How Informed Investors Take Advantage of Negative Information in Options and Stock Markets

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Abstract

We examine whether and how investors establish positions in options when they have negative information in the U.S. markets from August 2004 to January 2009. Our empirical results show that options seem to be actively and effectively used for the exploitation of negative information. General trading volumes and bid-ask spreads of options remarkably increase like those of stocks as the short sellers increase their selling pressure. Notably, we find that the difference between a stock's traded price and its implied price from the options market reaches its peak about two weeks before the short sale trading activity reaches its peak. We also observe that synthetic short positions measured by this difference are preferred over OTM put positions by investors with negative information. Finally, economically significant returns based on a strategy using the difference in the traded and implied stock prices as a trading signal support our evidence. Moreover, these profits confirm the findings of the previous research which argue that options are shelters for informed investors.

Key words: informed investors, options market, stock market, short sales, the stock price ratio

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1. Introduction

Whether limits of arbitrage truly impede information dissemination has been examined in numerous studies since addressed first in Shleifer and Vishny (1997). In particular, restrictions on short sales, a representative example of limits of arbitrage, are regarded as the culprit that makes it harder for investors to trade when they have negative information than when they have positive information. On the other hand, starting with Black (1975), for a long time it has been suggested that options are venues where investors can detour these restrictions in order to exploit their negative information. Even though several decades have passed from the time the usage of options for avoiding restrictions in the stock market was firstly discussed, the question whether investors with negative information first choose options to trade before stocks is still not resolved. Few studies have investigated changes in prices and trading activities directly in both the stock and options markets when negative information appears in the markets.

This study explores the trading strategies and habitats of informed investors, especially of informed investors with negative information, by examining the existence and the extent of synthetic short trades in the options market. To do this, firstly we set up an empirical circumstance where option trades with negative information can be easily observed. It is rational to presume that negative information appears in the markets when short sales are significantly increasing because there should be an incentive for investors to short sell a stock so the return from the short sale is large enough to cover its costs. Previous literature supports this presumption with empirical results in which stock returns decrease significantly for a few days after short sales suspiciously increase (Asquith and Meulbroek,1995; Desai, Ramesh, Thiagarajan and Balachandram, 2002; Christophe, Ferri and Angel, 2004). Therefore, we proxy the time of release of negative information into the markets with the time of an abnormal increase in short sale trades in the stock market. Then, we examine whether options are used like short selling by looking into prices and trading activities in the options market. Secondly, we investigate the sequence between the informed trades in the options market and short sales in the stock market in order to confirm more clearly that options, not stocks, are placed first on the table by investors with negative information. Thirdly, we examine whether the appearance of negative information can be detected by merely measuring the extent of synthetic short sale trades in the options market without considering the stock market. Finally, we test the economic significance of synthetic short sale trades and compare it with the productivity of short sales in the stock market.

If investors want to exploit their negative information in the options market, they can buy OTM puts or establish synthetic short positions. As argued in Xing, Zhang, Zhao (2010), relatively cheap OTM puts can attract more informed investors with negative information than other options. In their results, the difference in the implied volatilities of OTM puts and ATM calls can foreshadow a future stock return decrease – the greater the difference, the greater the decrease. However, if investors want to optimize and maximize their profit from their negative information, they will write calls and buy puts simultaneously, in other words, establish synthetic short positions. Although it sounds natural for investors with negative information to establish synthetic short positions, unfortunately, not many studies have examined the extent of synthetic short positions in the options market. This is because, unlike short sale trading volumes which are reported regularly, it is nearly impossible to calculate how many synthetic short positions are established in the options market. Therefore, it is questionable

which strategy investors will take for exploiting their negative information: short sales, OTM puts, or synthetic short positions.

We hypothesize that the options market is more attractive to informed investors with negative information than the stock market because of the following three reasons. First of all, the fee for establishing synthetic short positions is cheaper than directly short selling the stocks. The fee for short selling is composed of two costs, the opportunity cost of maintaining a margin and the cost of paying the lenders of the stock. Because the loss incurred by short sellers in the stock market is potentially unlimited, they are required to maintain a certain margin balance as collateral. Besides the opportunity cost of the margin, short sellers should also pay a commission to the lenders of the stock and the higher the risk is, the greater the commission is. Next, the number of shares which short sellers can borrow in the stock market is limited because all stock owners do not voluntarily lend their shares. Contrarily, options can be traded without a limit on the number of positions. Lastly, and most noteworthily, traders with negative information might be afraid that other traders will suspect they have negative information if they engage in short selling because the volume of short sales is reported on a regular basis by the exchange to the public. Therefore, whether the short seller's information is true or not, the market treats high short sale trading volume as suspicious. Thus, informed investors may want to trade in the options market in order to disguise their trading intention. Based on options' advantages in the above three aspects, we examine whether informed investors with negative information migrate to the options market.

We examine U.S. stocks and their individual options from August 2004 to January 2009 with a unique data set for short sale trades provided by Data Explorers. The data for short selling contain the commission to lenders, the total short trading volume, and the utilization level, which is the percentage of shares actually borrowed from among the total shares offered by lenders. With this data, we firstly calculate weekly short sale trading volumes in the stock market. Then, we use these weekly volumes to assess when negative information appears publicly in the stock market. Specifically, the week having the highest short sale trading volume among the ten previous weekly volumes is defined as the time when the information is revealed to the public. To investigate whether informed investors utilize options and whether they trade options before stocks, instead of calculating the number of synthetic short positions in the options market, we estimate the stock price ratio suggested by Ofek, Richardson, and Whitelaw (2004). This is because, contrary to short sale trading volume in the stock market, it is nearly impossible to calculate the number of synthetic short sales positions since we cannot trace the trading history of individual investors in the options market. Hence, we adopt the stock price ratio as a proxy for the extent of synthetic short positions. This ratio shows the difference between the actual traded stock price and the implied stock price from options. We assume that the more synthetic positions in the options market are established by informed investors with negative information, the greater the difference between the two stock prices is.

In our empirical results, consistent with the existing literature, stock prices decrease sharply after the peak of short sale trading volumes in the stock market. During the previous ten weeks before the short sale trading volume reaches its peak, the short sale fee and the short sale trading volume gradually increase together during the first eight weeks and then they both rise rapidly for the last two weeks. After the peak week, the fee stays at the elevated level, but the amount of short sales begins to decrease. The cumulative stock return shows no statistically significant variation from zero for the initial ten weeks, but decreases by 6% during the ten weeks

after the peak week. In the options market, for the same period, we also observe changes in the stock price ratio. However, the changes in the options market start and end at different times than the stock market. Most of the changes in the stock price ratio occur during the two week period that begins four weeks prior to the peak week. From the first week before the peak week, the ratio begins to decrease. Even though the level of the stock price ratio becomes greater as the option's maturity gets longer, the increase in the stock price ratio before the peak weak is detected regardless of the option's maturity. In addition, the general trading volume of the options market is observed to increase in tandem with the stock price ratio. However, OTM puts do not seem to be popularly used by investors with negative information since the volatility skew of the difference between the implied volatilities of these options does not show strong predictability about future stock returns. Next, we ascertain whether the appearance of negative information can be detected by solely estimating the extent of the stock price ratio in the options market without considering the stock market. Finally, we examine trading performances of portfolios constructed according to the stock price ratio. The trading strategy of selling stocks with high stock price ratios yields about a 15% return per year. Furthermore, establishing synthetic short positions generates an even greater 20% yearly return and this profit is still significant after considering transaction costs. Therefore, we conclude that informed investors establish synthetic short sale positions in the options market first and then engage in short sales in the stock market.

Our results provide evidence that the stock and options markets are efficiently linked by informed investors' trading activity. The previous price discovery literature that examines informed habitats (Hasbrouck, 1993; Amin and Lee, 1997; Easley, O'Hara, and Srinivas, 1998; Chakravarty, Gluen, and Mayhew, 2004; Chordia, Roll, and Subrahmanyam; 2005; Schlag and Stoll, 2005; Pan and Poteshman, 2006; Boehmer and Kelly, 2009) argues that informed investors exploit their information through the options market. However, some studies (Cochrane, 2002; Ofek, Richardson, and Whitelaw, 2004) argue that there is market separation between the stock and options markets because of the different groups of participants having different levels of rationality in each market. Their argument can make it harder to price derivatives based on their underlying stock prices. According to this market model, the opportunity set of an investment strategy is not increased through the options market. Under the perspective of this market separation hypothesis, informed investors execute short sales only in the stock market. However, based on our empirical results, we may interpret the negative relationship between short sale trading volumes and subsequent stock returns as a phenomenon that can occur at the last stage of negative information dissemination, thus empirically confirming the model espoused by the price discovery literature. During the dissemination of information, informed investors can first set synthetic short positions in the options market and then move to the stock market just before information becomes public. Therefore, we can say that the stock and options markets are connected efficiently by informed trades in both markets.

The rest of the paper is organized as follows. Section 2 reviews prior literature. Section 3 describes the data and Section 4 develops research design and discusses the empirical results. Section 5 concludes.

2. Literature review

2.1 Informed trades in the options markets

How and where informed investors exploit their information in the stock and options markets have been continuously and extensively investigated in numerous studies. The most popular empirical method used in these studies is to examine the lead-lag relationship in prices and trading activities between the two markets. This is because we can discover which market is the informed habitat from the direction of information dissemination between the stock and options market.

The lead-lag relationship is called the price discovery function in the literature because it reveals the sequence between trades in the stock and options markets when the investors are assumed to have information. Since the options market is originally designed to be closely associated with its underlying assets, the prices of options and their underlying stocks should fluctuate in tandem. Beyond this cohesion between the stock and options markets, Black (1975) posits that options lead stocks because informed investors would trade first in the options market to avoid limits of arbitrage in the stock market. His prediction about informed investors migrating to the options market evolved into the study of the options market as an informed habitat (Jayaraman, Frye, and Sabherwal, 2001; Chakravarty, Gluen, and Mayhew, 2004). Consistent with Black's prediction, many researchers in this literature have observed that the price changes in the options market lead changes in stock prices. That relationship is referred to as the price discovery function of the options market. A few other researchers claim that the lead-lag relationship goes in the opposite direction from the stock to the options market (Bhattacharya, 1987; Stoll and Whaley, 1990, Booth, So, and Tse, 1999; Chiang and Fung, 2001). This is also called the price discovery function, but of the stock market.

The majority of the price discovery function studies argue that the options market is an informed habitat. However, in two aspects, the empirical results of these price discovery function studies do not sufficiently support the claims that the options market is an informed habitat. The first aspect is that the study of the price discovery function presumes that prices changes in the stock and options markets are only due to the dissemination of information. Changes in prices, however, can occur because of factors other than information. Thus, the changes produced by the other factors in one market can also be transferred into the other market. For instance, as shown in (Kawaller, Koch, and Koch, 1987; Stoll and Whaley, 1987), liquidation trades and rollover trades that happen in both markets around options' maturity dates can generate the lead-lag relationship between the options and stock markets, but this relationship between the two markets is regarded to be triggered by liquidity, not information.

The second aspect in which the price discovery function studies do not sufficiently prove that informed investors migrate to the options market is that those studies do not distinguish between positive and negative information, in other words, information which drives the stock price higher or lower. In the information asymmetry studies of Diamond and Verrecchia (1987), there are benefits to informed investors in the options market that come from reducing the cost of trading and mitigating restrictions in trading. From these studies, it may be implied that trades in the options market may be more attractive to the negatively informed investors since short sale constraints cause informed trades with negative information in the stock market to be more expensive and restricted than informed trades with positive information. From their perspective, we may conjecture that the degree of the utilization of the options market by informed investors can be greater for negatively informed investors than for positively informed investors. There are studies that analyze the extent of

the use of options by informed investors. However, there are no studies that take the information type into consideration, positive or negative. Although, some studies related to earnings announcements examined the trading activities in the options market around the time earnings are actually announced, they performed their empirical tests on the aggregate trading activities, not trading activities that are classified according to whether they are positive information or negative information (Christophe, Ferri, and Hsieh, 2010; Blau and Wade, 2012). Both of these two mentioned aspects that make the price discovery function studies less convincing are ascribed to this kind of examination of the aggregate trades in the stock and options markets. Thus, if we can examine trades which occurr around the time when information appears in the markets, which market is the informed habitat may be more clearly ascertained.

