MARKET EFFICIENCY, SHORT SALES AND ANNOUNCEMENT EFFECTS

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In this dissertation I aim at improving the understanding of the informativeness of short-selling in the context of the motivation, the impact on future stock returns, and the relation with market efficiencies.

In Chapter 1, I study short sellers' reactions after quarterly earnings announcements as well as the associations between short sales and post announcement stock returns. Short sales increase immediately after both negative and positive earnings surprises. After positive earnings surprises, short sellers appear to act as contrarians, and trade against stock price overreaction, thereby inducing price reversal in the long run. After negative earnings surprises, short sellers act as momentum traders, and trade with post earnings announcement drift. However, they are not able to fully arbitrage away the downside post earnings announcement drift. The short sellers' different reactions at subsequent surprises in a series of same-sign earnings surprises implies that short sellers exploit the consequences of other investors' behavioral biases. The results highlight the motivations and impacts for short sales after earnings announcements.

In Chapter 2, I investigate the informativeness of short-selling by combining Probability of Information-based Trading measure and short sales transaction data. Short sales depress stock returns in the short run, regardless of the information asymmetry level. However, short sales can not predict future stock return in the long run if information asymmetry levels are low. Large size short sales are the most

informed. When short sales constraints are more binding, short-selling is more informed, especially for the stocks with high information asymmetry levels.

In Chapter 3, I examine short sales prior to merger and acquisition announcements for acquiring firms. Short-selling increases prior to stock-financed not cash-financed mergers and acquisitions. Pre-announcement abnormal short-selling is negatively related to post-announcement stock returns. Short sellers are informed of the method of payment, but not the outcome. The results also indicate that short-sellers are more active in stocks with larger firm size, lower book-to-market ratio, and higher liquidity.

BIOGRAPHICAL SKETCH

Lin Zheng received the B.A. degree in Economics from Peking University, and the M.A. degree in Economics from Cornell University. Her research is in Finance with a focus on Behavioral Finance, Financial Markets, Asymmetric Information, and International Finance.

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CHAPTER 1

Short Sales and Post Earnings Announcement Drift

1.1 Introduction

Post-earnings-announcement drift (PEAD) is an interesting subject that is studied by many researchers in finance and accounting. PEAD refers to the tendency of stocks to continue to earn positive average abnormal returns after positive earnings surprises, and to earn negative average abnormal returns after negative earnings surprises for two or three quarters. The magnitude and persistence of PEAD is puzzling, since abnormal returns appear to exceed direct trading costs, and survive after controlling for momentum, market risk, and size effect (Chan, Jagadeesh and Lakonishok (1996)).

Ball and Brown (1968) provide early evidence that, after earnings announcements, stock price tends to drift in the same direction as the earnings surprise. Bernard and Thomas (1989, 1990) find that price reactions do not fully reflect the implications of current earnings for future earnings. Other papers suggest that PEAD may reflect estimation issues, such as a return benchmark commensurate with risk (e.g., Ball (1992)).

Recently, researchers have attempted to explain PEAD using a behavioral point of view. The most influential theoretical papers are Barberis, Shleifer and Vishny (1998) and Daniel, Hirshleifer and Subrahmanyam (1998). They incorporate psychological biases, such as overconfidence and conservatism, into their models. Barberis, Shleifer and Vishny (1998) predict that initial investor underreaction and eventual overreaction induce PEAD, while Daniel, Hirshleifer and Subrahmanyam (1998) show that PEAD can result from continuing overreaction. Several empirical papers address the issue by examining trading activities of different investor groups after earnings announcements. Bartov, Radhakrishman and Krinsky (2000) find that PEAD is stronger in firms with lower institutional shareholding, implying an association with individual investor trading. In contrast, Hirshleifer, Myers, Myers and Teoh (2002) find no evidence that individual investors drive PEAD, while Ke and Ramalingegowda (2005) find that institutions trade to exploit PEAD. Shanthikumar (2004) tries to distinguish different models by investigating different trading patterns of small and large traders after earnings announcements.

The objective of my paper is to examine short-sellers as a group and investigate their trading behavior after quarterly earnings announcements. I focus on the trading behavior of short sellers for several reasons. First, short-selling has been quite common in recent years. During the sample period for this paper (January 2005 to April 2007), short-selling accounted for 20.88% of daily trading volume on the NYSE. Boehmer, Jones and Zhang (2008) show that, from January 2000 through April 2004, short-selling accounts for 12.86% of overall NYSE trading volume in the proprietary system order database. So, it is important to understand the nature and impact of short-selling because it is a very prominent part of stock market activity. Second, recently there are a lot of discussions of the informativeness of short-selling. Some empirical research shows that short sellers are informed traders (Boehmer, Jones and Zhang (2008), Christophe, Ferri and Angel (2004), and Diether Lee and Werner (2007)), others indicate that, on average short-sellers are not informed (Daske, Richardson and Tuna (2005)). Thus, understanding the motivation and impact of short-selling should offer further insights on how stock markets incorporate information into prices.

Since short-selling is apparently very important to stock valuation and trading, it is surprising that so little work has attempted to link short-selling to PEAD. So far, most empirical papers in this field have focused on short sales constraints and market efficiency (e.g., Jones and Lamont (2001), Reed (2007)) and the predictive ability of short-selling on future stock returns (e.g., Boehmer, Jones and Zhang (2008), Diether, Lee and Werner (2009)). Recently, researchers have begun to link short-selling with earnings announcements. However, the lack of detailed short sales transactions data has necessitated that they use either monthly short interest (e.g. Cao, Kolasinski, Dhaliwal, and Reed (2007)) or data from lending markets (e.g. Reed (2003)) as a proxy for short-selling. Such studies cannot comprehensively and directly investigate short-sellers' trading behavior after earnings announcements. Some recent papers have begun to use short sales transaction data, but only touch on limited aspects of this problem (e.g., Christophe, Ferri and Angel (2004)).

This paper addresses this gap in the literature by directly studying trading records of short selling around quarterly earnings announcements. The paper examines several issues. First, I test whether event-time short-selling differs from short-selling when there are no announcements. Second, after showing that there is a significant difference, I investigate whether the unusual level of short-selling reflects informativeness of short-sellers. If, on average, short-sellers are informed, they are expected to trade against other investors' mispricing, otherwise, event-time short-selling is dispersed across all stocks regardless of whether or not post announcement returns suggest the stock has been mispriced. Third, I examine the relation between the event time short-selling and PEAD to investigate whether short-sellers help accelerate the speed of price adjustment to earning news and improve market efficiency.

The paper differs from previous papers in several respects. First, to the best of my knowledge, this study is the first to combine intraday short sales transaction data and intraday quote and trade transaction data to investigate how short sellers respond to quarterly earnings announcements. Instead of using monthly short interest, monthly institutional ownership data, lending market data, or other proxies that previous authors have used for ease of shorting, I use intraday transaction data, including short sales from NYSE. Since information is incorporated into stock prices through trades (Kyle (1983)), this data can more directly assess the informativeness of short sellers and more accurately reflects the dynamic relation between short sales and stock returns after earnings announcements in both the short and long run.

Second, instead of examining short sales and PEAD only after negative earnings surprises, this paper shows that short sales transactions increase after both negative and positive earnings surprises, and indicates different impacts on market efficiency. It appears that short sellers trade with PEAD after negative earnings surprises, while pulling stock prices back to fundamental value after positive earnings surprises.

Third, this paper differs from most past studies of short-selling and PEAD in examining the relation of shorting behavior not just to earnings surprises, but also to subsequent returns beyond those announcements. This contributes to a more comprehensive understanding of the motivation and impact of short-selling after earnings announcements.

Fourth, this paper investigates short sellers' reactions to announcements in the same-sign sequences. It tests whether short sellers are sophisticated, informed and trade against other investors' mispricing after earnings announcements.

My major findings can be summarized as follows. First, short-selling increases immediately after both negative and positive earnings surprises. Second, short sellers target overpriced stocks and depress future stock prices after both negative and positive earnings surprises. In other words, short sellers trade against overreacting stocks after positive earnings surprises and target underreacting stocks after negative earnings surprises. Third, short sellers short less heavily for later earnings surprises in a series of negative earnings surprises than for the first negative earnings surprises. In contrast, they short more heavily for later earnings surprises in a series of positive earnings surprises than for the first positive earnings surprises. Fourth, after positive earnings surprises, short-selling helps pull overreacted prices back to the fundamentals, thereby contributing to market efficiency. After negative surprises, short sellers trade in a manner consistent with trying to exploit downside drift, but there is no evidence that the event days' short-selling accelerates the speed of the price adjustment to bad news.

