	36.14	34.61
D_{3}	3.29	41.03	-6.42	-74.86	38.20	37.01	1.87	2.55	5.10	5.30	37.00	34.83
D_{4}	3.41	41.60	-6.58	-76.08	39.03	35.71	0.18	0.25	4.19	4.32	36.43	33.66
D_{5}	3.52	41.86	-6.63	-75.72	39.03	33.85	1.48	1.84	2.43	2.43	37.21	28.35
D_{6}	3.60	41.86	-6.68	-75.23	37.51	32.37	1.11	1.29	1.71	1.70	35.81	25.85
D_{7}	3.66	41.59	-6.72	-74.62	37.08	30.77	0.69	0.76	-0.28	-0.28	34.35	24.27
D_{8}	3.73	41.45	-6.80	-74.86	36.23	28.07	-0.03	-0.03	-1.04	-0.96	31.43	23.39
D_{9}	3.82	41.64	-6.85	-74.53	35.83	27.14	-1.13	-1.12	-3.38	-3.23	31.03	21.31
D_{10}	3.92	41.92	-6.90	-74.31	37.46	23.99	-0.90	-0.81	-5.00	-4.48	30.00	18.43

Table V: Dummy Variable Regression Results for Abnormal Trading Volume around Recommendation Revision

This table presents the results for the model $(S_{ij} - \bar{S}_{ij,(j\neq -1,0,1)}) = \sum_{j=-10}^{10} \alpha_j D_{ij} + \varepsilon_{ij}$, where S_{ij} is the standardized abnormal trading volume for security *i* on day *j*. The sample period is from January 1996 to September 2002.

	Stocks				Calls				Puts			
	Up		Down		Up		Down		Up		Down	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
D_{-10}	-0.0366	-8.10	-0.0558	-11.20	-0.3470	-17.31	-0.3475	-18.85	-0.3626	-14.76	-0.3093	-14.65
D_{-9}	-0.0412	-9.14	-0.0593	-11.90	-0.3211	-16.44	-0.3161	-17.62	-0.3350	-14.96	-0.2997	-14.59
D_{-8}	-0.0393	-8.70	-0.0457	-9.17	-0.2620	-13.77	-0.2916	-16.65	-0.3485	-13.60	-0.2851	-14.23
D_{-7}	-0.0302	-6.69	-0.0461	-9.26	-0.2658	-14.29	-0.3002	-17.55	-0.2983	-12.35	-0.2684	-13.73
D_{-6}	-0.0264	-5.85	-0.0306	-6.15	-0.2138	-11.79	-0.2373	-14.18	-0.2612	-11.28	-0.2050	-10.71
D_{-5}	-0.0085	-1.88	-0.0423	-8.49	-0.1495	-8.45	-0.1955	-11.97	-0.2547	-10.00	-0.2215	-11.86
D_{-4}	0.0069	1.52	-0.0182	-3.65	-0.1234	-7.13	-0.1497	-9.36	-0.1789	-8.48	-0.1450	-7.94
D_{-3}	0.0316	7.02	0.0239	4.80	-0.0444	-2.62	-0.0999	-6.37	-0.1322	-5.05	-0.0421	-2.35
D_{-2}	0.1182	26.24	0.1171	23.53	0.1161	7.01	0.0145	0.94	-0.0378	-1.90	0.0960	5.48
D_{-1}	0.3617	80.27	0.4988	100.26	0.4494	27.79	0.3384	22.68	0.1909	-3.04	0.4614	27.13
D_{0}	0.5734	127.26	1.0261	206.25	0.8835	56.34	0.8409	59.40	0.4961	-12.45	1.0125	62.79
D_{1}	0.1946	43.18	0.3122	62.72	0.4168	26.48	0.3559	25.00	0.3091	-7.12	0.4196	25.85
D_{2}	0.0775	17.20	0.1287	25.85	0.2145	13.60	0.2062	14.43	0.2412	-5.31	0.2086	12.80
D_{3}	0.0319	7.08	0.0795	15.97	0.1449	9.16	0.1989	13.84	0.1709	-4.65	0.1334	8.15
D_{4}	0.0118	2.61	0.0332	6.67	0.1399	8.80	0.1518	10.52	0.1635	-3.78	0.1448	8.80
D_{5}	-0.0024	-0.54	0.0105	2.06	0.0978	6.11	0.1467	9.91	0.1595	-2.56	0.1157	6.86
D_{6}	-0.0116	-2.55	-0.0037	-0.73	0.1172	7.29	0.1174	7.89	0.1716	-1.19	0.1109	6.53
D_{7}	-0.0113	-2.49	-0.0137	-2.68	0.1295	8.01	0.1465	9.78	0.1848	0.76	0.0892	5.23
D_{8}	-0.0221	-4.88	-0.0198	-3.89	0.0734	4.52	0.1713	11.34	0.1969	3.67	0.1279	7.44
D_{9}	-0.0203	-4.47	-0.0280	-5.49	0.1142	6.99	0.1401	9.21	0.1757	5.56	0.1127	6.51
D_{10}	-0.0296	-6.53	-0.0342	-6.70	0.1186	7.21	0.1367	8.91	0.1815	8.15	0.1649	9.43

Table VI: 2nd Step Regression Results for Residuals of Bid Ask Spread

This table presents results for the 2nd step dummy regression of residuals on 21 event day dummies; $\hat{\varepsilon}_{ij} = \sum_{j=-10}^{10} \alpha_j D_{ij} + \nu_{ij}$. The residuals are obtained by estimating the following model; $spread_{ij}^{bid,ask} = \beta_0 + \beta_{past} SV_{ij} + \beta_{realized} mid_{ij}^{bid,ask} + \varepsilon_{ij}$. The sample period is from January 1996 to September 2002.