To clarify the utilization of the options market by informed investors, we can compare the studies that examine the options market preceding positive informational events with the studies which examine the options market preceding negative informational events. There are studies that examine whether informed investors choose to trade options before trading stocks when they have positive information. However, to our knowledge, informed trades in the options market preceding negative information events have been rarely investigated. An example of a positive information event study is the one done by Cao, Chen, and Griffin (2005) who examine takeover announcements. They show that option trading volume prior to takeover announcements has a strong predictability for positive next day stock returns. Therefore, based on the implication from the information asymmetry that we mentioned previously, we can assume the response of the options market prior to negative information events will be even stronger. Thus, by examining trading behavior prior to negative information events, we can complement Cao, Chen, and Griffin.

In summary, there are two weaknesses related to the extant price discovery function studies. One is that factors other than information drive the lead-lag relationship between the stock and options markets. Another is that the lack of investigation according to the different types of information. Those two weaknesses can be alleviated if we can examine trades that happen around the time of information appearance and if we examine positively informed trades and negatively informed trades separately. The role of the options market in discovering information and explaining investment opportunity sets has not been unquestionably confirmed. To clarify the importance of the options market in the financial world and to make the relationship between the price discovery function studies and the research about informed habitats solid, we examine whether informed investors exploit negative information in the options market and whether they trade in the options market prior to trading in the stock market.

2.2 Informed trades with negative information

For stock investors, there are only two ways to exploit negative information: sales or short sales. While it is hard to ascertain the investors' intent when they sell their own assets in the stock market, investors with short sale trades can be assumed with a great degree of certainty to have negative information. No rational investor would short sell if he did not have negative information. If the stock price goes up against the expectation of the short seller, he will have a huge loss that is as much as the increase in the stock price. Therefore, short sellers are regarded as informed investors. Numerous studies examine whether short sellers are indeed informed by

investigating the relationship between short sale trading volume and subsequent stock returns. In their results, a great decrease in stock prices follows a large increase in short sale trades. Thus, we can say that short sellers are informed investors. To some degree, information about short sale trading volume is public information. The SEC (FINRA) announces the amount of short sales bimonthly on their web-site. Besides the SEC, companies like Data Explorers gather information about the activity of short sales. This sort of company calculates the number of shares borrowed and lent in the short sale OTC market. With this data, many researchers have examined whether short sale trades are executed by informed investors or not (Saffi and Sigurdsson, 2011).

In addition to the stock market, there are two ways informed investors with negative information can exploit their information in the options markets. One is by establishing synthetic short positions and the other is purchasing OTM puts. Establishing a synthetic short positon is purchasing a call and selling a put simultaneously. However, unfortunately, we cannot estimate how many synthetic short sale positions are established because even the exchange cannot confirm whether an investor is a synthetic short seller or not. Therefore, researchers have developed measures to discover the extent of establishing synthetic short positions by estimating the resultant changes in option prices.

Ofek et al. design a measure by calculating the log difference between the implied stock price from options and the actual stock price. For European options, by rearranging the Put-Call Parity equation, the implied stock price can be calculated as follows:

$$S^* = C - P + Ke^{-r\tau} + D \tag{1}$$

where S* is the implied stock price, C and P are the call and put prices with the maturity of τ and the exercise price of K. r is the continuous compounded risk-free rate and D is the present value of the dividend during the life of the options.

For American options, early exercise premium should be considered. Following Chen, Diltz, Huang, and Lung (2011), we can rewrite equation (1) as:

$$S^* = C - P + Ke^{-r\tau} + D - EEP_{Call} + EEP_{Put} \tag{2}$$

where EEP_{Call} and EEP_{Put} are the early exercise premiums for American call and put options, respectively.

The second way to exploit negative information in the options market is by purchasing OTM puts. When informed investors purchase OTM puts, they can make money because their puts become ATM or ITM puts when the stock price goes down. Xing et al. (2010) examine these informed trades triggered by negative information with a new measure, the volatility skew, which calculates the relative expensiveness of OTM puts compared to the most liquid option, ATM calls. They assume that an increase in demand for OTM puts will raise those options' implied volatilities abnormally. In their results, a portfolio constructed by shorting stocks with a high volatility skew significantly outperforms the market. The following equation shows their volatility skew

measure.

$$VS = IV_{Put}^{OTM} - IV_{Call}^{ATM} \quad (3)$$

where IV stands for implied volatility. The first term in the equation represents the implied volatility of an OTM put, the second one the implied volatility of an ATM call.

With these two measures, we examine whether informed trades initiated by negative information occur in the options market, analyze which strategy between establishing synthetic short positions and purchasing OTM puts is preferred by informed investors, and investigate whether those trades precede short sale trades in the stock markets. If the result of our study is consistent with our expectation, it will support Black's assumption and strengthen the relationship between the price discovery function studies and informed habitat research. In addition, our study will provide evidence that options enlarge our investment opportunity.

3. Data

We examine U.S. stocks and their individual options markets from August 1st 2004 to January 31st 2009. The stocks are listed on the New York Stock Exchange or the NASDAQ stock markets. The stock data are provided by CRSP (Center for Research in Security Prices) and the option data are from OptionMetrics. The stock data contain the weekly closing bid and ask prices and the weekly trading volumes. For options, besides the closing prices and the trading volumes, the data give each option's maturity, its exercise price, its call-put indicator, and its implied volatility that is calculated by the binomial tree model. In addition, to calculate a firm's book-to-market ratio, we use the book value of its common equity recorded in COMPUSTAT. Finally, information about short sale transactions is provided by Data Explorers and this information is used as a proxy for assessing the amount of short selling in the stock market.

The short sale data set includes the daily short sale fee, the daily short sale trading volumes and the utilization level of short sales in the OTC market examined by Data Explorers. Short sale fees are presented in six levels instead of as an exact amount. The six levels are from 0 to 5 but each level does not have the same range. A firm's short sale fee is labeled as 0 if the fee of this firm is less than 30 basis points of the total value of the borrowed shares for that firm. Level 1 is from 30 to 80 basis points, level 2 is from 80 to 150 basis points, level 3 is from 150 to 250 basis points, and level 4 is between 250 and 450 basis points. The highest level, 5, represents that the short sale fee of a firm is more than 450 basis points. The daily short sale trading volume is the total number of borrowed shares of a firm reported by Data Explorers. The last type of information for short sale transactions, the utilization level of short sale, is the percentage of actually borrowed stocks by short sellers from among total available shares to be short observed in the Data Explorers universe. Thus, if the daily short sale trading volume or the utilization level is high, then we assume that the demand for short sale is high.

Our study excludes firms in financial and utility sectors because financial firms have a different business operation compared to industrial firms and because utility firms are regulated by the government (Stubben, 2010). Additionally, we limit our discussion to stocks having short sale information and options since we

examine the trading behavior of informed investors in the stock and options markets when there is a significant increase in short sale demand. Lastly, in order to ameliorate market microstructure bias caused by wide bid-ask spreads and low liquidity, we eliminate stocks with prices less than five dollars from our sample. Therefore, there are 2,116 firms in our data universe.

Table 1 shows the summary statistics for stocks, short sale transactions, and options of the selected firms over the whole sample period. In Panel A, the mean and median values of the market capitalization for the sample firms are $5,389,352 and $1,131,096. The first quartile of those firms' book-to-market ratios is 0.266 and the third quartile is 0.603. The trading volume of a firm is reported after being normalized by the number of its outstanding shares. The average normalized weekly trading volume is 12.523, which means that the volume of traded shares is about 12 times larger than that of outstanding shares. This trading volume is larger than that of an average firm in the CRSP universe because we limit our discussion to firms with options and short sale information. Thus our sample firms are relatively large in size and liquid in trade. In the last row of Panel A, statistics about the percentage of bid-ask spreads are shown. The mean value, 0.206, indicates that bid-ask spreads of the sample stocks are, on average, 0.206% of their stock prices.

Summary statistics for short sale transactions are reported in Panel B. The mean and the median values of weekly short sale fees are 1.400 and 1.206, respectively. Daily short sale fees are expressed as a level that is an integer number from 0 to 5 and the reported weekly fees in this panel are weekly averages. As the level increases, short sale fees become more expensive. For example, if the level of short sale fees of a firm is 2, the interval that includes its short sale fees is between 80 and 150 basis points compared to the total value of short sale. Because the third quartile for weekly short sale fees of the sample firms is 1.586, we can assume that most of the stocks can be borrowed by paying fees less than level 2. The second kind of information about short sale transactions is the utilization level, which is the demand for shares to be short among the total shares observed by Data Explorers. This level is denoted as a percentage, thus the mean value of 27.929 indicates that short sellers usually consume about 28% of the total available shares to be short in the OTC market in the universe of Data Explorers. The last variable is the normalized weekly short sale trading volume, i.e., short sale trading volume divided by the number of the outstanding shares of a firm. On average, 160% of the outstanding shares of a firm are being sold short. In light of Diether, Lee, and Werber (2009) that reports about 20% of the total trading volume is short and in light of the fact that the normal weekly trading volume is 12 times larger than the outstanding shares, this normalized weekly short sale trading volume should be 2.5 times greater than the outstanding shares of a firm if Data Explorers observes all the short sale transactions. Even though the actual short sale trading volume collected by Data Explorers is 1.6 times of the outstanding shares of a firm, Saffi and Sigurdsson (2011) argue that the short sale data from Data Explorers can represent the whole short sale market based on the high positive correlation between the aggregate short sale trading volumes of the whole market and that of Data Explorers. In addition, the short sale transactions examined in this study were worth about $3.5 trillion as of December 2008, which is large enough to be thought of as a sample that can describe the whole short sale market well.

Panel C describes option statistics sorted by their maturities. We extract ATM calls and puts and OTM puts in order to estimate the stock price ratio and the volatility skew. Because the option's moneyness can change as the stock price changes, we select ATM and OTM options based on the stock price of the first day during the period

when the information event is examined. The chosen ATM calls and puts and OTM puts are not replaced with other options until the event period is finished. For instance, in the situation where a negative information event is defined as the peak of the weekly short sale utilization level for ten weeks, the ATM and OTM options are determined by the stock price of the nine weeks prior to the peak week. The moneyness of ATM options, which is the ratio of the exercise price to the current stock price, is from 0.975 to 1.025 and that of OTM puts is from 1.025 to 1.075. Additionally, we classify the selected options into short, intermediate, and long-term maturity options. Short-term options have a time-to-maturity of less than 30 days and that of intermediate-term options is from 31 to 182 days. The long-term maturity options have a time-to-maturity of between 183 and 365 days. The normalized weekly trading volume of options is calculated in the same manner as the stock trading volume is calculated, i.e., a weekly trading volume of an option of a firm is divided by the number of its outstanding shares. Compared to stock trading volumes, options trading volumes are quite small regardless of their maturities, but the trading volume becomes larger as the option's maturity becomes shorter. The average normalized weekly trading volume of options with short-term maturities is 5.066, which is almost eight times larger than that of long-term maturity options. Strangely, the average percentage of bid-ask spreads of short-term maturity options is twice as wide as that of options with long-term maturities. This may be because prices of short-term options are dramatically lower than those of long-term options. Therefore, the bid-ask spreads of short-term maturity options are about half of their options' prices.

Figure 1 shows the cumulative return of the whole stock market in our data universe starting from August 2004. The stock market showed steady and strong increase until October 2007. After then, however, the market plummeted due to the U.S. subprime mortgage crisis causing the cumulative return of the market to decrease to that of August 2004. The monthly levels of short sale fees, which we mentioned previously and are denoted as 0-5, for the same period are depicted in Figure 2. To observe the trend of the levels of short sale fees more closely, we classify all firms in our universe into three groups according to their short sale fee levels. The short sale fee levels of the first group are the bottom 60% of all the short sale fee levels for that month, and the firms having short sales fee levels ranging from the bottom 60% to the top 20% belong to the second group. The last group represents the firms with the highest short sale fees. Regardless of the group, short sale fees of all groups steadily increased during the bullish period. Also, the short sale fees peaked just before the beginning of the crisis. The bottom 60% of the short sale fees were almost level 0. The short sale fees in the next category were between level 0 to level 2. Those short sale fees were less than level 1 until just before the mortgage crisis. The short sale fees in the highest category were mostly more than 2 and around the crisis they even reached 4.