The rest of the paper is organized as follows. Section 2 surveys the relevant literature while Section 3 describes the data and methodology. Section 4 presents empirical results and discusses possible explanations. Section 5 presents additional tests to confirm the robustness of the results. Section 6 summarizes the paper.

1.2 Literature Review

Much research in finance and accounting aims to explain PEAD by investigating investors' behavior around earnings announcements. Previous papers have examined questions involving the meaning of information, the efficiency of the stock market, and the workings of market microstructure. Ball and Brown (1968) provide early evidence that stock prices tend to drift in the same direction as the earnings surprises. Bernard and Thomas (1989, 1990) show that PEAD occurs because naïve investors fail to recognize the implications of current earnings for future earnings. Chan, Jagadeesh and Lakonishok (1996)) find that market risk, size and book-to-market effects do not explain PEAD, and suggest that the market responds only gradually to new information. Barberis, Shleifer and Vishny (1998) present a model of investor sentiment, which predicts that investors underreact to earnings announcements, and overreact to consistent patterns of good and bad news. Daniel, Hirshleifer and Subrahmanyam (1998) show that investor overconfidence about the precision of private information can cause overreaction and continuous overreaction will induce PEAD. Bartov, Krinsky and Radhakrishnan (2000) find that PEAD is decreasing in institutional ownership, suggesting that less sophisticated investors are driving the drift. Ke and Ramalingegowda (2005) suggest that transient institutional investors trade to exploit PEAD, thereby accelerating the speed of price adjustment. Hirshleifer, Myers, Myers, and Teoh (2002) examine the data from a large discount broker and find no evidence that individuals drive PEAD. Shanthikumar (2004) shows that both small and large trades underreact to earnings announcements and small traders overreact eventually.

Relevant work investigates the informativeness of short-selling and the relation of short sale constraints and market efficiency. Diamond and Verrecchia (1987) build a model showing the effects of short sale constraints on the speed of adjustment of security prices. Their results suggest that prohibiting traders from shorting reduces the adjustment speed of prices to private information, especially to bad news. Jones and Lamont (2001) use daily rebate rates from the lending market to show that stocks that are expensive to short or which enter the lending market have high valuations and low subsequent returns, which is consistent with the overpricing hypothesis. Reed (2007) studies the effect of short-sale constraints on the informational efficiency of stock prices using a direct measure of short sale constraints from the equity lending market. The results confirm the Diamond and Verrecchia (1987) hypothesis that short sale constraints reduce the speed at which prices adjust to private information. Recently, with the availability of short sales transaction data, a growing number of empirical papers use intraday short sales transaction data to investigate the informativeness of short-selling. Boehmer, Jones and Zhang (2008) construct daily short sales using proprietary NYSE order data, showing that short sellers are well-informed, and non-program institutional shorts are the most informed. Diether, Lee and Werner (2009) examine the relation between short sales and future stock returns by using intraday short sales transaction data. They conclude that short sellers increase their trading following positive returns and are able to correctly predict future negative abnormal returns.

Other relevant papers examine short-selling around earnings announcements. Reed (2007) uses data from the lending market to show that the distribution of announcement day returns is more left-skewed for infrequently-shorted stocks, and the fraction of long-run price reaction realized on the day of the announcement is smaller when short sales are constrained. Cao, Kolasinski and Reed (2007) use short interest and shares available for borrowing to investigate whether short sellers exploit both post-earnings-announcement drift and the accrual anomaly. They find that short-selling plays an important role in pricing of accruals. Christophe, Ferri and Angel (2004) use data from the Nasdaq National Market System (NMS) to examine short sales transactions in the five days prior to earnings announcements for NASDAQ-listed firms. They reveal that abnormal short-selling is significantly linked to post-earnings-announcement stock returns. However, using daily short sales transactions for 3651 securities on the NYSE from April 2004 to February 2005, Daske, Richardson, and Tuna (2005) find no evidence that short sales transactions are concentrated around bad news events.

1.3 Data and Methodology

The sample is restricted to stocks with short sales transaction data from the New York Stock Exchange between January 2005 and May 2007, excluding closed-end funds, Real Estate Investment Trust (REITs), and American Depositary Receipts (ADR). Following Diether, Lee, and Werner (2007), I exclude stocks with prices lower than three dollars to avoid firms that are very small or in distress. According to Mitchell, Pulvino, and Stafford (2004), merger arbitrageurs usually short acquirers' stock immediately after takeover announcements, which cause high price pressure. Therefore, I eliminate firms which have mergers and acquisitions during this period. I identify mergers and acquisitions using the SDC Global New Issue database.

Intraday short sales transaction data is obtained from the NYSE. As part of Regulation SHO, which came into effect in 2005, all U.S. stock markets must release transaction data indicating which trades are short sales. One advantage of this database is that I can distinguish short-selling which is subject to the uptick rule from that which is exempt from it. Diether, Lee, and Werner (2007) point out market makers who are exempt from uptick rules tend to be contrarian investors, and Boehmer, Jones, and Zhang (2008) note that exempt short sales are less likely to reflect negative fundamental information about the stock. Following them, I choose only short sale transactions that are subject to uptick rules. The main drawback to this data is that I cannot determine when short sale trades are covered.

Stock price, volume and beta excess return are taken from CRSP. Fama/French Benchmark Factors comes from French's website. Quarterly earnings announcements dates, announced earnings per share, analysts' forecasts, and number of analysts, are obtained from the Institutional Brokers Estimates System (I/B/E/S). The earnings surprise is the difference between the announced earnings-per-share and the mean of analysts' most recent forecast, normalized by stock price.

Daily shorting flow is the total shorting shares over trading volume. Daily abnormal shorting flow is the difference between daily shorting flow and mean daily shorting flow over the non-announcement period, divided by the standard deviation of shorting flow over the non-announcement period. The non-announcement period is (-60, -11) before earnings announcements.

Quote and trade data are obtained from the NYSE Trade and Quotation (TAQ) database. I use the algorithm of Lee and Ready (1991) to classify buyer- and seller-initiated transactions. For each trade, if the trading price is below the midpoint of bid-ask prices, it is classified as a seller-initiated trade, if the trading price is above the midpoint of bid-ask prices, it is classified as a buyer-initiated trade. For a trade at the bid-ask midpoint, it is seller-initiated if the trading price is lower than its preceding trading price and buyer-initiated if the trading price is higher. For the daily trading imbalance, first, I calculate the difference between buyer-initiated trading volume and seller-initiated trading volume, and then divide that by the summation of buyer-initiated trading volume and seller-initiated trading volume. Daily abnormal trading imbalance is the difference between daily trading imbalance and mean daily trading imbalance over the non-announcement period, divided by the standard deviation of daily trading imbalance over the non-announcement period. The abnormal stock return is the Fama-French three-factor abnormal return.

For the intraday analysis, I use the NYSE Trade and Quotation (TAQ) database to calculate intraday stock returns. For each earning announcement, I generate 30-minute returns using the last bid and ask quotes. If no quote is available for an interval, I use quotes from the previous interval. The return is the log of the ratio of quote midpoints in successive intervals. This gives thirteen intraday intervals per trading day from 9:30 a.m. to 4:00 p.m. I exclude after-hours trading and overnight open-close price movements. The shorting flow in intraday intervals is the portion of total shorting shares on total trading volume in 30-minute intervals. In order to control the cross-sectional variations across different stocks and options, I follow the method in Easley, O'Hara and Srinivas (1998), and Chan, Chung and Fong (2002) to get the intraday abnormal return and intraday abnormal short-selling. For each earnings announcement, I calculate the mean and standard deviation for intraday return and intraday short-selling in days (0, +3). Intraday abnormal return is intraday return minus the mean of intraday return and normalized by standard deviation. Using the same method, I subtract intraday short-selling by the mean of intraday short-selling and dividing the difference by the standard deviation.