	Calls				Puts			
	Up		Down		Up		Down	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
D_{-10}	0.0113	8.76	-0.0104	-8.68	-0.0091	-7.26	0.0124	10.27
D_{-9}	0.0116	9.16	-0.0126	-10.74	-0.0092	-7.52	0.0108	9.16
D_{-8}	0.0120	9.77	-0.0149	-13.06	-0.0117	-9.85	0.0102	8.93
D_{-7}	0.0105	8.76	-0.0154	-13.77	-0.0115	-9.89	0.0097	8.65
D_{-6}	0.0083	7.05	-0.0178	-16.25	-0.0132	-11.69	0.0105	9.56
D_{-5}	0.0074	6.48	-0.0191	-17.90	-0.0151	-13.61	0.0098	9.15
D_{-4}	0.0054	4.80	-0.0196	-18.76	-0.0171	-15.81	0.0083	7.94
D_{-3}	0.0033	3.04	-0.0218	-21.27	-0.0180	-17.06	0.0085	8.29
D_{-2}	-0.0010	-0.93	-0.0235	-23.49	-0.0210	-20.28	0.0043	4.31
D_{-1}	-0.0115	-11.01	-0.0267	-27.43	-0.0243	-24.02	-0.0064	-6.55
D_{0}	-0.0268	-26.51	-0.0199	-21.47	-0.0245	-25.11	-0.0265	-28.73
D_{1}	-0.0231	-22.76	-0.0140	-15.05	-0.0185	-18.81	-0.0237	-25.54
D_{2}	-0.0189	-18.56	-0.0069	-7.41	-0.0105	-10.68	-0.0192	-20.52
D_{3}	-0.0144	-14.06	0.0015	1.57	-0.0040	-4.01	-0.0149	-15.92
D_{4}	-0.0080	-7.77	0.0079	8.34	0.0027	2.72	-0.0101	-10.72
D_{5}	-0.0032	-3.11	0.0158	16.39	0.0098	9.86	-0.0025	-2.63
D_{6}	0.0029	2.83	0.0217	22.36	0.0187	18.70	0.0037	3.82
D_{7}	0.0088	8.42	0.0279	28.50	0.0274	27.26	0.0104	10.68
D_{8}	0.0158	15.11	0.0349	35.41	0.0341	33.72	0.0167	16.95
D_{9}	0.0220	20.82	0.0422	42.54	0.0418	41.02	0.0233	23.45
D_{10}	0.0290	27.30	0.0488	48.72	0.0513	49.94	0.0318	31.72

Table VII: Gains to a Delta Hedged Trading Strategy

This table presents gains to a delta hedged trading strategy as described in section 5. Stocks that fall in decile 9 and 10 of NYSE size decile as of the end of the previous year of the recommendation is classified as large firms. Delay refers to the number of trading days between recommendation revision and hedge portfolio formation. Bold numbers are statistically significant at 5%. Panel A provides gains using bid ask midpoint of the option price, and panel provides results using bid price of the call option. The sample period is from January 1996 to September 2002.

Panel A: Call price = bid ask midpoint

			π (in \$)			π / S (in %)			π / C (in %)		
	N	delay	up	down	all	up	down	all	up	down	all
All	338,710	0	**0.13**	**0.14**	**0.13**	**0.43**	**0.59**	**0.51**	**6.30**	**11.46**	**8.29**
		1	**0.11**	**0.13**	**0.12**	**0.41**	**0.55**	**0.48**	**6.51**	**11.24**	**8.29**
		5	**0.09**	**0.09**	**0.07**	**0.38**	**0.49**	**0.42**	**6.31**	**11.30**	**8.19**
Large	190,661	0	**0.23**	**0.22**	**0.23**	**0.54**	**0.56**	**0.56**	**6.14**	**10.47**	**8.08**
		1	**0.22**	**0.20**	**0.21**	**0.53**	**0.53**	**0.54**	**6.17**	**9.91**	**7.86**
		5	**0.20**	**0.18**	**0.18**	**0.52**	**0.49**	**0.50**	**5.86**	**10.62**	**7.87**
Small	198,049	0	0.02	**0.06**	**0.03**	**0.33**	**0.61**	**0.45**	**6.47**	**12.38**	**8.50**
		1	0.00	**0.06**	**0.02**	**0.30**	**0.58**	**0.42**	**6.84**	**12.46**	**8.72**
		5	-0.02	0.01	**-0.03**	**0.24**	**0.49**	**0.35**	**6.76**	**11.92**	**8.50**

Panel B: Call price = bid price

			π (in \$)			π / S (in %)			π / C (in %)		
	N	delay	up	down	all	up	down	all	up	down	all
All	338,710	0	**-0.04**	0.00	**-0.03**	-0.01	**0.09**	**0.04**	**-3.42**	**-1.08**	**-2.76**
		1	**-0.05**	-0.01	**-0.04**	-0.03	**0.05**	0.01	**-3.44**	**-1.64**	**-3.03**
		5	**-0.07**	**-0.05**	**-0.08**	**-0.07**	-0.01	**-0.05**	**-3.85**	**-1.85**	**-3.36**
Large	190,661	0	**0.07**	**0.08**	**0.08**	**0.24**	**0.25**	**0.26**	**-2.09**	0.30	**-1.01**
		1	**0.06**	**0.07**	**0.06**	**0.23**	**0.21**	**0.24**	**-2.30**	-0.62	**-1.53**
		5	0.03	**0.05**	**0.03**	**0.22**	**0.18**	**0.20**	**-2.73**	-0.09	**-1.66**
Small	198,049	0	**-0.15**	**-0.09**	**-0.12**	**-0.26**	**-0.06**	**-0.18**	**-4.76**	**-2.36**	**-4.44**
		1	**-0.16**	**-0.09**	**-0.13**	**-0.29**	**-0.10**	**-0.21**	**-4.58**	**-2.58**	**-4.46**
		5	**-0.18**	**-0.14**	**-0.18**	**-0.35**	**-0.19**	**-0.29**	**-4.97**	**-3.48**	**-4.99**

Table VIII: Gains to a Delta Hedged Trading Strategy: Year by Year Summary

This table presents gains to a delta hedged trading strategy as described in section 5 for each year in the sample period The sample period is from January 1996 to September 2002.

		π (in \$): bid ask midpoint			π (in \$): bid price			$\pi_{bid\text{-}ask\ mid}$ / S (in %)			$\pi_{bid\text{-}ask\ mid}$ / C (in %)		
year	N	mean	median	s.d.	mean	median	s.d.	mean	median	s.d.	mean	median	s.d.
1996	29,051	0.17	0.20	2.02	0.03	0.06	2.15	0.50	0.56	4.69	14.28	8.88	111.53
1997	39,828	0.15	0.17	2.36	-0.01	0.03	2.36	0.48	0.46	5.37	9.46	5.59	108.74
1998	52,505	0.06	0.14	3.37	-0.10	-0.01	3.37	0.33	0.38	5.36	3.50	4.00	148.96
1999	64,747	0.24	0.17	5.71	0.06	0.03	5.69	0.66	0.48	5.94	7.52	4.96	113.71
2000	84,480	-0.05	0.10	5.35	-0.23	-0.04	5.35	0.32	0.26	6.31	1.39	1.94	130.95
2001	75,707	0.29	0.17	1.60	0.16	0.05	1.59	0.88	0.59	4.29	18.54	6.79	81.42
2002	42,392	0.06	0.08	0.79	-0.05	-0.03	0.78	0.25	0.26	2.84	5.66	2.12	70.55
Total	388,710	0.13	0.14	3.83	-0.03	0.01	3.83	0.51	0.42	5.25	8.29	4.31	113.54

Figure 1. Average implied volatility level around recommendation revisions date

This figure presents average implied volatility level as well as ex post realized volatility and past historical volatility around recommendation date. Panel A is for upgraded revisions and Panel B is for downgraded revisions. Total refers to the combined implied volatility from both calls and puts. The sample period is from January 1996 to September 2002.