4. Empirical results

In this section, we perform several empirical tests to examine whether and how investors with negative information establish positions in the options market to exploit their negative information. We firstly give an overview of the measures used in this study, which are conducive to ascertaining whether informed trades triggered by negative information occur in the stock and options markets. We adopt two conventional measures, trading volume and transaction costs, on the stock and options markets and utilize two specialized measures, the stock price ratio and the volatility skew, only on the options markets. Secondly, we perform an event study with

those measures on the stock and options markets around ten weeks before and after the peak week of the utilization level of short sales in the stock market. For that period, we investigate cumulative stock returns, short sale trading volumes, short sale fees, the stock and option trading volumes, bid-ask spreads of the stock and options, the stock price ratios, and the volatility skews. Thirdly, we investigate whether informed investors choose the options market to trade before the stock market by examining the sequence between the ten-week peak in the utilization level of short sales in the stock market and the ten-week peak in the stock price ratio in the options market. Finally, we estimate the trading performances of shorting stocks, purchasing OTM puts, and establishing synthetic short positions when the utilization level or the stock price ratio has its peak during the ten weeks.

4.1 The summary statistics of the measures for the degree of negatively informed trades

Under a complete and perfect market, it is not worth it to gather information because information is conveyed to all investors without any costs as soon as it appears. As Glosten and Milgrom (1985) argue, however, the transmission of information to the public in a real world is usually delayed due to market frictions and the limited access of ordinary investors to private information. Hence, the informed investors can make more money than other investors by choosing good timing to trade. Numerous studies have examined whether the existence and pattern of informed trades in the market can be detected with various measures.

In this study, we employ four measures to examine the extent of informed trades in the stock or options markets. The first two measures, trading volumes and transaction costs are widely used for detecting informed trading activity in both markets. In particular, trading volumes such as total trading volume and short sale trading volume are associated with the amount of informed trades while transaction costs such as bid-ask spreads and short sale fees are associated with whether negative information appears in the market. Pan and Poteshman (2006) argue that total trading volume increases as informed investors join the market if we presume that the demand for trades from uninformed investors is constant. Even though their results show that the information makes trading volume increase, we cannot infer from an increase in the trading volume whether a stock price will increase or decrease. Besides trading volume, transaction costs such as bid-ask spreads or short sale fees can be used for identifying whether informed trades are occurring or not. As the proportion of informed traders among all investors rises, market makers will spread out bid and ask prices for compensating their possible loss from the trades by informed traders (Huang and Stoll, 1997). In other words, the reduced liquidity due to aggressive informed trades makes information asymmetry greater so that bid-ask spreads will increase (Bloomfield, O'Hara, and Saar, 2005). Short sale fees are another transaction costs and have also been used in the previous studies as an indicator for the increase in informed trades, especially trades with negative information (Kolasinski, Reed, and Ringgenberg, 2008).

In addition to trading volume and transaction costs, we adopt the stock price ratio and the volatility skew to estimate the extent of informed trades in the options market. As mentioned in Cao, Chen, and Griffin (2006), it is nearly impossible to detect option trades that are executed with the intent to exploit negative information. Investors can employ a wide variety of strategies by combining calls and puts with different moneynesses and maturities. Instead, researchers develop various measures that can estimate the resultant changes in prices or

implied volatilities from informed trades. The stock price ratio formulated by Ofek et. al (2004) is the log difference between the actual traded stock prices and the implied stock prices from options. Based on the idea that if the stock and option markets share the same information, the options market should imply the same value for stocks as shown in the stock market. Ofek et al. argue that the implied stock prices will be lower than the actual traded stock prices if informed investors who are not sure about a timely reflection of their negative information in the stock price establish synthetic short positions in the options market. They show that the stock price ratio of a firm becomes greater as its short sale fees become higher. In addition, they surmise that the more uncertain the reflection of negative information is, the greater the preference for options with longer maturity by informed investors is. In their results, as the maturity of an option becomes longer, the option appears to have a larger stock price ratio. They explain this as evidence that investors wait for their information to be reflected in the stock price within the options maturity. The volatility skew, the second measure to identify whether informed investors with negative information are trading in the options market is suggested by Xing et al. (2010). They define it as the difference between the implied volatilities of OTM put options and ATM call options. Given that Black-Scholes model and Put-call parity work, the volatility skew should not be significantly different from zero. However, if negative information arises, they argue that informed investors prefer to buy OTM puts so that those options become relatively more expensive than other options. In their results, the volatility skew is negatively associated with the future stock return.

Table 2 reports summary statistics of the four measures and their correlations. We have already introduced trading volumes and transaction costs in the stock and options markets in Table 1 to describe the characteristics of our sample data. Therefore, the same average values for these measures are reported again in Panel A of Table 2 from the first to the fourth rows. The last two rows of Panel A show the mean values of the stock price ratio and the volatility skew for different options' maturities. As options' maturities increase, their stock price ratios increase while their volatility skews decrease. In lieu of Ofek et. al (2004), the higher the uncertainty about the reflection of negative information into a stock price, the longer the maturity of the option's maturity that informed investors choose. This observation that the stock price ratio increases according to the option's maturity is consistent with Ofek et. al. However, the reverse pattern in which the volatility skew decreases as the options' maturity increases, implies that negatively informed investors prefer the options with short-term maturities and is not consistent with the evidence of Ofek et. al. These conflicting descriptive statistics of the stock price ratio and the volatility skew could be interpreted as the result of the combination of two kinds of informed trading behaviors on the basis of two kinds of information: one is information that requires a long time to be reflected into the stock price and the other is short-lived information. In other words, informed investors can show different trading behaviors according to the longevity of the value of the information (Bloomfield, O'Hara, and Saar, 2005). On the other hand, these statistics could be attributed to factors other than information affecting the levels of the stock price ratio and the volatility skew. In the event study in the next section, we will examine in detail whether the opposing patterns of the stock price ratio and the volatility skew are attributed to factors other than information or to the informed investors' changing preference for the option's maturity according to the required time of information reflection.

Panel B of Table 2 shows the correlations among the measures for discovering the extent of informed trades in the stock and options markets. The numbers in the lower triangle of Panel B represent the correlations

among measures and the figures in the upper triangle are the Pearson p values showing the significance of the correlations. The measures are calculated on a weekly basis and their correlations are estimated from their concurrent values. General trading volumes of the stock and options markets are highly correlated. Even long-term maturity options, which can be regarded as having the lowest connection with the current stock price among all options, have a high and positive correlation of 0.349 with the stock trading volume. The correlations with short sale trading volumes and the general trading volumes are also positive and highly significant. Besides trading volumes, bid-ask spreads of the stock and the options markets appear to move together. Therefore, we may say that the stock and options markets are closely linked. The correlations between all trading volumes and all bid-ask spreads are negative and significant, which are consistent with the intuition that high liquidity reduces the information asymmetry causing bid ask spreads to be reduced. Short sale fees have high correlations of 0.113 and 0.155 with the stock trading volumes and the bid-ask spreads of stocks, respectively. However, the correlations of short sale fees with option trading volumes and their bid ask spreads are very low and some of them are negative. That may be because negative information is exploited only in the stock market. Or it can be due to the time lag between informed trades in the stock and options markets. The stock price ratios are highly correlated among themselves, but they are weakly correlated with other measures. Even with short sale fees, the stock price ratios show low correlation. The volatility skews seem to decrease as trading volumes of the stock and options markets increase while they increase as bid ask spreads of both markets increase. However, contrary to our expectation in which negative information makes the volatility skew increase, the volatility skews have negative relation with short sale trading volumes and short sale fees. In other words, as the demand for short sales in the stock market increases, the difference between implied volatilities of OTM puts and ATM calls becomes smaller.

In summary, the stock and options markets seem to be closely linked, but we cannot find out whether the linkage between these two markets results from the dissemination of negative information. This might be because the stock and options markets reflect information at different times even though both markets share the same information. In the next section, by performing an event study, we can resolve the somewhat puzzling fact shown in the descriptive statistics of Table 2.

4.2 The informed trades in the stock and options markets prior to negative informational events

With the measures previously introduced, we now conduct an event study to ascertain whether informed investors trade in the options market. If informed option trades are observed, then we examine which strategy the informed investors prefer: establishing the synthetic short positions or purchasing OTM puts. In addition, we examine whether informed trades in the options market precede informed trades in the stock market.

We define a negative informational event as a significant increase in the utilization level of short sales, which represents the short sale demand from investors observed by Data Explorers. We calculate a weekly utilization level in which the amount lent out is divided by the amount available to borrow. Then we set a week as the event week if the utilization level of this week is the highest among the previous ten weeks and if there are no other events for these ten weeks. Figure 3-(a) shows the average weekly utilization level around the nine weeks before and after the peak week of the utilization level and the average weekly normalized short sale trading volume.

The utilization level reaches its highest level at the event time 0 for the nineteen week period. During the two weeks before the event week, the level of utilization increases quickly and after the event week, it decreases slowly. Like the utilization level, the short sale trading volume dramatically increases during the two weeks prior to the event week and then begins to decrease after the event week.

Figure 3-(b) shows that the cumulative raw return for the same nineteen week event period. The cumulative raw return at week *t* is calculated by the log difference between the stock price at week *t* and the stock price of the starting day of the event period. The cumulative stock return is not significantly different from zero before the event week, but it begins to decrease after the event week. For ten weeks after the event week, the stock return decreases by about 6%. This long-lasting decrease may be due to the slow dissemination of information among investors that results from short sale constraints and market frictions. Even though the stock return does not immediately decrease as soon as information appears in the market, its apparent decrease concurrent with the sharp increase in short sales supports the findings of the existing literature that investors short sell to exploit their negative information. We now look at Figure 3-(c) and 3-(d) to confirm whether the informed investors also utilize the options market to exploit their negative information.

Figure 3-(c) plots the average weekly normalized trading volume of the stock and its options with short-term maturities. Interestingly, the trades in the options markets seem to start increasing two weeks earlier than those in the stock market. Moreover, the option trading volume significantly drops one week before the event week. Comparing the pattern of the option trading volume to that of short sale trading volume, we can conjecture that informed investors choose options prior to stocks to exploit their negative information. Our guess can be more clearly confirmed by examining the changes in the stock price ratio that proxy the amount of synthetic short positions. In Figure 3-(d), the average weekly stock price ratios move in tandem with the option trading volumes, thus the observed changes in the ratio are supporting our inference based on the changes in the option trading volume. Even though the volatility skew shows a cyclical fluctuation over a period of four weeks, its peak in the cycle tends to increase as it becomes close to the event week and tends to decrease after the event week. Unlike the stock price ratio, however, the volatility skew does not give the clear impression about the preceding increase in informed trades in the options market compared to the stock market.

The changes in other measures during the nine weeks before and after the event week are shown in Table 3 and they support the results in Figure 3. First of all, short sale fees reported in the second row of the table start increasing distinctly from two weeks before the event week and stay at the elevated level after the event week. After a noticeable increase in short sale trades at the event week, stock prices gradually decrease and this seems to make short sale fees remain at the elevated level. The average stock trading volume increases until the peak week of short sale trading volume and then decreases. Regardless of the option's maturity, the option trading volumes start increasing four weeks before the event week and then decreasing one week before the event week. However, the increase in the trading volume of options with short-term maturities is much more apparent than that of others. The average percentage of bid-ask spreads of stocks show a sharp increase from two weeks before the event week while bid-ask spreads of options do not appear to have any significant changes any time around the event week. Because informed investors can hide their intent to exploit negative information in the options markets, bid and ask prices may not be spread out abnormally. Regardless of maturity, the stock price ratio peaks about two weeks earlier than the time the utilization level becomes its highest during the ten weeks. The

stock price ratios themselves are the highest for options with long-term maturities. On the other hand, the average level of the volatility skew decreases as the option's maturity increases. These opposing patterns in the two measures may be induced by two factors. The first is the hedging demand of institutional investors that concentrate on OTM put options with short-term maturities. This causes the level of the volatility skew to decrease as the option's maturity increases. The second is the more than 8 months that it takes for negative information to be fully reflected into the stock price. Because of this lag, as argued in Ofek et. al (2004), some investors can prefer options with loner-term maturities. This causes the stock price ratio to increase as the option's maturity increases. However, changes in the two measures both reach their peak around the event week. Moreover, the increase in both the stock price ratio and the volatility skew is greatest for the options with short-term maturities over the 19 week period. Therefore, we can say that the changes in the two measures around the event week are related to the negative information but their levels are determined by something other than negative information. Our event study in this section clarifies that the appearance and the extent of informed trades can be detected by the measures, especially by their changes.