Table 1.1

Descriptive Statistics of Shorting Flow Measure and Firms Characteristics

The sample consists of 1883 companies listed on the NYSE from January 2005 through December 2006. Panel A reports daily shorting flow measure and firms characteristics across all firms. Panel B shows average earnings surprise, number of analysts and earnings dispersion across all negative earnings surprise and positive earnings surprise based on analysts forecast.

Panel A

	mean	std dev	25%	50%	75%
Shorting Flow Measure					
number of shares sold short (trades)	457.4210	468.2696	149.8295	328.6879	596.8963
numbers of short transaction (shares)	210109.7	344037	40600.17	101037.17	228373.84
Numbers of short shares/ volume	0.836246	11.99663	0.1741	0.2072	0.2431
Firms Characteristics					
Share price	35.2963	32.1218	19.4550	30.7651	45.0371
Turnover	8.7639	8.9660	4.7116	6.9565	10.7699

Panel B

	mean	std dev	25%	50%	75%
Negative Earnings Surprises (n= 4565)					
Earning surprise	-0.0022	0.0964	-0.0031	-0.0067	-0.0103
Number of analysts	12.4582	10.1275	5	10	17
Earning dispersion	0.2801	1.6625	0.0283	0.0747	0.2807
Positive Earnings Surprises (n= 4940)					
Earning surprise	0.0051	0.0981	0.0004	0.0011	0.0025
Number of analysts	12.3277	8.7343	6	10	17
Earning dispersion	0.0701	0.4038	0.0153	0.0283	0.0558

The final sample includes 1883 firms. Table 1.1, Panel A provides summary statistics for shorting flow measures and firms characteristics. The sample stocks experience an average of 457.4210 short sale transactions in a given day, with a mean of 210,109.7 shares sold short per stock per day. Panel B summarizes the earnings announcement measures. There are 4565 negative earnings surprises and 4940 positive earnings surprises. The average number of analysts for negative earnings surprises is -0.0022, while the average number of analysts for positive earnings surprises is 0.0051.

1.4 Result and Discussion

1.4.1 Short-selling around Earnings Announcements

I begin by examining daily abnormal short-selling around earnings announcements. Following Corrado (1989), I use the nonparametric rank test to examine statistical significance. Table 1.2 summarizes daily abnormal short-selling from day -3 to day +10 for both negative and positive earnings surprises. The table shows that abnormal short-selling becomes significantly positive for negative earnings surprises from day +1, and becomes significantly positive for positive earnings surprises from day 0. This trend lasts through day +3 after negative earnings surprises and through day +2 after positive earnings surprises. The result also shows that there is no unusual level of short-selling prior to earnings announcements for both negative and positive earnings surprises.

Collectively, the nonparametric rank test conveys a noteworthy point. There is no unusual level daily short-selling before either negative or positive earnings surprises. However, short-selling increases after both negative and positive earnings surprises. This raises several questions: If short sellers try to exploit PEAD, why they increase short-selling after both negative and positive earnings surprises? Are short sellers informed after earnings announcements? Are there different motivations behind short-selling after negative versus positive earnings surprises? Does short-selling have different impacts on PEAD after negative versus positive earnings surprises? The remainder of this paper tries to answer these questions.

Table 1.2

Event Study of Abnormal Short Sales around Earnings Surprises

The table reports the event-study results for the whole sample around negative and positive earnings announcements. Daily abnormal short-selling (SHORT) is calculated as the difference between daily shorting flow and the mean daily shorting flow over non-announcement period, and then normalized by standard deviation of shorting flow over non-announcement period. Significance is tested using the Corrado (1989) non-parametric test. '***', '**' and '*' represent significance ant the 1%, 5% and 10% level respectively.

Dates	Negative Surprise	Positive Surprise
-3	-0.0043	-0.0052
	(-0.44)	(-0.59)
-2	-0.0133	-0.0087
	(-1.34)	(-0.84)
-1	-0.0323	0.0097
	(-1.45)	(-0.04)
0	0.0467	0.0241
	(1.36)	(1.88)*
1	0.0465	0.0361
	(5.04)***	(2.82)***
2	0.0264	0.0254
	(5.01)***	(1.98)*
3	0.0134	0.0005
	(2.84)***	(0.04)
4	0.0104	-0.0098
	(1.44)	(-0.76)
5	0.0045	-0.0154
	(1.12)	(-1.20)
6	0.0090	-0.0057
	(0.49)	(-0.44)
7	-0.0022	-0.0020
	(0.97)	(-0.16)
8	-0.0003	-0.0037
	(-0.23)	(-0.290
9	-0.0039	-0.0020
	(-0.03)	(-0.16)
10	-0.012	0.0044
	(-0.41)	(0.34)

1.4.2 The Informativeness of Short Sellers

Having shown that there is a sharp increase in short-selling after both negative and positive earnings surprises, I ask the question whether short sellers are informed and step in the market to trade against mispricing or they close their position prior to announcements and open them afterwards to avoid the risk. In order to answer this question, I document further links between abnormal short-selling and stock returns after earnings announcements. First, since short-selling increases from day 0 to day +3, I analyze the relation between intraday short-selling and intraday stock returns in event days. If short-sellers trade against overpricing, they will short when observe stock price overshooting. In such a case, I expect to see a positive relation between current intraday short-selling and past intraday stock returns. If on average short sellers are uninformed, I do not expect to see a significant relation between intraday short-selling and past intraday stock return. Second, according to Boehmer, Jones, and Zhang (2008), it takes around 20 trading days for the information behind shorting flow to be fully incorporated into prices. I investigate the relation between event time short-selling and future stock returns to see whether short-sellers are informed about future low stock returns. Third, I look at the difference of event-day short-selling for consecutive same-sign surprise sequences. According to behavioral finance literature, investors overreact when similar information is repeated. If short-sellers trade against other investors' mispricing, they are expected to trade differently for first surprises and later surprises, after both negative and positive earnings surprises; otherwise, there is not significant shorting difference between consecutive same sign earnings surprises.

1.4.3 Even-time Short-selling and Stock Return

I begin using the bivariate VAR model to investigate the dynamic relationship between intraday abnormal short-selling and intraday abnormal stock returns during event days (0, +3). According to Dechow et al. (1997), short sellers are able to identify temporarily overpriced securities even after taking into account high transaction costs. So, there is positive relation between short-selling and past stock returns. This also indicates that short-selling strategies are based on fundamental analysis. For each stock, I generate 30-minute returns and short-selling. Abnormal short-selling is the intraday 30-minute short-selling minus the mean of the intraday 30-minute short selling in days (-60, -10) in the same interval in a day, and normalized by the standard deviation of the short selling over the same interval in days (-60, -10). Abnormal stock return is the intraday 30-minute return minus the mean of intraday returns over days (-60, -10) in the same interval in a day. Since there are thirteen half-hour intervals per day and four days per announcement, totally there are 52 intervals for each announcement. I run the following VAR for each event separately. Following Warner, Watts, and Wruck (1988) and Chung, Van Ness, and Van Ness (1999), I obtain the Z-statistics by adding individual regression t-statistics across earnings announcements and then dividing the sum by the square root of the number of regression coefficients. This procedure assumes that the individual regression t-statistics follow asymptotically a unit normal distribution.

The following is VAR model,

$$SHORT_t = \sum_{i=1}^{6} \alpha_i \times SHORT_{t-i} + \sum_{i=1}^{6} \beta_i \times RET_{t-i} + \varepsilon_{1t} \qquad (1)$$

$$RET_t = \sum_{i=1}^{6} \alpha_i \times SHORT_{t-i} + \sum_{i=1}^{6} \beta_i \times RET_{t-i} + \varepsilon_{2t} \qquad (2)$$

where RET_t is the intraday abnormal return in 30-minute interval t and $SHORT_t$ is the intraday abnormal short-selling in 30-minute interval t. It is assumed that the disturbances in (1) and (2) have zero means and are serially uncorrelated. I include 6 lags, which allows 3 hour reaction time, to test whether past stock returns affect current short-selling. Since Aitken, Frino, McCorry and Swan (1998) show that short sales executed near information events precipitate larger price reactions at the intraday level, I also investigate the predictive ability of short-selling in future stock returns at the intraday level.