Panel A: Upgrades **Panel B: Downgrades**

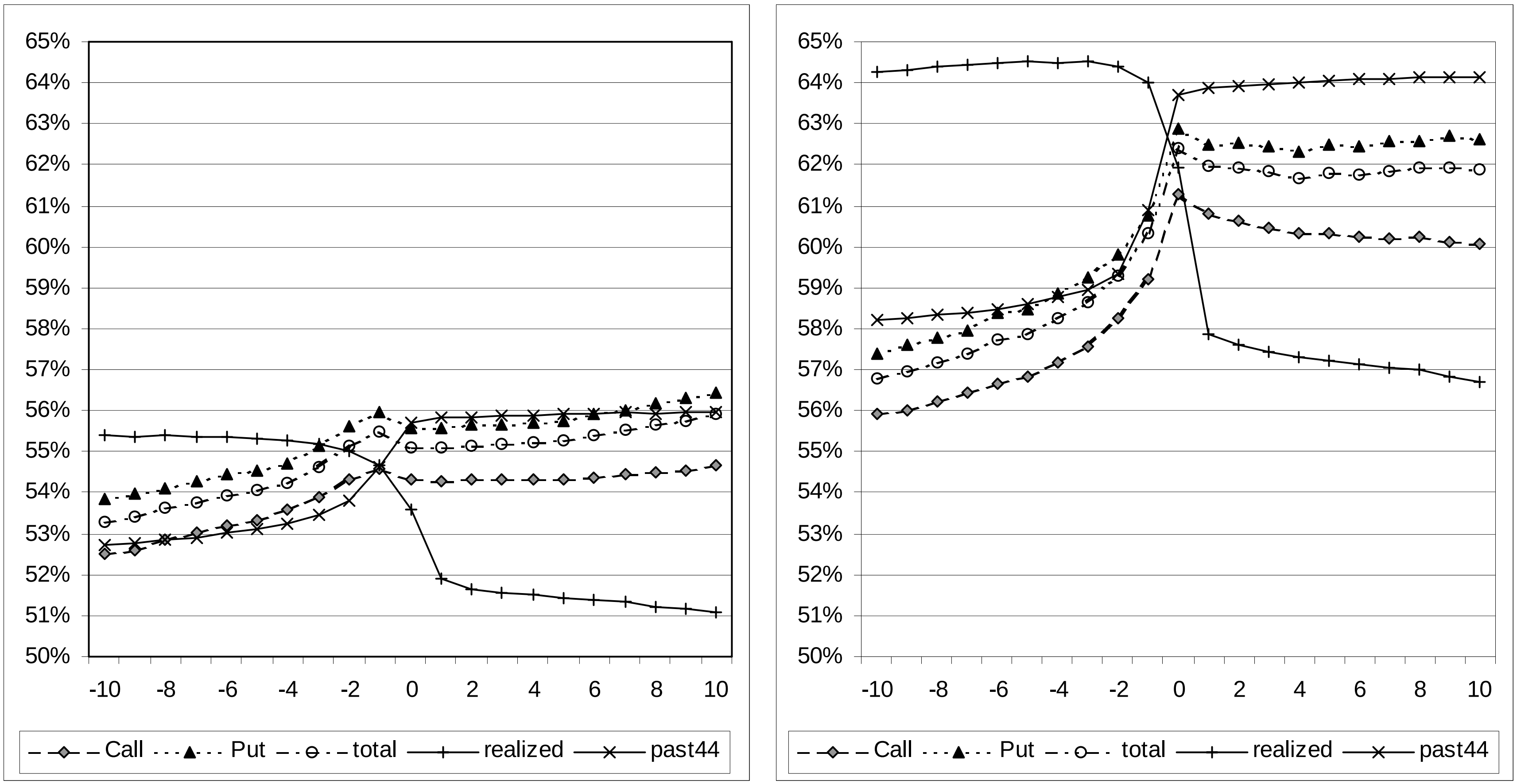
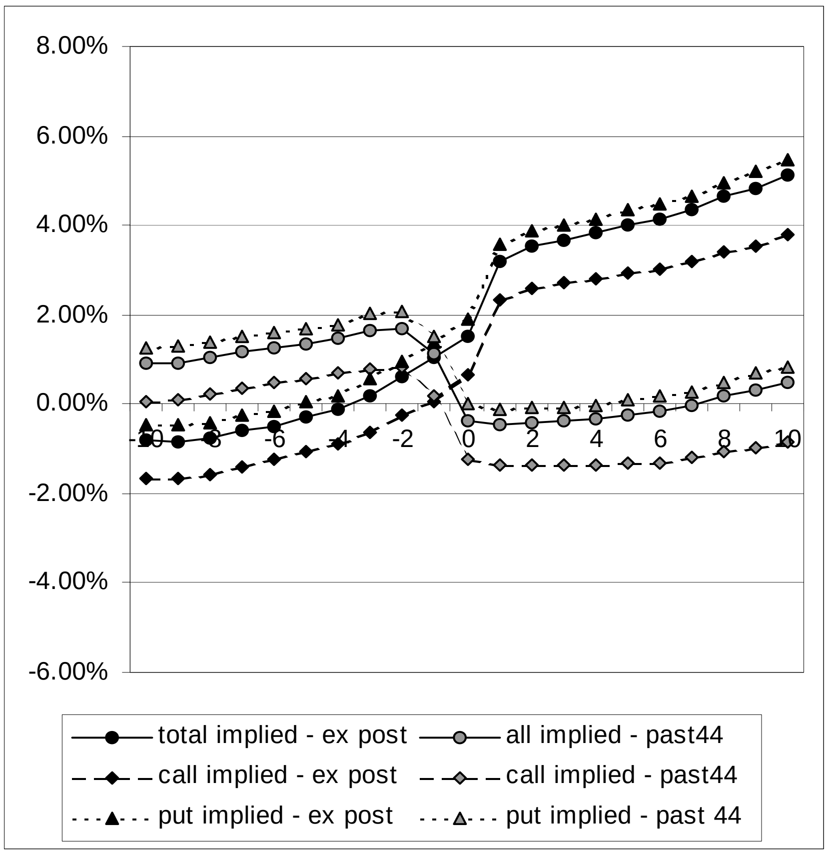


Figure 2. Average difference between implied volatility and ex post realized/past historical volatility

This figure presents average difference between (a) implied volatility and ex post realized volatility, and (b) implied volatility and historical volatility calculated using past 44 trading days. Panel A is for upgraded revisions and Panel B is for downgraded revisions. Total refers to the combined implied volatility from both calls and puts. The sample period is from January 1996 to September 2002.