In summary, we document that informed investors start trading in the options market about two weeks earlier than they do in the stock market. Two weeks after informed investors initiate their trades in the options market, short sale trades in the stock market begin to increase and reach their peak after another two weeks. Along with the peak in the utilization level of short sales, negative information seems to become public. The stock price decreases gradually but significantly for ten weeks after the peak in short sale trades, and the cumulative return for those ten weeks is about -6%. The significant changes in the stock price ratio and the volatility skew of options with short-term maturities compared to those of options with longer-term maturities indicate that informed investors prefer to trade short-term maturity options when they have negative information. In addition, informed investors seem to prefer establishing synthetic short positions to purchasing OTM puts in light of the results that changes in the stock price ratios are much clearer than those in the volatility skews. Therefore, from now on, in the robustness check and trading performance sections, we perform the remaining analyses focusing only on the stock price ratio.

4.3 Robustness check

In this section, we perform additional empirical tests to examine whether our hypothesis about the informed investors' trading behavior can be undermined by other possible interpretations of the results of our event study. There may be two other ways to explain the results of the event study. The first way is to construe the results as the increase in demand only for ATM puts not for synthetic short positions. The other way to analyze the results from the event study may be that changes in the options market shown in this event study can also be observed when noise investors establish synthetic short positions. From the perspective of this second interpretation, our findings would be weakened if we look into other time periods, not periods with the abnormal increase in short sales.

We can rule out the first of these interpretations about the event study results by examining the trend of the trading volumes of ATM calls and ATM puts separately for the event period. Figure 3-(e) depicts the average trends of weekly normalized trading volumes of ATM calls and ATM puts with short-term maturities. Both

levels of the trading volumes of these options range from 0.010 to 0.016 and they are increasing before the event week. The trading volume of ATM calls reaches its peak at the event week and it decreases after the event week, while the trading volume of ATM puts increases continuously even after the event week. The increase in the trading volume of ATM puts after the event week can be explained by the increase in the demand for OTM puts after the dissemination of the negative information. If the information spreads out the market, the stock price begins to decrease so the moneyness of a put option moves from OTM. Thus, as reported in many studies, we can think that investors purchase more OTM puts as the stock price decreases, causing the trading volume of ATM puts to increase continuously. With this increasing trading volume of ATM puts, the significant increase in the trading volume of ATM calls around the event week seem to be enough to resolve the issue about the usage of synthetic short positions by negatively informed investors.

To exclude the second interpretation that suggests that we might not observe the same results if we examine other time periods, we conduct two kinds of empirical tests. The first one is an event study that has the same format as the event study in the previous section, but defines negative information events as the abnormal increase in the stock price ratio, not the utilization level of short sales. The second test is to examine the lead-lag relation between the utilization level of short sales and the stock price ratio.

Figure 4 and Table 4 show the result of the event study that defines a negative information event as an abnormal increase in the stock price ratio of options with short-term maturities without considering the utilization level of short sales in the stock market[3]. Like the way we defined the event week in the previous event study, we set a week as an event week if the stock price ratio of this week is the highest among the previous ten weeks and if there is no other event week for these ten weeks. From the result of this event study, we can be assured that some changes in the options market, such as a large increase in the stock price ratio, independently forecast the future stock return decrease. If we look at Figure 4-(a), because we define the event as the abnormal increases in the stock price ratio, the stock price ratio calculated from short-term maturity options and the traded stock price increases by about 20% at the event week. Moreover, the normalized weekly option trading volume increases from 0.175 to 0.195 at the event week. Consistent with our argument, the cumulative raw return and the cumulative return in excess of the market decrease sharply after the event week. However, unlike the event study that defines the event as the significant increase in the utilization level of short sales, this event study shows a significant decrease in the stock return before the event. Although the return decrease for the ten weeks before the event is considerable, it does not undermine the predictability of the stock price ratio. A significant increase in the utilization level follows the increase in the stock price ratio. As we observed in the previous event study, Figure 4-(c) shows that there is a two-week time lag between the stock and options markets. Two weeks after the peak of the stock price ratio, there is a substantial increase in the utilization level of short sales and short sale trading volumes. Additionally, based on the increase in the utilization levels and trading volumes in the stock market at the beginning two weeks of the event window, we can infer that the return decrease before the event week may be caused by some previous negative information event. Because bad information about a firm's performance sometimes is revealed over several earnings

[3] If we define an event with the stock price ratio of options with intermediate or long-term maturities, the results are similar to Figure 4 and Table 4.

announcements after IPOs or SEOs, the impact of prior negative information can be overlapped in the event study.

In Table 4, overall results are similar to those in Table 3. The cumulative raw return decreases by about 6% nine weeks after the event. Option trading volumes, regardless of their maturities, reach their peaks at the event week. However, unlike in the event study of the previous section, options' bid-ask spreads increase until right before the event week and then decrease. Although this increase in the bid-ask spreads is not noticeable, it indicates that the sharp increase in synthetic short positions affect liquidity in the options market to some degree, as short sales do in the stock market. The reason we did not observe this increase in the bid-ask spreads of options in the previous event study may be that the abnormal increase in the utilization level of short sales is less informative than the abnormal increase in the stock price ratio. This conjecture will be confirmed below by the lead-lag relationship examination. The volatility skews in the last three rows of Table 4 are also cyclic and the peak of their cycles tends to increase around the event week. However, the changes in the volatility skews are not as significant and large as those in the stock price ratio.

As we demonstrated in the second event study, we can confirm more clearly that the stock price ratio increases abnormally if negatively informed investors establish synthetic short positions. Moreover, informed option trades seem to occur two weeks earlier than a large increase in short sales. Now, we examine whether short sale trades always follow a sharp increase in the stock price ratio. Our findings from the two event studies raise the intriguing question regarding how frequently informed investors use both markets to exploit their negative information. In order to examine this, we look into the lead-lag relation between informed trades in the stock and options markets. However, because we design the negative informational events to be possible at most once in a ten-week period, changes due to informed trades in the stock and options markets can be weakened by the conventional lead-lag relation examination that simultaneously regresses composed of concurrent and lag values. Therefore, we devise a new way to examine the lead-lag relation between informed trades in the two markets, which will reveal the extent of the use of the stock and options markets by informed investors.

To examine the lead-lag relation between informed trades in the sock and options markets, we first classify all negative information events into five cases. Then we examine the frequencies of those five cases and compare the cumulative stock returns around the time those cases happen. We assume there are M event weeks for our whole sample period which are the highest in utilization level of short sales and number all these events. As we see in Figure 5-(a), i-9 and i+9 denote the weeks which are 9 weeks before and after the i^{th} utilization level event. By definition, there are no other events from i-9 to i+9 for the event i.

Likewise, we again number all events defined by the stock price ratio with a ten-week high and with no other ten-week highs for the ten-week examination period. For our whole sample period, we assume there are N events for these information events defined by the stock price ratio. Figure 5-(b) shows the j^{th} event and there is no other stock price ratio event from j-9 to j+9. We classify the utilization level events and the stock price ratio events into five cases according to synthetic short trades in the options market and short sale trades in the stock market as follows.

A. The case in which synthetic short trades precede short sale trades
B. The case in which synthetic short trades simultaneously happen with short sale trades

C. The case in which synthetic short trades lag short sale trades
D. The case in which synthetic shot trades occur without short sale trades
E. The case in which short sale trades occur without synthetic short trades

First of all, if the j^{th} stock price ratio event occurs during the 19 weeks period around i^{th} utilization level event, in other words, if the i^{th} event in Figure 5-(b) falls into the range of the i^{th} event in Figure 5-(a), we consider these two events in the stock and options markets happen due to the same negative information. If two events occur from the same information, we further categorize them into three cases: A, B, and C. Secondly, if only one event occurs, i^{th} or j^{th} event, then we categorize it into two cases: D and E. Case A is the case where the j^{th} stock price ratio event precedes the i^{th} utilization level event. we count these two events as one event. Case B is the case where the j^{th} stock price ratio event and i^{th} utilization level event happen simultaneously. They are also counted as one event. Case C is the case where the j^{th} stock price ratio event follows the i^{th} utilization level event. Those events are considered as one event. However, Case D is the case where there are no utilization level events during the period between j-9 and j+9 in Figure 5-(b) which denotes the period 9 weeks before and after the j^{th} stock price ratio event. We count the j^{th} stock price ratio event as one event. Lastly, Case E is the case where there are no stock price ratio events during the 9 weeks before and after the i^{th} utilization level event depicted in Figure 5-(a). We regard this i^{th} utilization level event as one event.

Table 5 shows the frequencies of the five cases from among all negative information events examined in this study and reports the cumulative stock returns during the nineteen-weeks around the events for each case. As we expected, case A, in which the abnormal stock price ratio precedes the abnormal utilization level of short sales, heavily outnumbers the rest of the cases. If abnormal stock price ratios and abnormal utilization levels have the same number, we regard them as the same negative informational events. Then, the number of all negative informational events examined in this study is 20,611. Among these cases, 54.99% appear to be actively exploited by informed investors both in the stock and options markets. On the other hand, 5,726 events, which are 27.78%, are shown only in the options market and 3,557 events, which are 17.26%, are observable only in the stock market. Based on the frequencies in Table 5, we may say that informed investors are inclined to exploit their negative information in the options market. The cumulative stock returns around these events support our inference. Even though all cases show significant and negative cumulative return at the 8^{th} week after the event week, the return at the 8^{th} week decreases more when the abnormal stock price ratio occurs faster than the abnormal utilization level of short sales. Moreover, case D, in which informed investors seem to trade only in options market, shows the lowest cumulative return. However, when informed trades are explicitly shown only in the stock market, case E, even there is a significant increase in stock prices. So as we conjectured above, the stock price ratio seems to be more informative than the utilization level of short sales. Therefore, we again confirm that informed investors establish positions in the options market before they do in the stock market when they have negative information.

4.4 Trading performance using the extent of negatively informed trades as a trading signal

The observed strong predictability of the stock price ratio for stock returns may encourage investors to

examine how profitable trading strategies are if the stock price ratio is used as a trading signal. In this section, to do this, we compare the trading performances of trading strategies which use the stock price ratio as a trading signal to those of trading strategies which use the utilization level of short sales as a trading signal. Next, we examine whether the gains from the trading strategies adopting the stock price ratio as a trigger come from the compensation for bearing high risk generated by common risk factors.

We begin by calculating the weekly stock price ratios for the ten weeks prior to the time we implement a strategy. In particular, every Tuesday we examine the ten previous weekly stock price ratios. The weekly stock price ratio is calculated as the average stock price ratio among the daily stock price ratios from Wednesday to Tuesday. If the weekly stock price ratio of the last week is the highest from among the ten stock price ratios, we construct three kinds of trading strategies: shorting a stock, purchasing an OTM put, and establishing a synthetic short position. There are also three kinds of holding periods for each trading strategy: short, intermediate, and long. The holding periods are determined by the time to maturity of the options we use in establishing the positions. The trading strategies using the utilization level of short sales as a trading signal are constructed in the same way.