If short-sellers are informed of firms' fundamentals, they will increase trading after observing overpriced stock prices. So, I expect to see a positive relation between abnormal short-selling and past abnormal stock returns after both negative earnings surprises and positive earnings surprises. Otherwise, abnormal short-selling is not expected to be positively related to past stock returns.

Table 1.3 shows the result of VAR regressions. First, coefficients of lagged intraday abnormal returns in specification (1) indicate the effects of past returns on current short-selling. The coefficients for $RET_{t-2,}$ $RET_{t-3,}$ and RET_{t-4} are significantly positive after negative earnings surprises, and the coefficients for $RET_{t-2,}$ $RET_{t-3,}$ $RET_{t-4,}$ RET_{t-5} and RET_{t-6} are significantly positive after positive earnings surprises. This indicates that intraday short-selling is positively related to past intraday stock return after both negative and positive earnings surprises. The coefficient for RET_{t-1} is significantly negative after both negative and positive earnings surprises. It is possible that short-sellers need some time to react to overpricing, or it shows that short-sellers correctly pick the time when overpriced stock price is beginning to drop.

Second, the coefficients of lagged intraday abnormal short-selling in specification (2) describe the price effect of short-selling. After negative surprises, coefficients for lagged stock returns are not significant until lag 6. After positive surprises, coefficients for stock returns are negatively pronounced for lag 4, 5, 6. It seems that short-selling takes some time to induce the downside pressure on stock prices after earnings announcements. Particularly, it takes more time for negative earnings surprises than for positive earnings surprises. When combined the result with

Aitken, Frino, McCorry and Swan (1998), it may due to the relatively low transparent short-selling setting in NYSE immediately after trade.

Table 1.3

Relation between Intraday Short-selling and Stock Return

The table reports the regression results for the whole sample in days (0, +3) for negative and positive earnings announcements. The Following bivariate VAR model is estimated:

$$SHORT_t = \sum_{i=1}^{6} \alpha_i \times SHORT_{t-i} + \sum_{i=1}^{6} \beta_i \times RET_{t-i} + \varepsilon_{1t} \quad (1)$$

$$RET_t = \sum_{i=1}^{6} \alpha_i \times SHORT_{t-i} + \sum_{i=1}^{6} \beta_i \times RET_{t-i} + \varepsilon_{2t} \quad (2)$$

Where RET_t is intraday abnormal return during 30-minute time interval t and $SHORT_t$ is intraday abnormal shorting during 30-minute time interval t. Regression is run separately for each event. I use 6 lags for the explanatory variable, and report the cross-sectional mean of the coefficients. Z- Statistics is used to test the significance.

	Negative Surprise		Positive Surprise	
	(1)	(2)	(1)	(2)
	$SHORT_t$	RET_t	$SHORT_t$	RET_t
$SHORT_{t-1}$	1.7095	-0.0114	1.7390	0.0197
	(92.54)***	(-0.61)	(94.74)***	(1.07)
$SHORT_{t-2}$	0.3519	-0.0194	0.2754	-0.0206
	(19.05)***	(-1.05)	(15.01)***	(-1.12)
$SHORT_{t-3}$	0.2211	-0.0247	0.2556	-0.0128
	(11.97)***	(-1.34)	(13.93)***	(-0.70)
$SHORT_{t-4}$	0.04826	-0.0609	-0.0176	-0.0456
	(2.61)***	(-3.30)	(-0.96)	(-2.49)**
$SHORT_{t-5}$	0.0849	-0.0160	0.0876	-0.0359
	(4.60)***	(-0.87)	(4.77)***	(-1.96)**
$SHORT_{t-6}$	-0.1012	-0.0477	-0.0882	-0.1077
	(-5.48)***	(-2.58)**	(-4.80)***	(-5.87)***
RET_{t-1}	-0.1246	-0.2953	-0.0382	-0.3086
	(-6.74)***	(-15.99)***	(-2.08)**	(-16.81)***
RET_{t-2}	0.0387	-0.3595	0.1197	-0.3833
	(2.10)**	(-19.46)***	(6.52)***	(-20.88)***
RET_{t-3}	0.0381	-0.1827	0.0807	-0.1591
	(2.06)***	(-9.89)***	(4.40)***	(-8.67)***
RET_{t-4}	0.0307	-0.2470	0.0687	-0.2370
	(1.68)*	(-13.37)***	(3.74)***	(-12.91)***
RET_{t-5}	0.0229	-0.1251	0.0552	-0.1285
	(1.24)	(-6.77)***	(3.00)***	(-7.00)***
RET_{t-6}	0.0091	-0.2174	0.0387	-0.2167
	(0.49)	(-11.77)***	(2.11)**	(-11.81)***

In all, in this section, I use bivariate VAR regressions to show that short sellers react to overpricing at the intraday level immediately after earnings announcements. In other words, they trade against overreaction after positive earnings surprises, and target underreaction after negative earnings surprises.

1.4.4 Event-time Short Sales and Future Stock Returns

The previous sections show that, in event days, intraday short-selling is positively related to intraday past stock return, and has an immediate price effect. In this section, I go further to investigate the informativeness of short-selling by looking at the relation between event-time short-selling and future stock returns. According to Boehmer, Jones, and Zhang (2008), short-selling appears to take 20 trading days for the information behind shorting flow to be fully incorporated into prices. So, I look at the relation between event-time short-selling and cumulative abnormal returns over days (+4, +30) (CAR (+4, +30)). A number of studies argue that short-selling may prevent overpricing and enhance market efficiency. Diether, Lee and Werner (2009) suggest that investors who choose to short may profit from being able to recognize transient market overreactions. If stock prices after positive earnings surprises exceed their fundamental value, some investors may short these stocks to benefit from the eventual reversal of overreaction. So, if short sellers are indeed trading against overreaction after positive earnings surprises, I expect to see the price reversal in the future. In other words, the price drop is not temporary and is not induced by price pressure. If short sellers trade under-reacting stocks after negative earnings surprises, stock prices are also expected to decrease after event-days. The relation between shorting-selling and future stock returns is expected to be negative.

I run the following regression.

$$CAR\ (+4, +30) = \alpha 0 + \alpha 1 \times SHORT\ (0, +3) + \alpha 2 \times IMB^{+}\ (0, +3) + \alpha 3 \times IMB\ (+4, +30) + \alpha 4 \times SURPRISE + \alpha 5 \times DISPERSION + \alpha 6 \times N\_ANALYSTS + \delta \quad (3)$$

SHORT (0, +3) is cumulative abnormal short-selling over days (0, +3). CAR (+4, +30) is cumulative abnormal return over days (+4, +30). I also do robustness checks by using cumulative abnormal returns over days (+4, +20) and (+4, +40). If short sellers trade against overpriced stocks after earnings surprises, SHORT (0, +3) is expected be negatively related to future cumulative abnormal return.

IMB^{+} (0, +3) equals to the cumulative trade imbalance over days (0, +3), if the cumulative trade imbalance over days (0, +3) is positive, and equals to 0 otherwise. I include IMB^{+} (0, +3) to control the "voluntary liquidity provision" shorting. According to Diether, Lee and Werner (2009), short sellers step in and trade when there is a significant, temporary order imbalance. That is, they provide liquidity when there is buying pressure, as the order imbalance decreases, prices revert to fundamental value and short sellers cover their positions at a profit. Under this scenario, increased short sales coincide with positive order imbalances followed by reduced order imbalances. Thus, to test whether information-based short sellers' trade against overreaction after positive earnings surprises, and with PEAD after negative earnings surprises, I need to control short-selling due to voluntary liquidity provision.

I include IMB (+4, +30) as an independent variable to disentangle the price pressure induced by short-selling itself on the future stock returns. According to Mitchell, Pulvino and Stafford (2004), even if short-selling is uninformed, if it dominates after earnings surprises, it will induce price pressure, which can decrease the price and cause it to temporarily deviate from its fundamental value. Shkilko, Van Ness and Van Ness (2008) research predatory short-selling, demonstrating that shorting by speculators triggers a wave of selling by other market participants, which bring down pressure on prices and allow for speculative profits. If pressure is the result of uninformed or speculative short-selling, the price will temporarily deviate from the fundamental value, and return to fundamentals in the future. Since Lee and Ready (1991) and Hvidkjaer (2006) show that the order imbalance measure is a proxy for price pressure, I use IMB (+4, +30) to capture the price pressure induced by short-selling. If the price drop is only because of price pressure created by short-selling, the coefficient for CAR (+4, +30) will be insignificant, and, at the same time, the coefficient for IMB (+4, +30) will be significantly positive.