Panel A: Upgrades



Panel B: Downgrades

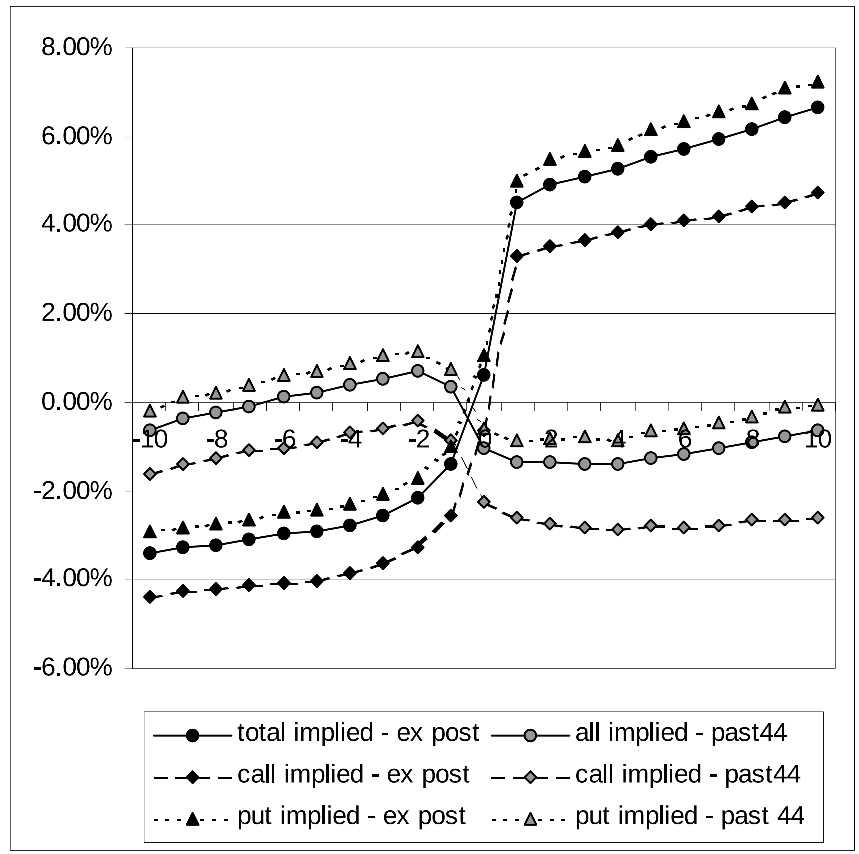


Figure 3. Cumulative abnormal returns for underlying stocks, calls and puts around recommendation revision date.

This figure presents cumulative abnormal returns for underlying stocks, calls and puts around recommendation revision date. The abnormal returns are obtained by subtracting off cumulative market returns on each date *j*. The sample period is from January 1996 to September 2002.