Table 6 shows the trading performances of these trading strategies. Panel A reports the trading results of the strategies using the stock price ratio as a trading signal and Panel B reports the trading performances using the utilization level of short sales as a trading signal. In addition, in each panel, the first three columns show the trading performances without considering transaction costs and the next three columns report the trading performances less transaction costs and the last three columns show the medium holding periods for the three trading strategies with the three different investment horizons. Regardless of holding periods and strategies, most of the trading performances are highly significant and positive. The trading strategy in which we establish a synthetic short position generates the highest return. For that trading strategy in Panel A, the performances of short, intermediate, and long-term holding periods are 1.078%, 5.028%, and 10.041%, respectively. It is quite surprising that we can earn 10.041% in only half of the year just by observing the weekly stock price ratios, which are almost public information. Even though we consider transaction costs in a way where we subtract short sale fees if we short sell and we subtract bid-ask spreads for all trades, all strategies still generate high profits if we hold our positions longer than four weeks. In Panel A, the synthetic short position yields 7.210% after considering transaction costs and it is almost double the performance of purchasing an OTM put. The trading performances of trading strategies that use the utilization level of short sales are also mostly positive and significant. However, they are slightly lower than the trading performances of trading strategies using the stock price ratio as a trading signal. One disappointing feature of this examination about trading performance is the negative performance of purchasing OTM puts and establishing synthetic short positions for short holding periods when we consider transaction costs. This can be explained by the slow dissemination of negative information which we observed in the previous two event studies. Thus, for short-term holding periods, the proceeds from trading options do not cover the costs.

If the highly significant trading performances in Table 6 are solely related to common risk factors that affect the whole financial market, we have to say that the abnormally high stock price ratio of a firm indicates a plummet in the whole market causing a simultaneous decrease in the firm's stock price. If then, we cannot say that the trading strategies examined in our study produce abnormal profits. To clarify whether the trading

performances come from bearing high risk generated by common risk factors, we regress the trading performances of strategies using the stock price ratio as a trading signal less risk-free returns on the concurrent risk premiums. We adopt three empirical asset pricing models for this regression: CAPM (Sharpe, 1964; Lintner, 1965), Fama-French three-factor model (Fama and French, 1992, 1996), and Fama-French three-factor model adding the momentum factor (Carhart, 1997). For each investment horizon, short, intermediate, and long-term, we regress the excess returns from the three kinds of trading strategies on the risk premiums of the three asset pricing models. In addition, to compare the profitability of each trading strategy per its total risk, we calculate its Sharpe ratio.

Table 7 reports the regression results and the Sharpe ratio of each trading strategy. We first illustrate how well these three models explain the trading performances of the three trading strategies. Then, we look into how well the positively high stock price ratio can predict the firm-specific decrease in its stock price. In addition, we compare the Sharpe ratios of the trading performances with the market Sharpe ratio for our sample period. When we calculate the Sharpe ratio, we annualize the excess return and the standard deviation of the excess return.

In all regressions reported in Table 7, the market risk premium and the size risk premium affect negatively and significantly the trading performances. It implies that, during the period when we hold trading portfolios, the market on average performs poorly and small firms in our trading set perform worse than large firms in the trading set. However, the book-to-market ratio and momentum factors are less significant for explaining the trading performances. The coefficients of these two factors, β_3 and β_4, have mostly negative signs for the short-term investment horizon and they have notably more positive signs for intermediate and long-term investment horizons. The second last column of Table 7 shows the goodness-of-fit of each model for each trading strategy and each investment horizon. Except for the performances from the strategy of buying OTM options for the short-term investment horizon, all three models have over 20% explanatory power for the trading performances. In light of the significance of the estimated coefficients and the high goodness-of-fit, the trading performances in this paper could be interpreted as the compensation for bearing high risk. However, in Table 7 if we look at the alphas which represent the unexplained performance of the models, the trading strategies of short selling stocks and establishing synthetic short positions generate significant abnormal positive returns for intermediate and long-term investment horizons. In Fama-French three-factor models for the long-term investment horizon, the alpha of the trading strategy of short selling stocks is 0.331 and that of establishing synthetic short positions is 1.451. Thus, we can argue that the ability of the stock price ratio to detect firm-specific negative information contributes to the trading performances of our trading strategies. Moreover, the Sharpe ratios of all trading strategies shown in the last column of Table 7 support this argument. For our whole sample period, the Sharpe ratio of the market calculated with monthly data is -0.361 and the Sharpe ratio with daily data is -0.176. Due to the financial crisis happened in 2008, these Sharpe ratios are negative. Thus if we expand the period to December 2010, the Sharpe ratios with monthly data and with daily data are 0.291 and 0.267. For the short-term investment horizon, only the trading strategy of short selling stocks outperform the market and the other two strategies show a negative risk premium for bearing one unit of their total risk. However, for the long-term investment horizon, all strategies outperform the market and especially the trading strategy of establishing synthetic short positions gives a quite high premium, 0.403.

In summary, we can say that the stock price ratio is a very useful measure to detect negatively informed trades, particularly trades triggered by firm-specific negative information. Moreover, we show that this measure is a stronger indicator than the utilization level of short sales. We also demonstrate that the discrepancy between the stock and options markets indicated by the high stock price ratio can be a trading signal generating economically significant profits.

5. Conclusion

Since Black (1975), many studies have examined whether and how informed investors trade in the stock and options markets when they have negative information. Among those studies, the price discovery function study investigating the lead-lag relation between the stock and options markets is the study that most extensively examines this issue. Even though price discovery function studies show that information generally flow from the options market to the stock market, the question regarding the informed habitats is still not resolved because it is hard to detect the time of arrival of the information in the market and to quantify the information. In this study, by detecting negative information events that are defined as the weeks with abnormally sharp increases in the utilization level of short sales in the stock market, we investigate whether and how informed investors trade in the options market prior to the stock market.

In our empirical results, consistent with the extant literature, a stock's price decreases significantly after the utilization level of short sales in the stock market reaches its ten-week high with no other ten-week highs during that ten-week period. Around the ten-week high which is denoted as the event week, short sale trading volume and short sale fees increase together. In addition, trading volumes in the options market also increase as the event week approaches. However, the peak of trading volumes in the options market occurs two weeks prior to the peak of short sales in the stock market. In particular, the stock price ratio which is used to detect the extent of synthetic short positions in the options market moves in tandem with the trading volumes of options. This implies that negatively informed trades in the options market precede short sales in the stock market. We also conduct the same event study but, instead of employing the utilization level to define the event week, we define an event week as the week when the stock price ratio reaches its ten-week high. After the sharp increase in the stock price ratio, there is also a large decrease in the stock price. More importantly, just as shown in the first event study, the peak of the utilization level of short sales appears to follow the peak of the stock price ratio by about two weeks. In addition, another measure to detect negatively informed trades in the options market, the volatility skew, is examined in both event studies. We find that negatively informed trades in the options market tend to be detected more clearly with the stock price ratio, which suggests that establishing synthetic short positions is preferred to OTM puts for exploiting negative information. The powerful predictive ability of the stock price ratio to forecast a future stock return decrease also generates a highly significant trading profit. In the trading strategies using the stock price ratio as a trading signal, a synthetic short position produces almost a 10% return for a six month holding and the return less transaction costs is still high and economically significant. In the regressions of the trading performance of the strategy adopting the stock price ratio as a trading signal on the risk premiums of three kinds of asset pricing models, the alphas of the unexplained performance of the models

are highly significant. In addition, the Sharpe ratio of the strategy adopting the stock price ratio as a trading signal is almost double to the Sharpe ratio of the market.

In light of the results of this paper, we can say that an investor's investment opportunity set is expanded by the options market and this is possible because the options market alleviates the restrictions caused by limits of arbitrage in the stock market. The role of the options market as a shelter for informed investors, however, does not undermine the market efficiency. Rather, as stated in the previous studies, the options market increases the market efficiency in that information that appears firstly in the options market eventually is disseminated into the stock market. Without the options market, the reflection of negative information into a stock price would take a long time or sometimes would not happen. Therefore, we can say that the options market increases an investor's investment opportunity set as well as market efficiency.

In this study, we find evidence supporting the claim that the options market is an informed habitat and we clearly demonstrate for the first time that negatively informed investors actively establish synthetic short positions. For the further future studies, it will be interesting to examine other measures to detect the appearance of information in the market or to examine which investor groups are involved in negatively informed trades. Moreover, another topic that we briefly touched on is the opposing pattern in the stock price ratio and the level of the volatility skew as the option's maturity increases. This topic is also worth being examined in that the results will shed more light on how options are indeed used by investors.

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Table 1. The summary statistics for sample data

This table shows summary statistics for stocks and options that the study examines. For each firm, weekly firm characteristics are calculated over our sample period, August 2004 to January 2009, and then for average firm characteristics of all the firms, their mean, median, 1st quartile, and 3rd quartile are calculated. Panel A depicts the distribution of these characteristics: market capitalization, book-to-market ratio, trading volume, and bid-ask spreads. The trading volume of a firm is reported after being normalized by the number of its outstanding shares. Bid-ask spreads are calculated as their percentage value compared to their stock prices. Panel B shows the summary statistics for short sale transactions. In the same manner of Panel A, weekly short sale fees, weekly utilization level, and weekly short sale trading volume of each firm are calculated and then their mean, median, 1st quartile, and 3rd quartile are reported. Short sale fees that are represented as integer levels in the universe of Data Explorers from 0 to 5 are averaged. In Panel C, sorted by their maturities, option statistics are described. The option trading volume of a firm is reported after being normalized by the number of the outstanding shares of its stock. Bid-ask spreads are calculated as their percentage value compared to their option prices.

Panel A. Summary statistics for stocks					
		Mean	Median	1st quartile	3rd quartile
Market capitalizations		5,389,352	1,131,096	489,235.7	3,203,001
Book-to-market ratios		0.462	0.411	0.266	0.603
Normalized weekly trading volumes		12.523	10.628	7.304	15.512
The percentage of bid-ask spreads (%)		0.206	0.153	0.109	0.237
Panel B. Summary statistics for short sale transactions					
Weekly short sale fees		1.400	1.206	1.101	1.586
Weekly utilization level (%)		27.929	22.375	10.664	42.231
Normalized weekly short sale trading volume		1.601	0.960	0.442	2.052
Panel C. Summary statistics for options					
	Maturity				
Normalized weekly trading volumes	short	5.066	1.714	0.505	5.031
	intermediate	1.111	0.513	0.178	1.327
	Long	0.636	0.303	0.098	0.746
The percentage of bid-ask spreads	short	54.838	50.264	33.024	73.126
	intermediate	31.977	26.508	16.235	41.975
	long	23.579	18.358	10.802	30.291

Table 2. Summary statistics for measures indicating informed trades

This table shows summary statistics of measures indicating the extent of informed trades in the stock or options markets: trading volumes in stocks and options, short sale trading volume, the percentage of bid-ask spreads of stocks and options, short sale fees, and the stock price ratio and the volatility skew of options. All measures are calculated on weekly basis and their mean values are reported in Panel A. To calculate the stock price ratio, ATM calls and puts are used. The moneyness of ATM options, which is the ratio of the exercise price to the concurrent stock price, is from 0.975 to 1.025. The volatility skew is calculated from the difference between implied volatilities of OTM puts and ATM calls. The moneyness of OTM puts is from 1.025 to 1.075. Panel B shows the correlations among the measures. The numbers in the lower triangle of Panel B represent the correlations among measures and the figures in the upper triangle are the Pearson p values showing the significance of the correlations.