I include SURPRISE, which is earning surprise, to control the effect of earning surprise on short-selling. Recent literature gives evidence that information uncertainty affects the PEAD. Zhang (2006) investigates the role of information uncertainty in price continuation anomalies and cross-sectional stock return variations. Francis, Lafond, Olsson, and Schipper (2006) show that greater PEAD profitability for higher idiosyncratic volatility securities is attributable to these securities having greater information uncertainty. They conclude that greater information uncertainty should produce relatively higher expected returns following good news and relatively lower expected returns following bad news. So, I include DISPERSION and N_ANALYSTS to control the information environment. DISPERSION is analysts' forecast dispersion, the standard deviation of individual analysts' most recent forecasts of a firm's quarterly earnings. N_ANALYSTS is the number of analysts following a particular firm.

Table 1.4 presents regression results. After both negative and positive earnings surprises, the coefficients for CAR (+4, +30) are significantly negative, which is consistent with the hypothesis that short sellers are informed investors, trading against overpricing, and predict future stock returns after both negative and positive earnings surprises. The coefficients for IMB^+ (0, +3) are significantly negative for both negative and positive earnings surprises. This supports the argument that the part of short-selling which can be explained by liquidity provision part also contributes to future stock price decrease. The coefficients for IMB (+4, +30) after both negative and positive earnings surprises are significantly positive. Stock return is significantly positively related to concurrently trading imbalance. This is consistent with the price pressure hypothesis: short-selling can put price pressure on the future, which induce the price drop. The coefficient for DISPERSION and N_ANALYSTS are insignificant after negative and significantly positive after positive earnings surprises. The coefficient of SURPRISE for negative surprise is significantly positive, which shows that when the negative surprise is bigger, the future stock return declines more. The significant positive coefficient of SURPRISE for positive surprise is significantly negative, showing that when surprise is bigger, the price reversal is more pronounced. It suggests that investors tend to overreact to large positive earnings surprises.

In all, in this section, I provide evidence that event-time short-selling is negatively related to future stock returns after both negative and positive earnings surprises. This supports the argument that short sellers trade against overreaction after positive earnings surprises, therefore inducing price reversal in the future. It also provides evidence that short sellers depress future stock returns after negative earnings surprises. Combined with the intraday analysis, this demonstrates that short sellers target underreacting stocks and induce decreasing stock price.

Table 1.4

Relation between Event Time Short-selling and Future Stock Return

The table shows the relation between abnormal short-selling over days (0, +3) and cumulative abnormal return (CAR) over days (+4, +30). Abnormal return is calculated by using Fama-French three-factor return. SHORT (0, +3) is cumulative abnormal short shares divided by shares outstanding over (0, + 3). IMB^+ (0, +3) equals cumulative abnormal trading imbalance over (0, +3) if it is greater than zero, equals to 0 otherwise. CAR (+4, +30) is cumulative abnormal return over days (+4, +30). IMB (+4, +30) is cumulative abnormal trading imbalance over (+4, +30). VOL (0, +3) is cumulative abnormal trading volume in days (0, +3). DISPERSION is analysts forecast dispersion, and N_ANALYSTS is number of analysts. SURPRISE is earnings surprise. Result of specification (2) is showed. "***", "**" and "*" represent significance at the 1%, 5% and 10% level respectively. All tests are White heteroskedasticity consistent. T-statistics are reported in parentheses beneath each coefficient estimate.

$$\text{CAR }(+4, +30) = \alpha 0 + \alpha 1\times \text{ SHORT }(0, +3) + \alpha 2\times \text{ IMB}^{+} (0, +3) + \alpha 3\times \text{ IMB }(+4, +30) +\alpha 6\times \text{ N\_ANALYSTS} + \alpha 7 \times \text{ DISPERSION} +\alpha 8 \times \text{ SURPRISE} + \varepsilon \qquad (3)$$

	Negative Surprise	Positive Surprise
Intercept	0.0077	-0.0013
	(2.65)**	(-0.46)
SHORT (0, +3)	-0.0013	-0.0010
	(-2.52)**	(-2.01)**
IMB^+ (0, +3)	-0.0038	-0.0020
	(-3.15)***	(-1.70)*
IMB (+4, +30)	0.0017	0.0012
	(12.24)***	(10.01)***
DISPERSION	0.0005	0.0273
	(0.48)	(2.95)***
N_ANALYSTS	0.0002	0.0004
	(1.54)	(2.61)***
SURPRISE	0.0846	-0.0998
	(2.19)**	(-2.56)***
Adjusted-R^2	0.0603	0.0444

1.4.5 Short Sales and Consecutive Earnings Surprises

In this section, I give more evidence that short sellers are informed and trade against mispricing after earnings announcements by investigating whether short sellers react differently across a series of same-sign earnings surprises.

Behavioral Finance suggests that investor reactions increase as a series of same-sign earnings surprises continues. Barberis, Shleifer and Vishny (1998) develop a model showing that investors affected by "representativeness" and "conservatism" react differently across initial versus subsequent similar surprises. Daniel, Hirshleifer and Subrahmanyam (1998) ascribe similar behavior to investor "overconfidence" and "biased self-attribution." In addition, research suggests that trading behavior varies based on investor sophistication. Shanthikumar (2004) confirms that small investors exhibit increasing reactions to consecutive same sign earnings surprises, but large investors do not. In addition, they find that PEAD is weaker for each subsequent surprise than the first surprise in a series of same-sign surprises.

The basic conclusion in these papers is that psychological biases lead investors (especially less sophisticated ones) to react differently across initial versus subsequent similar information: they overreact when similar information is repeated. Since short sellers trade against other investors' mispricing after earnings surprises, their trading will be affected by psychological biases of other investors. If short sellers trade against overreaction after positive earnings surprises, they are expected to trade more strongly after successive positive earnings surprises as a sequence continues. If short sellers eliminate underreaction after negative earnings surprises, they are expected to trade less strongly at successive negative earnings surprises as the sequence continues.

To detect such patterns, I indicate each earnings announcement's place in a sequence of same-sign earnings surprises for negative versus positive surprises. N=1 if it is the first of the same sign surprises, N=2 if it is the second of the same sign surprises, and N>=3 if it is the third or later subsequent surprises in a series of same-sign surprises. Then, I calculate daily average abnormal short-selling from day 0 to day +5 for (N=1), (N=2) and (N>=3) respectively. T-tests are used to test significance of each daily abnormal short-selling and the difference in abnormal short-selling between groups (N=1) versus (N>=3).

Table 1.5

Shorting differences on groups for different series of similar earnings surprise

The table reports the difference for daily abnormal shorting for different same-sign surprises. N=1 is the group of the first surprises of the same type, N=2 if it is the second surprises of the same type, and N>=3 if it is the third or later subsequent same type surprises. T-test is used to test the significance and the difference of the abnormal shorting for groups N=1 and and N>=3. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

	N=1	N=2	N>=3	(N=1)-(N>=3)
Negative Surprise				
0	-0.0006	0.0071	0.0160	-0.0040
	(-0.04)	(0.50)	(1.36)	(-0.08)
+1	0.0442	0.0651	0.0458	-0.043
	(3.30)***	(4.57)***	(3.90)***	(-0.81)
+2	0.0545	0.0371	0.0443	0.102
	(4.08)***	(2.61)**	(3.78)***	(1.95)*
+3	0.0381	0.0271	0.0041	0.163
	(2.85)***	(1.91)*	(0.35)	(3.17)***
+4	0.0154	0.0033	0.0078	0.062
	(1.15)	(0.23)	(0.66)	(1.17)
+5	0.0076	0.0097	0.0025	0.062
	(0.57)	(0.68)	(0.21)	(1.09)
Positive Surprise				
0	0.0257	0.0008	0.0269	-0.0552
	(1.24)	(0.04)	(2.08)**	(-1.12)
+1	0.0258	0.0187	0.0421	-0.0874
	(1.24)	(1.10)	(2.47)**	(-1.74)*
+2	0.0074	0.0034	0.0229	-0.0986
	(0.36)	(0.20)	(1.76)*	(-2.03)**
+3	-0.0221	-0.0045	-0.0068	-0.0902
	(-1.06)	(-0.26)	(-0.52)	(-1.77)*
+4	-0.0333	-0.0117	-0.0062	-0.1401
	(-1.60)	(-0.69)	(-0.48)	(-2.65)**
+5	-0.0379	-0.0411	-0.0104	-0.1274
	(-1.82)*	(-2.41)**	(-0.80)	(-2.45)**