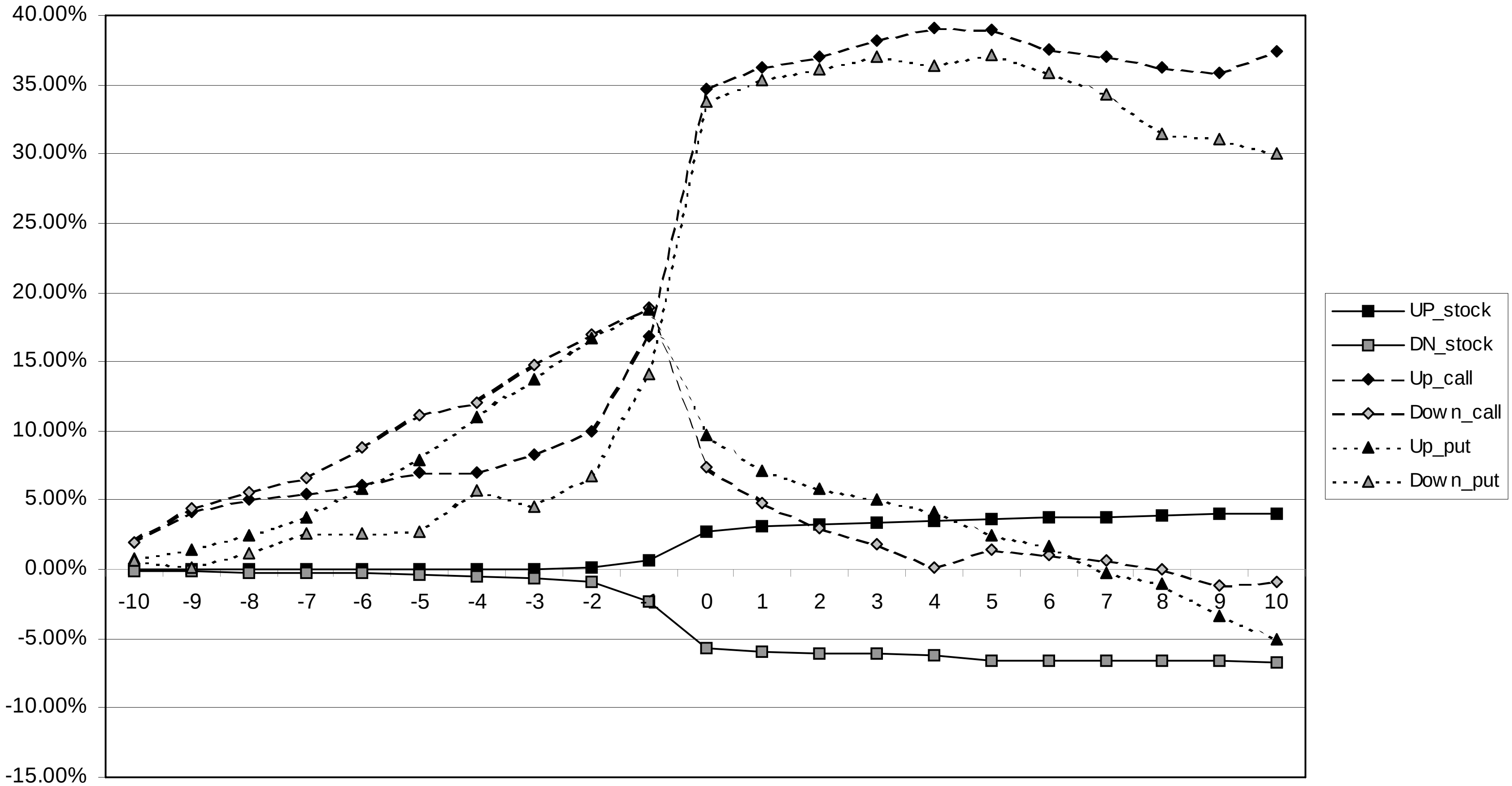
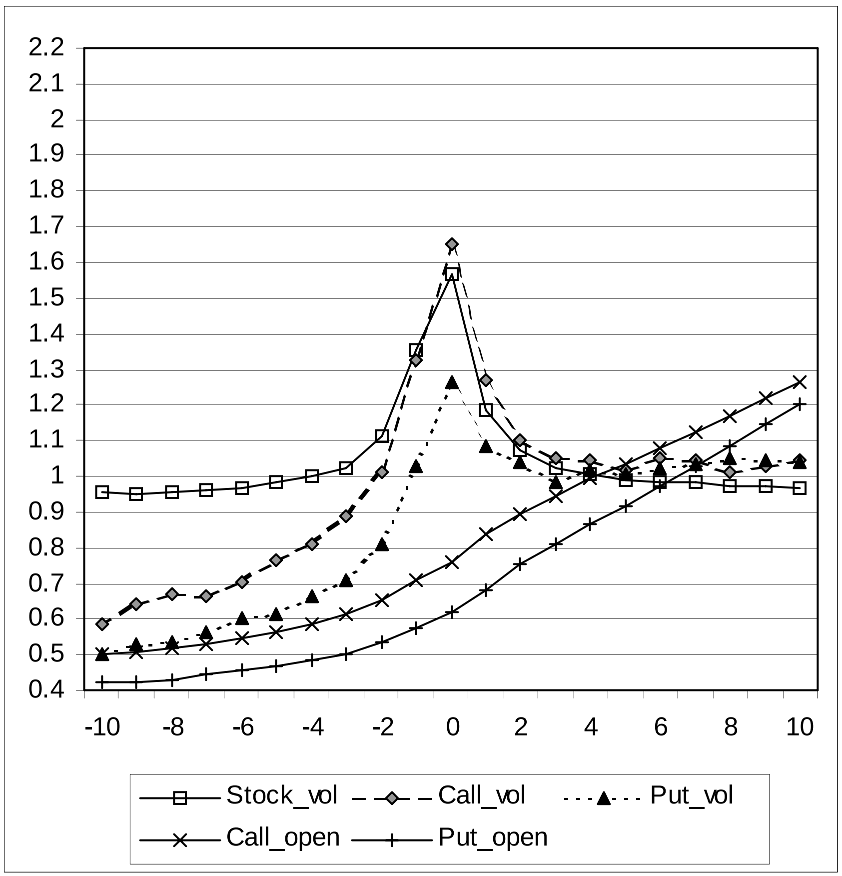


Figure 4. Abnormal trading volume for underlying stocks, calls and puts around recommendation revision date

This figure presents average abnormal trading volume for underlying stocks, call and puts. Abnormal volume on day *j* is the relative magnitude of volume on day *j* compared to average volume from day –20 to day + 20. Panel A is for upgraded revisions and Panel B is for downgraded revisions. The sample period is from January 1996 to September 2002.