Panel A. Summary statistics for measures

Variables	Stock (s)	Option		
		short-term (o1)	intermediate-term (o2)	long-term (o3)
Normalized weekly trading volume (TV)	12.329	5.066	1.111	0.636
Normalized weekly short trading volume (SSTV)	1.601	-	-	-
The percentage of bid-ask spreads (BA)	0.206	54.838	31.977	23.597
Short sale fees (SSF)	1.124	-	-	-
Stock price ratios (SPR)	-	0.084	0.169	0.262
Volatility skew (VS)	-	0.185	0.090	0.063

Panel B. Correlation coefficients among measures

	TV_s	TV_o1	TV_o2	TV_o3	SSTV	BA_s	BA_o1	BA_o2	BA_o3	SSF	SPR_o1	SPR_o2	SPR_o3	VS_o1	VS_o2	VS_o3
TV_s		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.963	0.000	0.000	0.000	0.000
TV_o1	0.616		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TV_o2	0.451	0.487		0.000	0.000	0.011	0.000	0.000	0.000	0.000	0.014	0.002	0.147	0.000	0.000	0.000
TV_o3	0.349	0.357	0.368		0.000	0.000	0.000	0.000	0.000	0.132	0.773	0.228	0.779	0.000	0.000	0.024
SSTV	0.244	0.232	0.175	0.142		0.000	0.000	0.000	0.000	0.000	0.673	0.000	0.000	0.000	0.000	0.000
BA_s	-0.024	-0.023	-0.008	-0.028	-0.072		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BA_o1	-0.178	-0.209	-0.156	-0.121	-0.201	0.238		0.000	0.000	0.000	0.000	0.000	0.227	0.000	0.000	0.000
BA_o2	-0.157	-0.174	-0.144	-0.117	-0.172	0.250	0.687		0.000	0.000	0.000	0.000	0.793	0.000	0.000	0.000
BA_o3	-0.134	-0.160	-0.136	-0.118	-0.150	0.283	0.662	0.842		0.000	0.000	0.000	0.000	0.000	0.000	0.000
SSF	0.113	0.015	0.021	-0.006	0.138	0.155	-0.022	0.010	0.075		0.000	0.403	0.002	0.000	0.000	0.000
SPR_o1	-0.011	0.012	0.008	0.001	-0.001	-0.013	0.046	0.060	0.076	-0.012		0.000	0.000	0.000	0.000	0.000
SPR_o2	0.000	0.016	0.010	0.005	0.016	-0.056	0.019	0.034	0.053	-0.002	0.320		0.000	0.000	0.000	0.000
SPR_o3	-0.009	0.012	0.005	-0.001	0.024	-0.032	0.003	0.001	0.037	0.008	0.185	0.281		0.000	0.000	0.000
VS_o1	-0.229	-0.178	-0.154	-0.134	-0.121	0.035	0.433	0.400	0.398	-0.153	0.129	0.064	0.065		0.000	0.000
VS_o2	-0.089	-0.079	-0.065	-0.068	-0.089	0.105	0.340	0.311	0.329	-0.013	0.123	0.162	0.107	0.503		0.000
VS_o3	-0.011	0.018	0.013	-0.009	-0.037	0.121	0.225	0.208	0.285	0.072	0.143	0.155	0.286	0.305	0.651	

Table 3. The event study with the utilization level of short sales

This table shows the result of the event study with the utilization level of short sales. If a week has a ten-week high in the utilization level of short sales with no other ten-week high for the ten-week examination period, this week is set to an event week and is denoted as 0 in the table. On weekly basis, stock prices, short sale fees, utilization level of short sales, trading volumes, the percentage of bid-ask spreads, the stock price ratio, and the volatility skew are calculated during the period from nine week before to nine week after the event week. Cumulative return at week *t* is the average buy and hold return from nine week before the event to that *t* week. All trading volumes are normalized by outstanding shares of their own stocks. . * and ** represent whether cumulative returns are significantly different from zero at 5% and 1% levels of significance, respectively.

Variables		Weeks										
		-8	-4	-3	-2	-1	0	1	2	3	4	8
Cumulative return		-0.001	0.000	-0.001	-0.001	0.001	-0.005	-0.007	-0.014	-0.020	-0.026	-0.046
Short sale fees		0.993	1.176	1.180	1.150	1.239	1.261	1.366	1.240	1.216	1.172	1.368
Utilization level of short sale (%)		20.977	20.612	20.869	21.269	22.274	26.529	26.121	25.635	25.174	24.919	24.677
Trading volume	short sale trades	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Total stock trades	13.019	13.250	13.314	13.926	15.166	15.076	14.398	14.611	14.551	14.668	15.576
	options with short maturity	0.017	0.017	0.017	0.017	0.019	0.018	0.019	0.020	0.018	0.019	0.019
	options with intermediate maturity	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	options with long maturity	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
The percentage of bid-ask spread	Stocks	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	options with short maturity	0.406	0.403	0.394	0.419	0.423	0.395	0.380	0.405	0.419	0.408	0.415
	options with intermediate maturity	0.215	0.219	0.221	0.226	0.228	0.217	0.214	0.216	0.219	0.218	0.226
	options with long maturity	0.150	0.151	0.153	0.156	0.159	0.155	0.155	0.156	0.157	0.156	0.161
The stock price ratios	options with short maturity	0.024	0.045	0.057	0.072	0.084	0.048	0.030	0.022	0.023	0.021	0.031
	options with intermediate maturity	0.072	0.114	0.119	0.112	0.117	0.064	0.042	0.039	0.047	0.050	0.092
	options with long maturity	0.108	0.125	0.130	0.126	0.124	0.078	0.064	0.063	0.083	0.070	0.108
The volatility skew	options with long maturity	0.148	0.148	0.151	0.156	0.151	0.150	0.155	0.158	0.152	0.149	0.147
	options with short maturity	0.070	0.072	0.072	0.074	0.075	0.069	0.071	0.074	0.076	0.074	0.074
	options with intermediate maturity	0.049	0.049	0.048	0.049	0.049	0.048	0.048	0.050	0.051	0.051	0.051

Table 4. The event study with the stock price ratio

This table shows the result of the event study with the stock price ratio. If a week has a ten-week high in the stock price ratio with no other ten-week high for the ten-week examination period, this week is set to an event week and is denoted as 0 in the table. On weekly basis, stock prices, short sale fees, utilization level of short sales, trading volumes, the percentage of bid-ask spreads, the stock price ratio, and the volatility skew are calculated during the period from nine week before to nine week after the event week. Cumulative return at week *t* is the average buy and hold return from nine week before the event to that *t* week. All trading volumes are normalized by outstanding shares of their own stocks. . * and ** represent whether cumulative returns are significantly different from zero at 5% and 1% levels of significance, respectively.

Variables		Weeks										
		-8	-4	-3	-2	-1	0	1	2	3	4	8
Cumulative return		0.001	-0.016	-0.019	-0.022	-0.024	-0.014	-0.018	-0.024	-0.029	-0.039	-0.066
Short sale fees		1.146	1.333	1.267	1.227	1.255	1.336	1.363	1.334	1.358	1.324	1.482
Utilization level (%)		25.158	24.826	24.903	24.859	24.891	24.974	25.478	25.878	26.044	25.799	24.778
Trading volume	short sale trades	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002
	Total stock trades	13.798	14.036	14.081	14.294	14.596	15.495	14.839	14.782	14.911	14.878	15.417
	options with short maturity	0.017	0.016	0.017	0.018	0.018	0.019	0.020	0.019	0.019	0.019	0.017
	options with intermediate maturity	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	options with long maturity	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.002	0.002
The percentage of bid-ask spread	stocks	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	options with short maturity	0.366	0.372	0.368	0.412	0.437	0.403	0.374	0.407	0.421	0.400	0.416
	options with intermediate maturity	0.202	0.206	0.209	0.218	0.220	0.215	0.209	0.214	0.219	0.216	0.220
	options with long maturity	0.138	0.142	0.145	0.149	0.150	0.156	0.152	0.153	0.155	0.154	0.160
The stock price ratios	options with short maturity	0.009	0.000	-0.002	0.003	0.027	0.244	0.170	0.108	0.050	0.018	0.011
	options with intermediate maturity	0.040	0.094	0.106	0.118	0.129	0.248	0.159	0.113	0.053	0.028	0.077
	options with long maturity	0.105	0.128	0.133	0.148	0.149	0.287	0.196	0.162	0.114	0.092	0.136
The volatility skew	options with long maturity	0.145	0.135	0.142	0.150	0.144	0.149	0.150	0.159	0.157	0.147	0.145
	options with short maturity	0.067	0.070	0.070	0.074	0.075	0.074	0.069	0.072	0.074	0.073	0.076
	options with intermediate maturity	0.048	0.050	0.049	0.050	0.050	0.050	0.048	0.051	0.051	0.051	0.054

Table 5. Lead-lag relation between negative informed trades in the stock and the options markets

This table shows the frequencies of the five cases from among all negative information events examined in this study and reports the cumulative stock returns during the nineteen week around the events for each case. * and ** represent whether cumulative returns are significantly different from zero at 5% and 1% levels of significance, respectively.

case	# of events	Weeks								
		-8	-4	-2	-1	0	1	2	4	8
A	6149	-0.003**	-0.011**	-0.013**	-0.010**	-0.015**	-0.019**	-0.026**	-0.036**	-0.054**
B	879	0.007**	-0.017**	-0.026**	-0.027**	-0.016**	-0.017**	-0.019**	-0.029**	-0.046**
C	4306	0.003**	-0.002	-0.013**	-0.021**	-0.031**	-0.029**	-0.028**	-0.030**	-0.035**
D	5726	-0.001	-0.023**	-0.041**	-0.048**	-0.038**	-0.046**	-0.054**	-0.069**	-0.093**
E	3551	0.007**	0.019**	0.018**	0.017**	0.009**	0.007*	0.002	-0.006	-0.026**

Table 6. Trading performance

This table shows the trading performances of shorting stocks, purchasing OTM puts, and establishing synthetic short positions. There are also three kinds of holding periods for each trading strategy: short, intermediate, and long. The holding periods are determined by the time-to-maturity of the options we use in establishing the positions. Panel A reports the trading results of the strategies using the stock price ratio as a trading signal and Panel B reports the trading performances using the utilization level of short sales as a trading signal. Transaction costs are considered in a way where we subtract short sale fees if we short sell and we subtract bid-ask spreads for all trades. * and ** represent whether cumulative returns are significantly different from zero at 5% and 1% levels of significance, respectively.

Panel A. Using the highest stock price raitos for ten weeks as a trading signal									
strategies	Trading performance								
	Without transaction costs			With transaction costs			Holding days (median)		
	Investment period			Investment period			Investment period		
	short	medium	long	short	medium	long	short	medium	long
Short sale stocks	1.430**	3.140**	4.593**	0.989**	2.356**	3.465**	28	56	84
Purchasing OTM puts	0.682**	1.665	4.890**	-0.357**	0.514	3.544**	25	88	173
Synthetic short positions	1.078**	5.028**	10.041**	-1.006**	2.620**	7.210**	25	88	173
Panel B. Using the highest utilization level for ten weeks as a trading signal									
Short sale stocks	1.161**	2.053**	3.068**	0.740**	1.288**	1.962**	28	56	84
Purchasing OTM puts	0.543**	2.529**	5.238**	-0.415**	1.430**	3.948**	25	88	172
Synthetic short positions	0.783**	4.058**	8.626**	-1.120**	1.786**	5.946**	25	88	172

Table 7. Analysis of trading performance

This table reports the regression results of the following three regressions.

(1) $r_t^s - r_{f,t} = \alpha + \beta_1 \left(r_{m,t} - r_{f,t} \right) + e_t$

(2) $r_t^s - r_{f,t} = \alpha + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 SML_t + \beta_3 HML_t + e_t$

(3) $r_t^s - r_{f,t} = \alpha + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 SML_t + \beta_3 HML_t + \beta_4 MOM_t + e_t$

r_{ts} is the trading performance of a trading strategy s that is implemented at time t. r_{ft} and r_{mt} are Treasury bill rate and CRSP volume weighted return for a holding period starting at time t. SML_t, HML_t and MOM_t are risk premiums of size, book-to-market, and momentum risk factors for the holding period of a strategy starting from time t. * and ** represent whether an estimated coefficient is significantly different from zero at 5% and 1% levels of significance, respectively.