Table 1.5 presents daily abnormal short-selling from day 0 to day +5 for groups (N=1), (N=2), and (N>=3), and the shorting difference between groups (N=1) and (N>=3). For negative earnings surprises, abnormal short-selling is significantly positive from day +1 to day +3 for groups (N=1) and (N=2), and from day +1 to day +2 for group (N>=3). The difference of daily abnormal short-selling between groups (N=1) and (N>=3) is significantly positive for day +2 and day +3. For positive surprises, daily abnormal short-selling is significantly negative for day +5 for groups

(N=1) and (N=2), and it is significantly positive from day 0 to day +2 for group (N>=3). The difference in daily abnormal short-selling between groups (N=1) and (N>=3) is significantly negative from day +2 to day +5.

Thus, consistent with the prediction, the result shows that short sellers exhibit increasing reactions to subsequent surprises in a series of positive earnings surprises. They exhibit decreasing reactions to subsequent surprises in a series of negative earnings surprises. The result provides further evidence that short sellers are informed and trade against other investors' overpricing; thus, they trade to exploit underreaction after negative earnings surprises and trade against overreaction after positive earnings surprises.

1.4.6 Short Sales, Market Efficiency and PEAD

In the previous analysis, I provide evidence that short-sellers are informed and trade against other investors' overpricing. My next question is whether trading against other investors' overpricing improves market efficiency and weakens the persistence of post-earnings-announcement drift. I go further to investigate the relation between short-selling and PEAD by examining future stock returns for different shorting groups after negative and positive earnings surprises separately. If short sellers trade against overpricing after earnings announcements, in the long run, heavily shorted stocks are expected to incorporate negative information quickly after negative earnings surprises, and have a price reversal after positive earnings surprises. In other words, after negative earnings surprises, lightly shorted stock price drops mostly in the event time, and heavily shorted stock price drops immediately after event time. Fewer stock price drops will happen in the long run. After positive earnings surprises, lightly shorted stocks may have upward drift, and heavily shorted stocks are expected to have a price reversal.

Stocks are partitioned into 5 groups based on cumulative abnormal short-selling over days (0, +3) for negative and positive earnings surprises separately. Quintile 1 contains lightly shorted stocks and quintile 5 the heavily shorted stocks. Then, I calculate average cumulative abnormal returns over periods (0, +3), (+4, +30), (+31, +60), (+61, 90), and (+91, +120) for all quintiles and the return difference between quintile 1 and quintile 5. I use T-statistics to test the significance of average cumulative abnormal returns and the return difference between quintile 1 and quintile 5 groups.

Table 1.6 shows future cumulative abnormal returns for different shorting quintiles, and the return difference for lightly shorted stocks and heavily shorted stocks, after negative and positive surprises, respectively. The results show that, after negative earnings surprises, cumulative abnormal returns become significantly negative in periods (0, +3) for stocks at each short-selling level. For quintile 5, cumulative abnormal return is significantly negative in periods (0, +3). The difference in cumulative abnormal return of quintile 1 versus quintile 5 is significantly negative for (0, +3) and then turns significantly positive for (+4, +30), (+31, +60) and (+91, +120). Thus, stock returns drop much more quickly for lightly shorted stocks than for heavily shorted stocks after negative earnings surprises. Furthermore, the drift for heavily shorted stocks is more pronounced in the future. Since short-sellers aim at overpriced stocks, it is reasonable that stock price drops quickly in event-time for the lightly shorted stock group. However, the persistence of downside drifts for heavily shorted stocks is not consistent with the prediction of previous literature. Diamond and Verrecchia (1987) build a model showing that short sale constraints reduce the speed of adjustment of security prices to private information, especially to bad news. Reed (2007) uses the data from the lending market to show that the distribution of announcement day returns is more left-skewed for infrequently-shorted stocks, and the fraction of long-run price reaction realized on the day of the announcement is smaller when short sales are constrained. According to these papers, short-selling can accelerate the price adjustment to news, especially bad news. So, I expect to see the price of heavily shorted stocks adjust to fundamental values quickly.

Table 1.6

Future cumulative abnormal return for different shorting quintiles

The table shows the future cumulative abnormal return for different shorting quintiles after both negative surprise and positive surprise. Abnormal return is Fama-French three factor return. Stocks are divided into 5 groups based on cumulative abnormal short sales measure over days (0, +3) for negative surprise and positive surprise separately, with quintile 1 the lightest shorted group and quintile 5 the heaviest shorted group. T test is used to test the difference of the cumulative abnormal return of stocks in quintile 1 and stocks in quintile 5. Parametric t-test is reported to test for the difference. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

Dates	Q1	Q2	Q3	Q4	Q5	Q1-Q5
Negative Surprise						
(0, +3)	-0.0224	-0.0135	-0.0176	-0.0042	-0.0051	-0.0170
	(-8.60)***	(-5.34)***	(-6.81)***	(-1.83)*	(-2.36)**	(-5.10)***
(+4, +30)	0.0027	0.0029	0.0030	0.0013	-0.0035	0.0061
	(0.89)	(0.88)	(0.99)	(0.45)	(-1.16)	(1.75)*
(+31, +60)	-0.0026	0.0035	-0.0011	-0.0003	-0.0090	0.0064
	(-0.71)	(0.93)	(-0.32)	(-0.08)	(-2.08)*	(1.78)*
(+61, +90)	0.0053	0.0033	-0.0021	0.0020	0.0004	0.0048
	(1.54)	(0.83)	(-0.57)	(0.52)	(0.11)	(0.92)
(+91, +120)	0.0013	0.0014	-0.0005	-0.0024	-0.0058	0.0070
	(0.35)	(0.34)	(-0.13)	(-0.70)	(-1.73) *	(1.80)*
Positive Surprise						
(0, +3)	0.0042	0.0161	0.0204	0.0228	0.0257	-0.023
	(1.80)*	(5.76)***	(9.49)***	(11.32)***	(13.10)***	(-7.28)***
(+4, +30)	0.0041	-0.0007	0.0007	0.0042	-0.0050	0.0091
	(1.27)	(-0.19)	(0.21)	(1.33)	(-1.77)*	(2.06)*
(+31, +60)	0.0065	0.0014	0.0039	0.0023	-0.0008	0.0085
	(2.13)*	(0.47)	(1.35)	(0.90)	(-0.28)	(2.12)**
(+61, +90)	0.0032	-0.0051	-0.0036	0.0070	-0.0055	0.0087
	(0.83)	(-1.32)	(-0.85)	(1.76)*	(-1.58)	(1.61)
(+91, +120)	-0.0017	-0.0020	0.0019	0.0009	0.0024	-0.004
	(-0.52)	(-0.67)	(0.60)	(0.29)	(0.80)	(-0.93)

Next, I examine short-selling quintiles after positive earnings surprises. Average (0, +3) CAR mirrors the earlier regressions in that it is significantly positive for both quintiles 1 and 5, particularly the latter. For quintile 5, CAR is significantly positive in days (0. +3) and becomes significantly negative in days (+4, +30). The return difference between quintile 1 and quintile 5 is significantly negative for (0, +3) and becomes significantly positive for (+4, +30) and (+31, +60). Thus, the price of heavily shorted stocks increases immediately after positive earnings surprises and reverses afterwards. This provides some evidence that short-sellers trade against overreaction after positive earnings surprises, therefore inducing price reversal in the future.