Panel A: Upgrades



Panel B: Downgrades

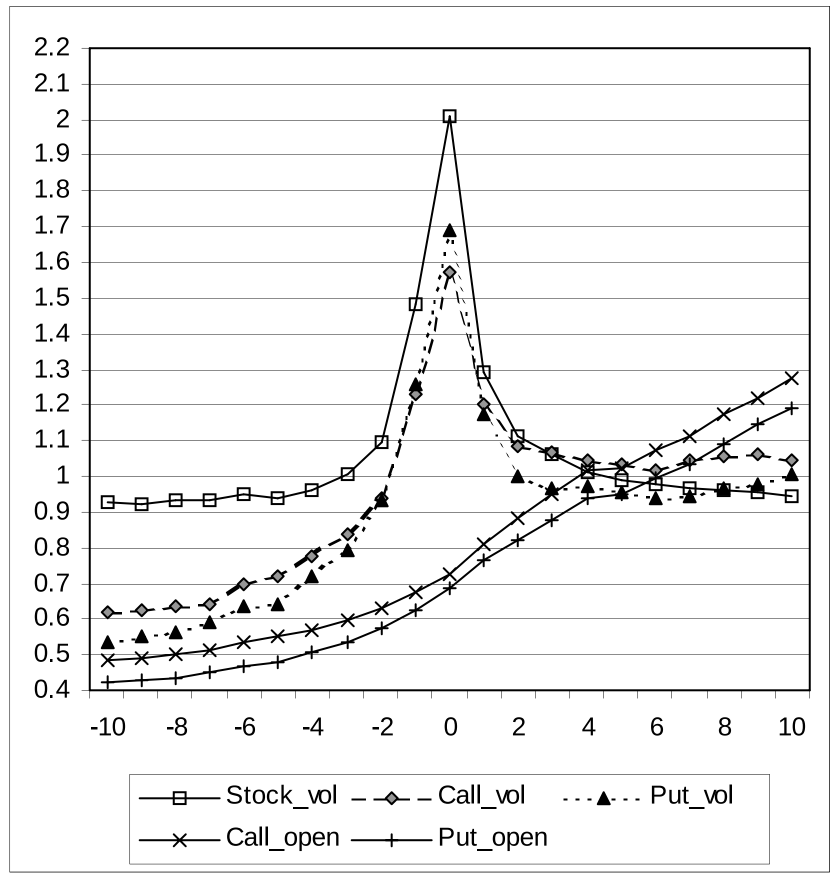
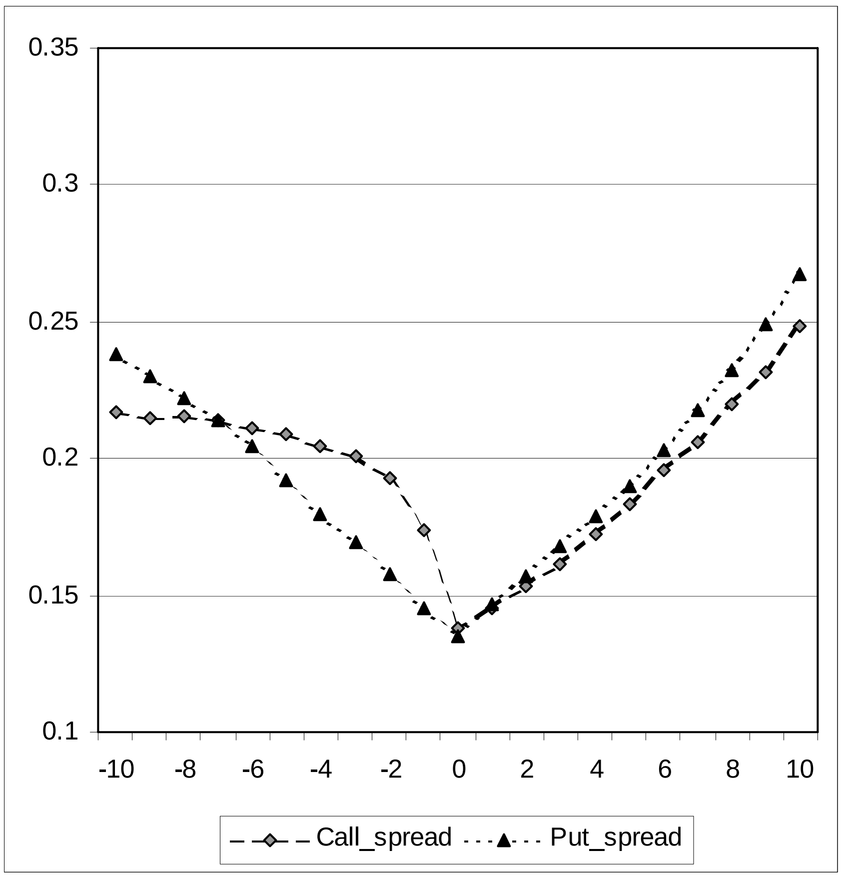


Figure 5. Average bid-ask spread for calls and puts around recommendation revision date

This figure presents average bid – ask spread for call and puts around recommendation revision date. bid – ask spread is defined as (ask – bid)/(ask + bid)0.5. Panel A is for upgraded revisions and Panel B is for downgraded revisions. The sample period is from January 1996 to September 2002.

Panel A: Upgrades



Panel B: Downgrades

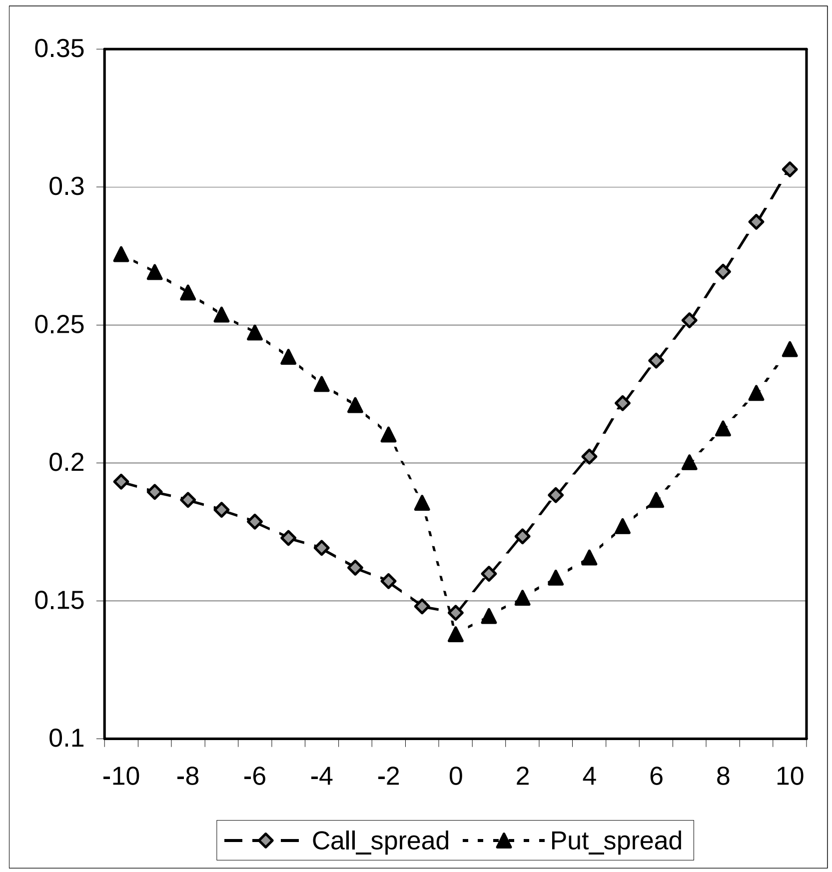
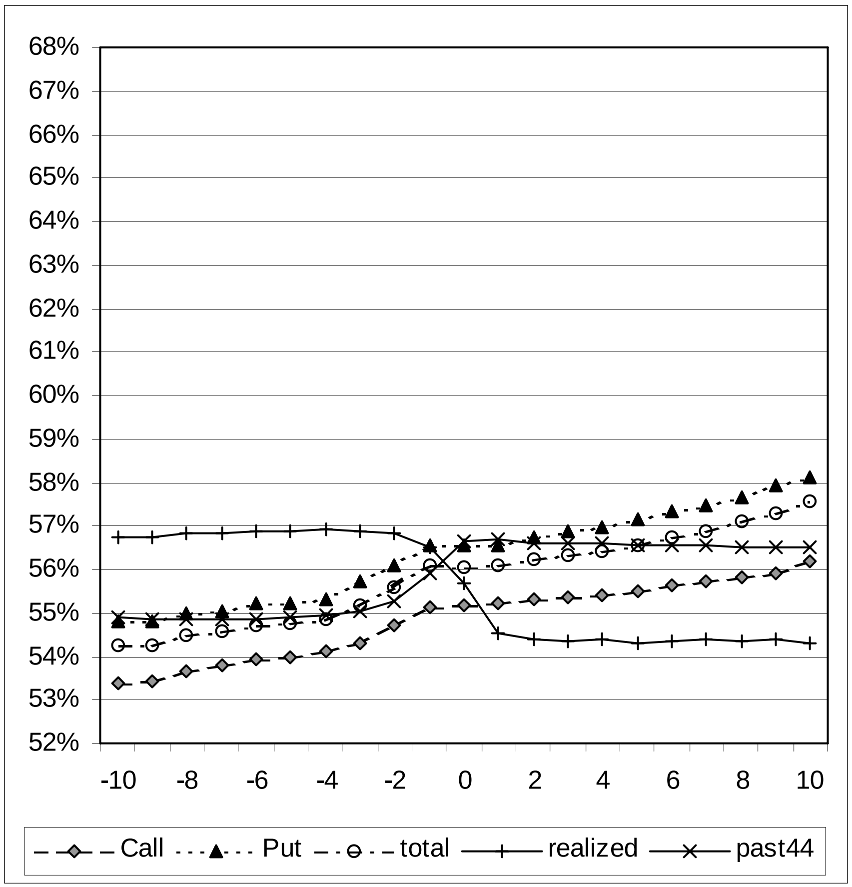