Investment horizon	Model	Trading strategy	Estimated coefficients						Sharpe ratio
			α	β_1	β_2	β_3	β_4	Adj. R^2	
Short-term	CAPM	Short sale stocks	0.343**	-1.079**				0.208	0.300
		Purchasing OTM puts	-0.285**	-0.204**				0.077	-0.102
		Synthetic short positions	-0.150	-1.109**				0.227	-0.216
	FF-3 factor	Short sale stocks	0.310**	-0.973**	-0.587**	-0.062		0.220	
		Purchasing OTM puts	-0.277**	-0.185**	-0.070**	-0.106**		0.086	
		Synthetic short positions	-0.135	-1.029**	-0.471**	-0.215**		0.240	
	FF-3 factor with momentum	Short sale stocks	0.302**	-0.972**	-0.586**	-0.055	0.006	0.220	
		Purchasing OTM puts	-0.259**	-0.189**	-0.071**	-0.118**	-0.011	0.086	
		Synthetic short positions	0.141	-1.030**	-0.471**	-0.219**	-0.004	0.240	
Intermediate-term	CAPM	Short sale stocks	0.390**	-1.071**				0.267	0.279
		Purchasing OTM puts	-0.687	-0.376**				0.237	0.169
		Synthetic short positions	0.655**	-1.023**				0.271	0.384
	FF-3 factor	Short sale stocks	0.334**	-1.016**	-0.444**	-0.087		0.275	
		Purchasing OTM puts	-0.641	-0.357**	-0.234**	-0.004		0.251	
		Synthetic short positions	0.707**	-0.992**	-0.468**	0.014		0.279	
	FF-3 factor with momentum	Short sale stocks	0.364**	-1.021**	-0.439**	-0.102	-0.012	0.275	
		Purchasing OTM puts	-0.909	-0.335**	-0.259**	0.062*	0.085**	0.254	
		Synthetic short positions	0.772**	-0.996**	-0.461**	0.000	-0.020	0.279	
Long-term	CAPM	Short sale stocks	0.165**	-1.061**				0.265	0.239
		Purchasing OTM puts	-1.031	-0.439**				0.299	0.256
		Synthetic short positions	1.401**	-0.976**				0.315	0.403
	FF-3 factor	Short sale stocks	0.185**	-1.020**	-0.412**	-0.026		0.271	
		Purchasing OTM puts	-1.048	-0.446**	-0.184**	0.016		0.303	
		Synthetic short positions	1.219**	-0.998**	-0.538**	0.002		0.323	
	FF-3 factor with momentum	Short sale stocks	0.331**	-1.034**	-0.399**	-0.068	-0.051	0.271	
		Purchasing OTM puts	-1.235	-0.438**	-0.191**	0.023	0.043**	0.304	
		Synthetic short positions	1.451**	-1.010**	-0.533**	-0.001	-0.055*	0.324	

Figure 1

This figure shows the cumulative return of the whole stock market in our data universe starting from August 2004 to January 2009.

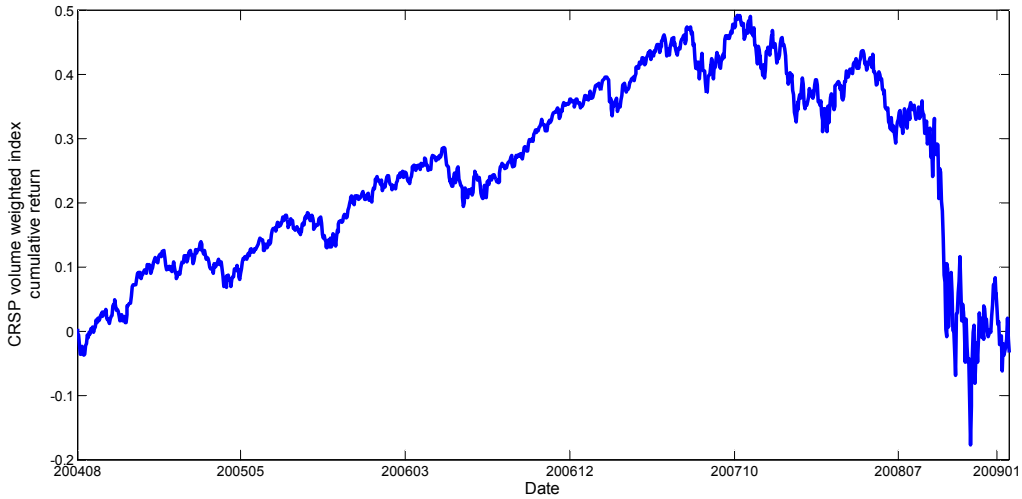


Figure 2

This figure depicts the monthly average levels of short sale fees for the period between August 2004 and January 2009. Short sale fees are presented in six levels instead of as an exact amount. The six levels are from 0 to 5 but each level does not have the same range. A firm's short sale fee is labeled as 0 if the fee of this firm is less than 30 basis points of the total value of the borrowed shares for that firm. Level 1 is from 30 to 80 basis points, level 2 is from 80 to 150 basis points, level 3 is from 150 to 250 basis points, and level 4 is between 250 and 450 basis points. The highest level, 5, represents that the short sale fee of a firm is more than 450 basis points.

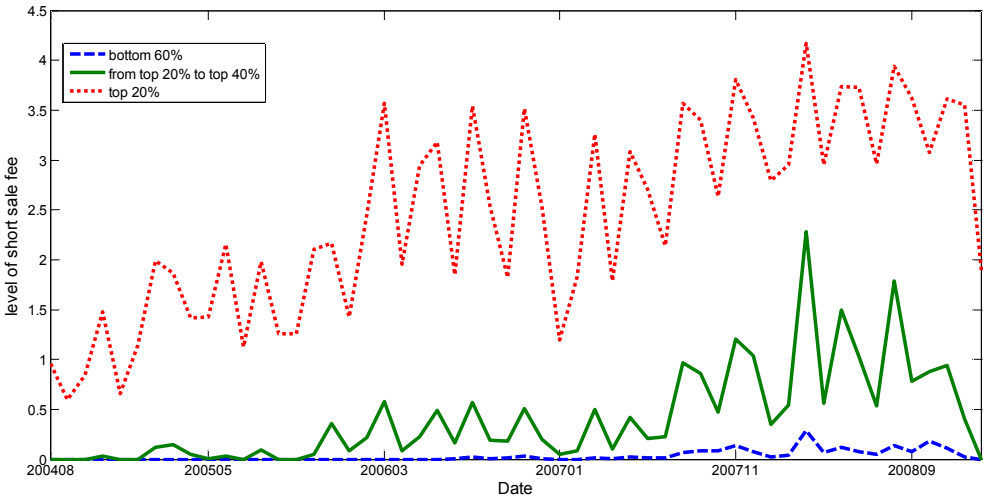
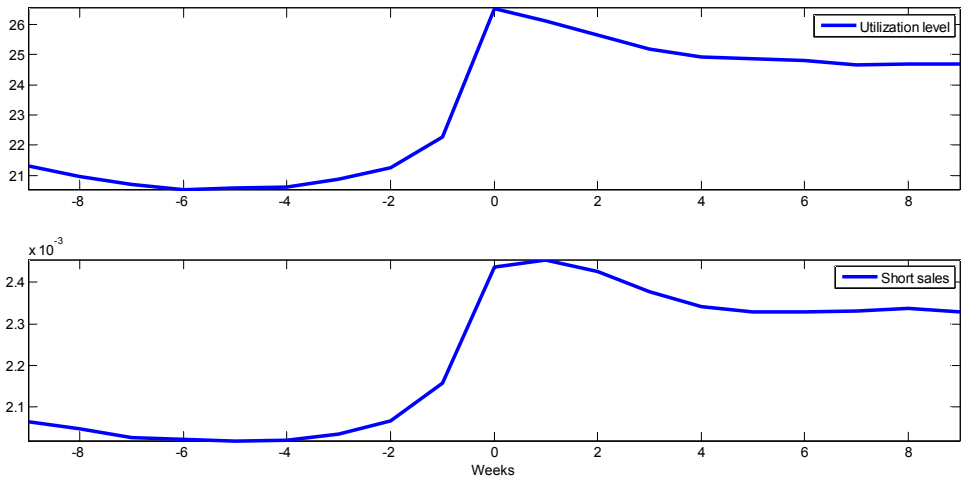


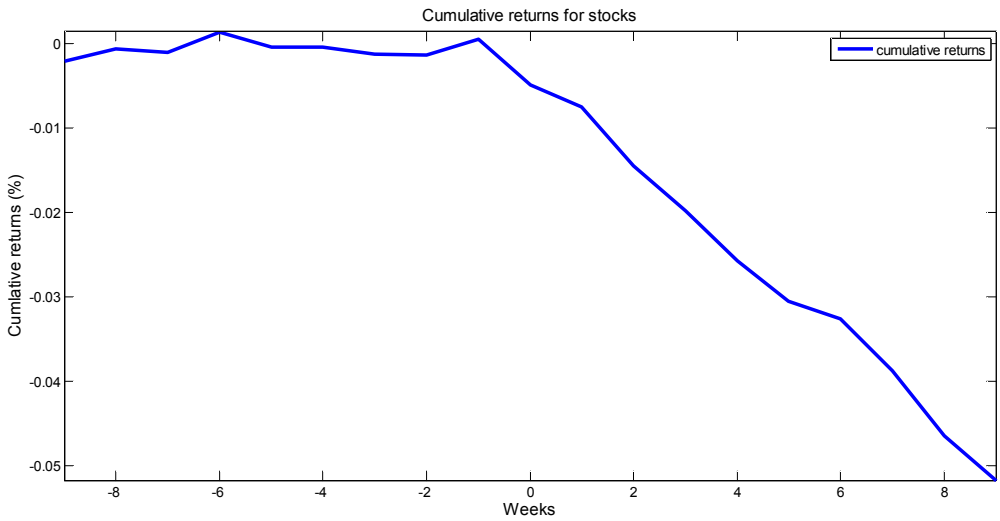
Figure 3. Events with the highest weekly utilization level

Figure 3-(a) shows the average weekly utilization level around the nine weeks before and after the peak week of the utilization level and the average weekly normalized short sale trading volume. Figure 3-(b) shows that the cumulative raw return for the same nineteen week event period. The cumulative raw return at week *t* is calculated by the log difference between the stock price at week *t* and the stock price of the starting day of the event period. Figure 3-(c) plots the average weekly normalized trading volume of the stock and its options with short-term maturities. In Figure 3-(d), the average weekly stock price ratios and the volatility skew around the event week are illustrated. Figure 3-(e) depicts the average trends of weekly normalized trading volumes of ATM calls and ATM puts with short-term maturities.

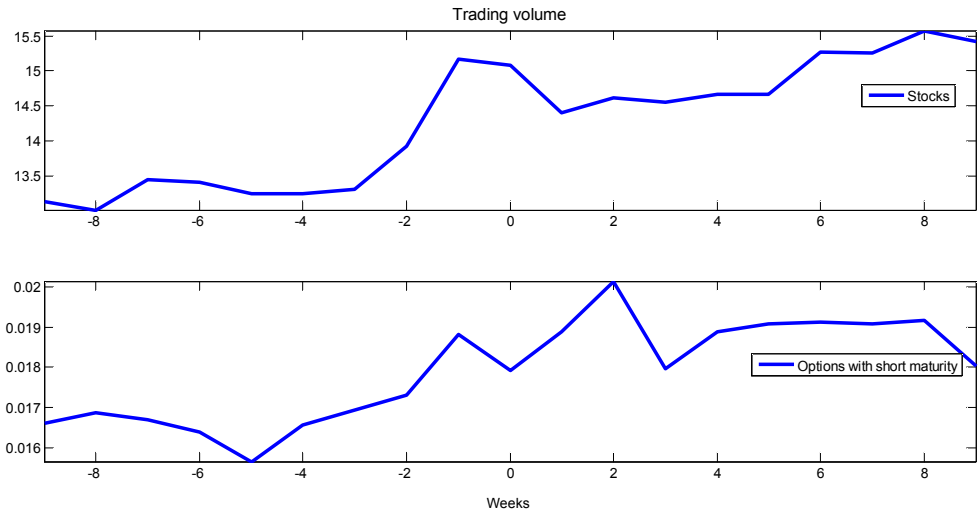
(a)