In all, after investigating the relation between event-time short-selling and PEAD, I find that, short-selling has different effects on market efficiency after negative and positive surprises. After positive earnings surprises, short-selling trades against overreaction and induces price reversals in the future, therefore helping improve market efficiency. After negative earnings surprises, short sellers aim at under-reacting stocks, and short stocks which underreact to earnings news. However, the relation between event-time short-selling and PEAD shows that heavily shorted stocks have more pronounced long run downside drift. There is no evidence that short-selling improves market efficiency or helps eliminate downside PEAD. The failure of quick adjustment of heavily shorted stocks after negative surprises contradicts what previous literature predicts and indicates an asymmetric relation between short-selling and market efficiency after negative versus positive earnings surprises. There are several possible explanations for this. The first explanation is the existence of short sale constraints. Usually, in order to short stocks, investors' brokers need to find an institution or individual willing to lend shares. It can be difficult or impossible to find a willing lender for some stocks, and, thus, those stocks face short sale constraints. Diamond and Verrecchia(1987) show that short sales constraints reduce the speed of price adjustment to private information, particularly to bad news. Reed (2007) studies the effect of short-sale constraints on the informational efficiency of stock prices using a direct measure of short sale constraints from the equity lending market, and confirms the hypothesis of Diamond and Verrecchia (1987) that short-sale constraints hold negative opinions off the market. The second explanation is that investors are affected by "disposition effect". In behavioral finance, investors (especially those who are less sophisticated) are reluctant to sell assets at a loss relative to the price at which they were purchased. Andrea Frazzini (2006) investigates 'disposition effect' after negative surprises, and provides evidence that negative earnings news travels slowly in stocks with large capital losses as disposition-prone trades tend to dampen the transmission of information, thus generating return continuation. This implies that stock prices underreact to bad news when a lot of investors face loss. The reluctance to sell stocks may prohibit the speed of information adjustment after negative earnings surprises. However, I am not able to investigate these explanations with existing data.

1.4.7 Robustness Checks

First, I use extreme earnings surprises instead of all positive and negative earnings surprises. According to Ke and Ramalingegowda (2005) and Hirshleifer et al. (2003), if the earning surprise is close to zero, it may produce some noise, which will affect the analysis. I partition stocks into 10 groups. Deciles 1, 2 and 3 are extreme negative earnings surprises and deciles 8, 9 and 10 are extreme positive earnings surprises.

Second, I adjust the shorting measure for calendar effects. Chen and Singal

(2003) show that speculative short sales contribute to the weekend effect. The inability to trade over the weekend is likely to cause short sellers to close their speculative positions on Fridays and reestablish new short positions on Mondays. So, daily short-selling is likely to be affected by weekdays. Aitken, Frino, McCorry and Swan (1998) show that short-selling is tax related. In order to eliminate any risk associated with price volatility, investors prefer to hold short and long positions simultaneously at the end of a financial year. Both papers cited above show that short sales are affected by calendar effects. In order to control for such calendar effects, first, I regress daily short-selling on indicators for month and day-of-week for each stock separately, over the entire sample period. Then, I normalize the residual by removing the mean and dividing by the standard deviation for each stock separately to get the abnormal calendar-adjusted shorting measure. Then, I use this measure to do the robustness check.

Third, in addition to using the abnormal return calculated by using Fama-French three- factor model, I use two other abnormal returns: an abnormal return using Fama-French four- factor model and a beta-adjusted abnormal return. I get the beta-adjusted abnormal return directly from CRSP.

The results of all robustness checks are consistent with the results in the paper, and support the argument above.

1.5 Summary and Conclusions

Although many papers study investor behavior after earnings announcements, a complete understanding of short-selling after earnings announcements, and the relation between short-selling and PEAD after both negative and positive earnings surprises has been lacking. This study uses comprehensive intraday data to examine short-selling after both negative and positive earnings surprises for 1883 NYSE-listed stocks from January 2005 through May 2007. The results offer plausible explanations for short-seller behavior and its associations with future stock returns.

I find that short-selling increases immediately after both negative and positive earnings surprises and remains higher than normal for several days. Then I investigate whether short-sellers are informed of firms' fundamental values and trade against mispricing. First, by using VAR regression, I find that intraday short-selling is positively related to intraday past abnormal stock returns, and has immediate price pressure. This suggests that short sellers target overpricing stocks. Second, I follow Diether, Lee, and Werner (2007) in investigating the relation between event-time short-selling and future stock returns, and confirm that short-sellers appear to be informed of future stock prices. Third, when looking at the shorting difference between sequences same sign earnings surprises, I find that investors trade much more heavily for subsequent as opposed to initial positive earnings surprises, and trade less heavily for subsequent as opposed to initial negative earnings surprises. Combined with previous behavioral finance work about investor behavior for the same sign earnings surprise sequences, this suggests that short-sellers are informed and trade against mispricing surrounding positive earnings surprises.

Given that short sellers may be informed traders, I next examine whether short-selling after earnings announcements contributes to market efficiency. After positive earnings surprises, short-selling reverses stock prices back to fundamentals, which helps improve market efficiency. However, after negative earnings surprises, stocks which are shorted heavily have a pronounced downward drift until 120 days after earnings announcement. Thus, short-selling does not appear to contribute to market efficiency by correcting downward drift after negative earnings announcements.

Short-selling has always attracted controversy, particularly in times of market turmoil. This paper indicates that short-selling works differently around good news versus bad news. When good news is released, short-selling helps fight against possible price bubbles, trades against overreaction and pulls prices back to fundamental values. When combined with the results of previous authors (Jones and Lamont (2001)), which shows that stocks become overpriced if short-selling is limited, the paper suggests that impediments to short-selling in good times may harm market efficiency. In contrast, although short-sellers target underreacting stocks at times when bad news arrives, there is no evidence that short-selling helps quickly transmit negative information to stock prices. Instead, there is a persistent price drop for stocks with high short-selling levels. Thus, this paper distinguishes the variety of roles that short-sellers in different economic situations, in contrast to what previous research has been able to demonstrate.

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CHAPTER 2

Information-based Trading, Short Sales and Stock Return

2.1 Introduction

Whether short sellers are informed has been an interesting topic for a long time. Diamond and Verrecchia (1987) theoretically prove that short-sellers are informed. Later on, some literature (e.g., Dechow et al., 2001; Christophe, Ferri, and Angel, 2004; Desai et al. (2002)) investigates the informativeness of short sellers from different points of views. Recently, the availability of the Reg SHO intraday short sales transaction data allows researchers to revisit this topic by using more detailed data. Various conclusions have been drawn. Boehmer, Jones, and Zhang (2005) show that institutional short sale transactions predict future stock return very well. Diether, Lee and Werner (2007) show that short sellers are mostly contrarian traders, who short stocks following positive return, instead of informed traders. Christophe, Ferri and Angel (2004) use data from the Nasdaq National Market System (NMS) to examine short sales transactions in five days prior to earnings announcements for NASDAQ-listed firms. They reveal that abnormal short-selling is informed and is significantly linked to post-earnings-announcement stock returns. Daske, Richardson, and Tuna (2005) examine short sales prior to earnings announcements and find that on average short sale transactions do not precede bad news events. They conclude that short sellers are not informed.

Investors short stocks for many purposes. Diether, Lee and Werner (2005) show that, investors may have other motives to short other than private information, such as trade on short-term overreaction, voluntarily provide liquidity, motivated by arbitrage or hedging or act as opportunistic risk bears. However, all these short can predict future low stock return. In other words, short-selling itself can be the reason for future low stock return. Abnormal increase in the number of short sales not only predicts, but also induces price pressure which can cause negative returns. So, it is not sufficient only using future stock return to judge whether shorts are informed or not.

This paper addresses this problem by incorporating the probability of information based trading (PIN) from microstructure literature into the analysis. By combining PIN, short sales transaction data and stock return, this paper contributes to the existing literature in examining the information content of short-selling in several ways.

First, instead of investigating only the price effect of short-selling, this paper directly test the role of information asymmetry in the relationship between short-selling and future stock return. By including PIN, it distinguishes the price effect of informed shorting from shorting for other reasons, such as arbitrage, trade against over-reaction.

Second, the paper tries to capture the difference between the horizons chosen for estimation of future returns by investigating the 5 days, 30 days and 60 days future return separately. If the increase of short-selling is not because of fundamental value, but of other reasons, it may induce the downside price pressure in the short run, but not in the long run. So, when investigating the informativeness of short-selling, it is necessary to look at the future stock return in the long run.