Figure 6. Average implied volatility level around recommendation revisions date: excluding corporate announcements

This figure presents average implied volatility level as well as ex post realized volatility and past historical volatility around recommendation date for the subsample that excludes observations with corporate announcement within 21 day event period. Panel A is for upgraded revisions and Panel B is for downgraded revisions. The sample period is from January 1996 to September 2002.

Panel A: Upgrades



Panel B: Downgrades

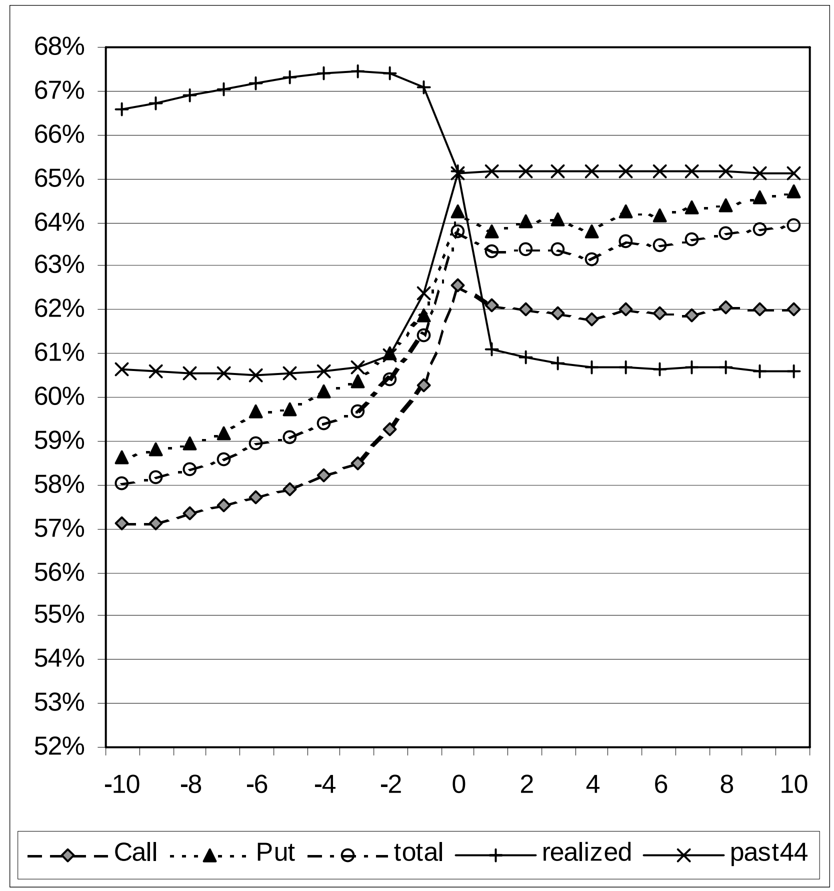


Figure 7. Cumulative abnormal returns for stocks, calls and puts: excluding corporate announcements

This figure presents cumulative abnormal returns for underlying stocks, calls and puts around recommendation revision date date for the subsample that excludes observations with corporate announcement within 21 day event period. The abnormal returns are obtained by subtracting off cumulative market returns on each date *j*. The sample period is from January 1996 to September 2002.