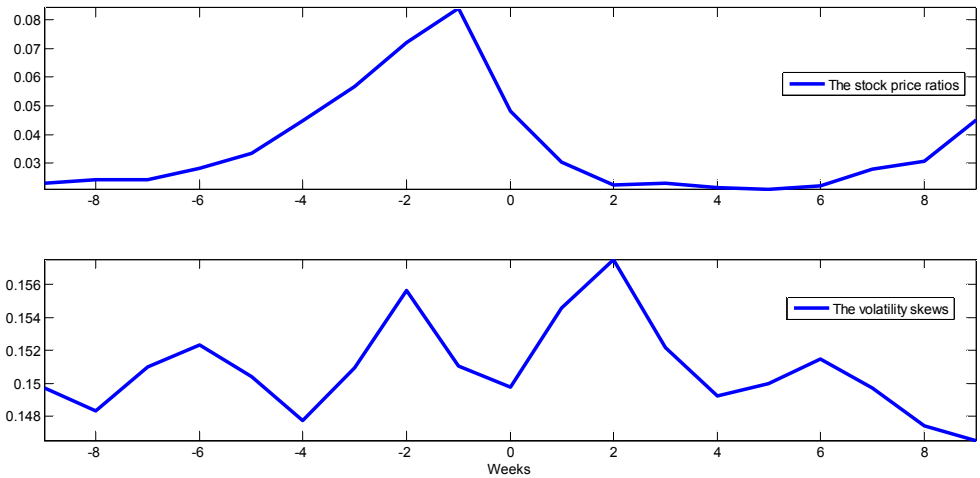
(b)



(c)


Trading volume
Stocks
Options with short maturity
Weeks

(d)


The stock price ratios
The volatility skews
Weeks

(e)

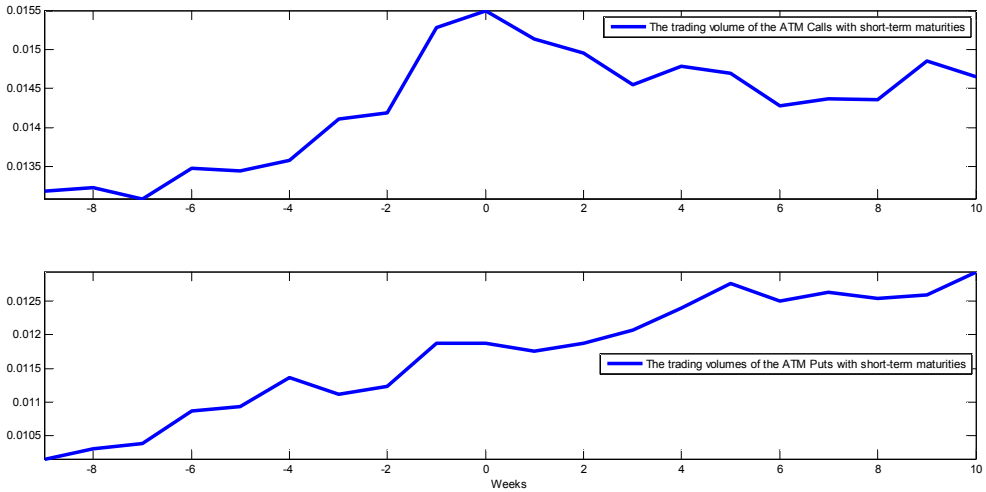
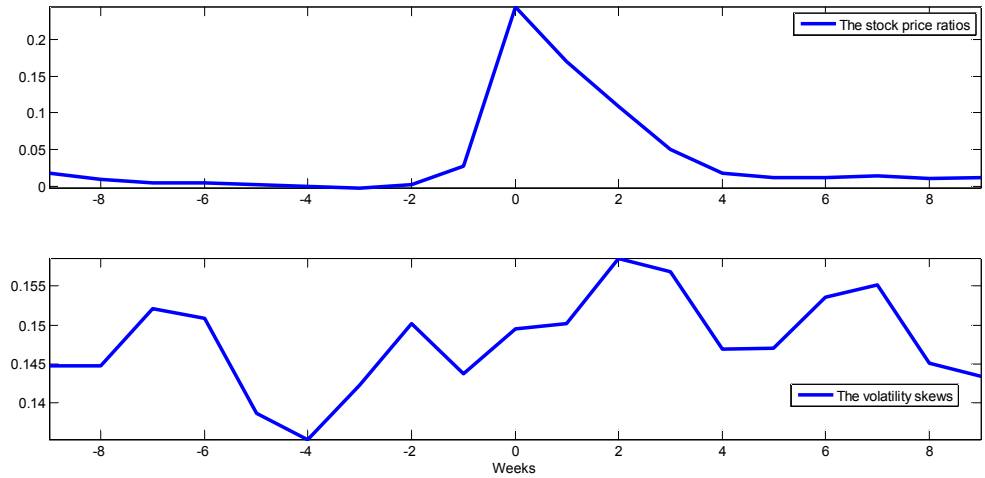

The trading volume of the ATM Calls with short-term maturities
The trading volumes of the ATM Puts with short-term maturities
Weeks

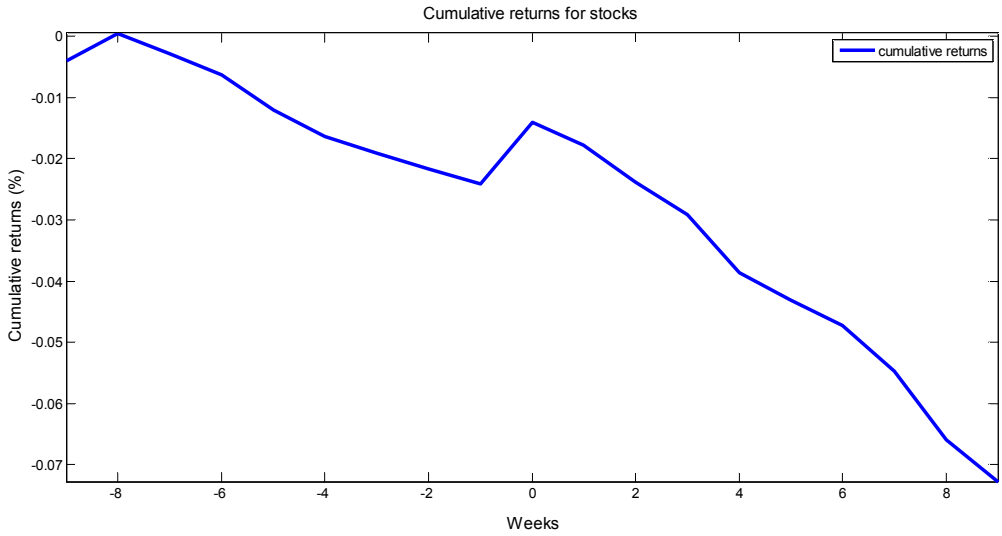
Figure 4. Events with the highest weekly stock price ratio

Figure 3-(a) shows the average weekly utilization level around the nine weeks before and after the peak week of the utilization level and the average weekly normalized short sale trading volume. Figure 3-(b) shows that the cumulative raw return for the same nineteen week event period. The cumulative raw return at week t is calculated by the log difference between the stock price at week t and the stock price of the starting day of the event period. Figure 3-(c) plots the average weekly normalized trading volume of the stock and its options with short-term maturities. In Figure 3-(d), the average weekly stock price ratios and the volatility skew around the event week are illustrated.

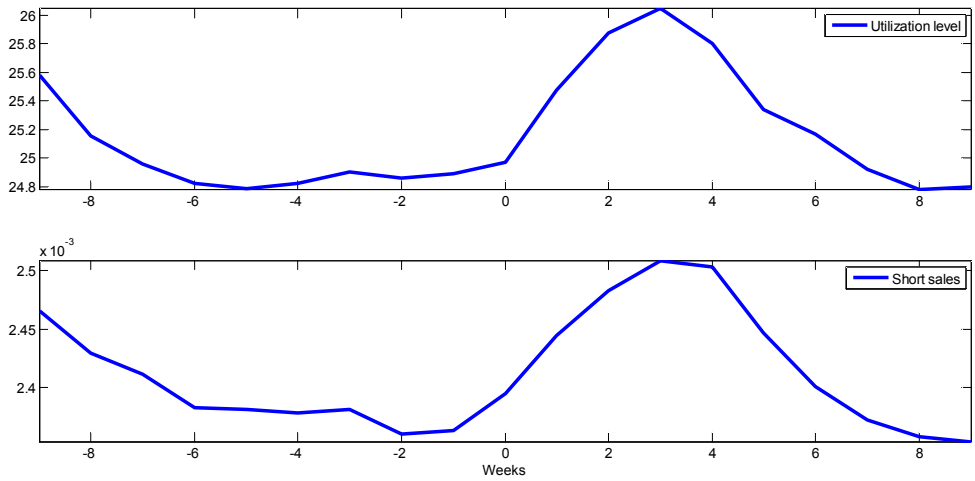
(a)



(b)



(c)


Utilization level
26
25.8
25.6
25.4
25.2
25
24.8
-8
-6
-4
-2
0
2
4
6
8
x 10^-3
Short sales
2.5
2.45
2.4
Weeks

(d)

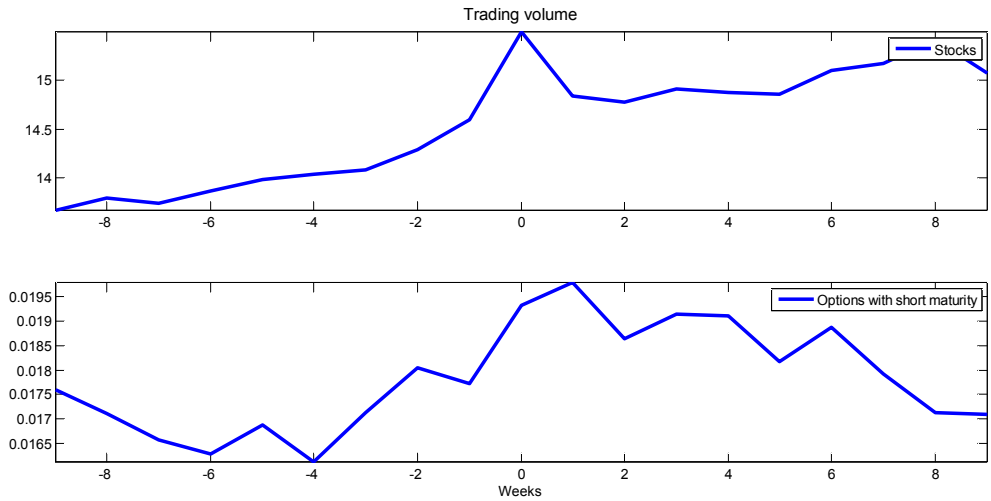
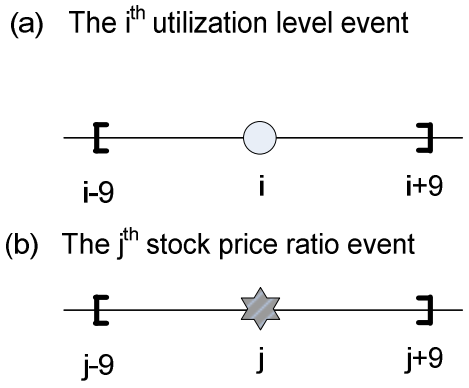

Trading volume
Stocks
15
14.5
14
Options with short maturity
0.0195
0.019
0.0185
0.018
0.0175
0.017
0.0165
-8
-6
-4
-2
0
2
4
6
8
Weeks

Figure 5

Figure 5-(a) shows the event period of i^{th} utilization level of short sales event. In the figure, i-9 and i+9 denote the weeks which are 9 weeks before and after the i^{th} utilization level event. We assume there are M event weeks for our whole sample period between August 2004 and January 2009 which are the highest in utilization level of short sales and number all these events. By definition, there are no other events from i-9 to i+9 for the event i. Figure 5-(b) shows the j^{th} event and there is no other stock price ratio event from j-9 to j+9. Likewise, we again number all events defined by the stock price ratio with a ten-week high and with no other ten-week highs for the ten-week examination period. For our whole sample period, we assume there are N events for these information events defined by the stock price ratio.



where, $i \in \{1,2,\cdots,M\}$ and $j \in \{1,2,\cdots,N\}$