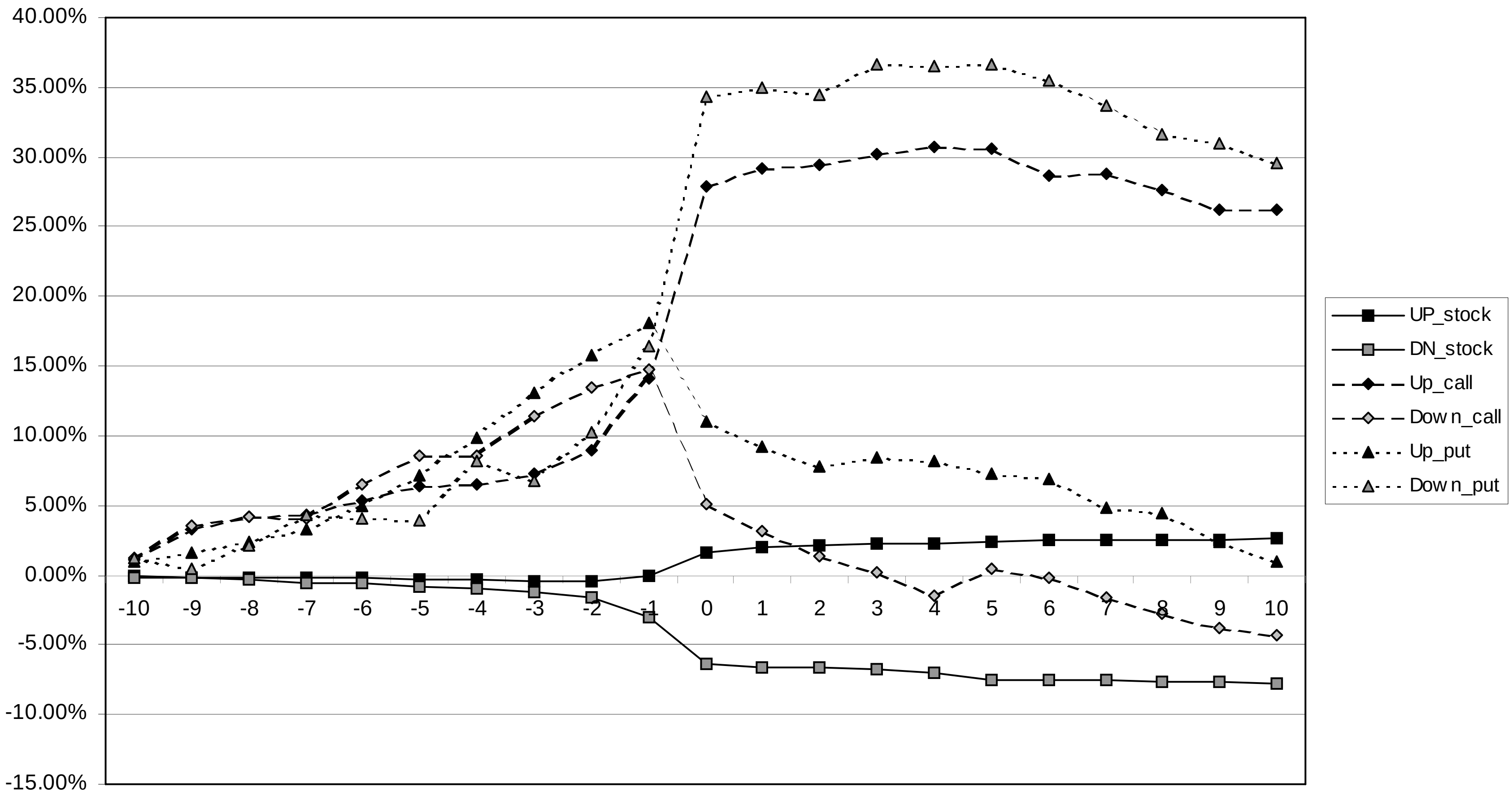


Figure 8. Monthly average gains to a delta-hedged strategy

This figure presents average relative gains($\pi_{bid\text{-}ask\ mid}$ / S) to a delta hedged trading strategy as described in section 5 for each month in the sample period. The sample period is from January 1996 to September 2002.

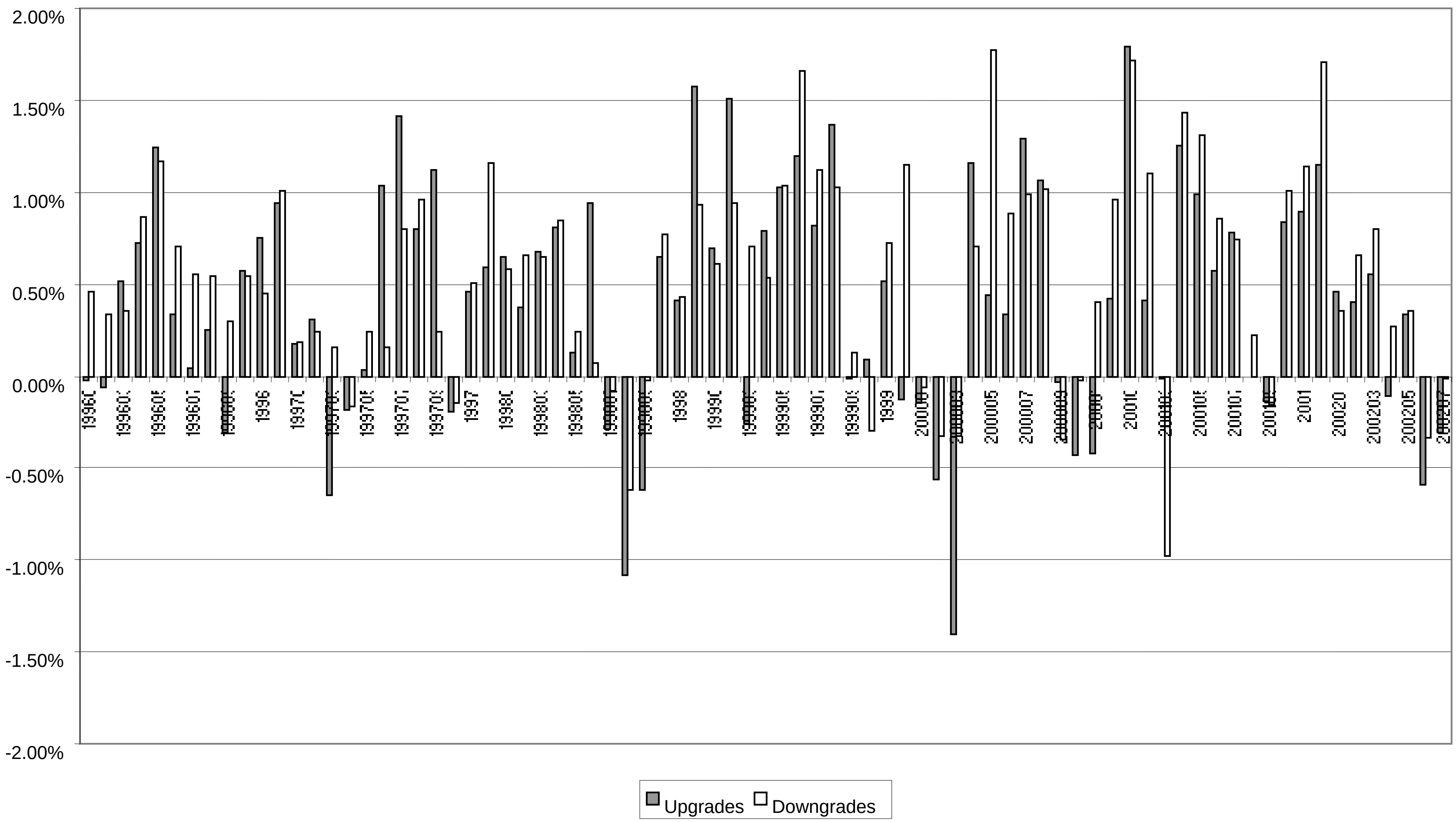


Figure 9. Distribution of average gains to a delta-hedged strategy

This figure presents the histogram of average relative gains($\pi_{bid\text{-}ask\ mid}$ / S) to a delta hedged trading strategy as described in section 5 for the whole sample periods. Kernel density using Epanechnikov kernel function is also plotted. Panel A is for upgraded revisions and Panel B is for downgraded revisions. The sample period is from January 1996 to September 2002.

Panel A: Upgrades **Panel B: Downgrades**