Third, there are some discussions of the informativeness of short-selling in different trading sizes. Chakravarty (2001) and Barclay and Warner (1993) show that small and medium size shorts are more informed, because informed traders have incentive to hide their information and delay the information from becoming public. So, it is possible that they split orders into smaller trade sizes. However, Boehmer, Jones and Zhang(2005) use short sales transaction data to find that the large short sales are the most informed. In this paper, by using probability of informed trading measure, I reexamine this question by distinguishing the price effect caused by price pressure from large size shorting and price effect from small size informed shorting.

The paper also relates to the literature about the relationship between information asymmetry and future stock returns. Easley, Hvidkjaer and O'Hara (2002) show that information risk is priced in future stock price, so that PIN has a positive relationship with cross section return. In other words, the high PIN portfolios have higher future stock return than low PIN portfolios. This paper finds that when the short sale transaction is low, future returns of high PIN stocks are significantly higher than low PIN stocks. While for heavily shorted stocks, this difference disappears. The result indicates that if short sellers are informed, heavy shorts indicate lower future return, which may cancel out the price increase induced by information risk.

The rest of the paper is organized as follows. Section 2 surveys the relevant literature while Section 3 describes the data and methodology. Section 4 presents empirical results and discusses potential explanations. Section 5 summarizes the paper.

2.2 Literature Review

There are several papers investigating the information content of short-selling. Diamond and Verrecchia (1987) build a theoretical model to show that because shorting is prohibitive and restrictive, uniformed traders are driven out of the pool of shorts, which makes the shorted volume largely informed. Morse and Stice (1990) find that monthly short interest does not predict either the cross-section or time-series behavior of return. Jones and Lamont (2002) find that stocks which are expensive to short or which enter the borrowing market have high valuations and low subsequent returns, consistent with the overpricing hypothesis. Lamont (2005) finds that short sale constraints allow stocks to be overpriced, and firms taking anti-shorting actions have in the subsequent year very low abnormal returns of about -2 percent per month. Dechow, Hutton, Meulbroek and Sloan (2001) shows that short sellers are able to identify firms which are overvalued based on their book-to-market ratios, and then cover their positions as the ratios mean-revert. Desai, Ramesh, Thiagarajan and Balachanran. (2002) find that firms with large short positions experience negative and significant abnormal returns when they are heavily shorted, which is consistent with short sellers having private information. Christphe, Ferri, and Angel (2004) demonstrate that abnormal short-selling prior to earnings announcements is negatively related to subsequent stock return. However, the level of pre-announcement short-selling mostly appears to reflect firm-specific information rather than these fundamental financial characteristics. Daske, Richardson, and Tuna (2005) show that excessive short-selling does not precede price declines caused by bad news. They argue that, in aggregate, short sale transactions are not based on private information. Boehmer, Jones, and Zhang (2005) use proprietary system order data from the New York Stock Exchange to examine the incidence and information content of various kinds of short sale orders. They find that institutional short sellers have identified and acted on important value-relevant information, so that short sellers are extremely well-informed.

Several papers try to distinguish informed short-selling from short-selling for other purposes. Diether, Lee, and Werner (2007) shows investors may have other motives to short other than private information about fundamentals, such as trade on short-term overreaction, voluntarily provide liquidity, motivated by arbitrage or hedging or act as opportunistic risk bears. All shorts can decrease future returns. Short sellers trade on short-term deviations of the price from fundamentals and help correct short-term overreaction of stock prices to information. Henry (2006) use probability of information-based trading probability of information to examine the effect of private information on the returns to stocks with high levels of monthly short interest. He gets the result that the underperformance of high short interest stocks is driven by firms which have high levels of informed trading. However, the negative relationship between informed trading and returns is reversed for stocks with low to moderate short interest levels.

The paper relates to paper about information asymmetry and stock return. Easley, Hvidkjaer, and O'Hara (2002, 2004) use probability of information based trading (PIN) to argue that information risk is priced in the cross-section of asset returns, and find there is a positive relation between the probability of informed trading and the cross section of returns. Chung, Li and McInish (2004) show that both the price impact of trades and serial correlation in trade direction are positively and significantly related to the probability of information-based trading. Tian (2008) uses the probability of information-based trading as a proxy for private information and find that when private information is high, the magnitudes of momentum effect is large even after controlling for size.

The paper also connects to the information content of different order sizes. Menkveld (2004) shows that informed investors strategically split their orders among market centers. Chakravarty (2001) and Barclay and Warner (1993) develop a stealth trading hypothesis that informed traders split large order into medium sized trades to camouflage their superior information. Boehmer, Jones, and Zhang (2005) investigate different order sizes of short sales and find that contrary to the stealth trading hypothesis, largest short sale orders are the most informed.

In this paper I combine the probability of information-based trading measure (PIN) from microstructure literature and daily short sale transaction data to investigate the informativeness of short sellers. It advances the understanding of information content in short sales, and the relationship between short-selling and future stock return.

2.3 Data and Methodology

The sample is restricted to ordinary common shares trading with short sales transaction data in the New York Stock Exchange between January 1, 2005 and December 31, 2006, excluding closed-end funds, Real Estate Investment Trust (REITs) and American Depository Receipts (ADR). Following Diether, Lee and Werner (2007), I exclude stocks of which the price is less than 3 dollars to avoid firms that are very small or in distress. According to Mitchell, Pulvino and Stafford (2004), merger arbitragers usually short acquirers' stock immediately after takeover announcements, which cause large price pressure. I eliminate firms which have mergers and acquisitions during this period, and I identify mergers and acquisitions using SDC Global New Issue database.

Intraday short sales transaction data are obtained from Regulation SHO. Stock return, price, volume, book value, market capitalization, number of shares outstanding are taken from CRSP/COMPUSTAT. Daily turnover is calculated as daily volume divided by the number shares outstanding.

Institutional ownership of firms' common stocks data comes from the CDA/Spectrum database provided by Thomson Financial, which is derived from institutional investors' quarterly filings of SEC Form 13F. Institutional ownership is defined as the fraction of the market capitalization of a firm's total outstanding common stocks that is owned by institutional investors.

Quote and trade data is obtained from TAQ database. I use the algorithm of

Lee and Ready (1991) to classify buyer and seller initiated transactions. For each trade, if the trading price is below the midpoint of bid-ask prices, it is classified as a seller initiated trade, if the trading price is above the midpoint of bid-ask prices, it is classified as buyer initiated trade. For trade at the bid-ask midpoint, it is seller initiated if the trading price is lower than its preceding trading price, it is buyer initiated if the trading price is higher than it.

Table 2.1

Descriptive Statistics of Shorting Flow Measure and Firms Characteristics

The sample consists of companies listed on the NYSE from January 2005 through December 2006. Panel A reports daily shorting flow measure and firms characteristics across all firms. Panel B shows fraction of total short sale orders in the given order size category and average number of shares sold short/shares outstanding.

Panel A: Shorting Flow Measure

	mean	std dev	25%	50%	75%
Shorting Flow					
number of shares sold short	180746.69	305005.34	26461.01	82496.38	198800.65
numbers of short transaction	370.25	398.39	90.18	263.40	504.59
Number of shares sold short/ trading volume	0.2207	0.1806	0.1806	0.2145	0.2522
Firms Characteristics					
Share Price	34.80	32.32	17.82	29.89	45.22
Share Outstanding	173534.10	486845.19	25638.25	54399.14	13557.12
Turnover	7.73	10.35	3.80	6.09	9.66

Panel B: Shorting at various order sizes

	Fraction of total short sale orders in the given order size category	Average number of shares sold short/ trading volume
Order Size (in shares)		
1-499	0.4578	0.0954
500-1,9999	0.3252	0.0703
2,000-4,999	0.1016	0.0221
4,999-	0.0935	0.0204

Table 2.1 Panel A provides summary statistics about shorting flow measures

and firms characteristics. The sample stocks experience an average of 370.24 short-sale transactions in a given day, with a mean of 180746.69 sold short per stock per day. The average share outstanding is 173534.10 and average turnover is 7.7375. Panel B shows the summary of shorting flow measure in different trade size. Short sales are divided into four groups by trading size: trading size less than 500 shares, trading size equal to or larger than 500 shares and less than 2,000 shares, trading size equal to or larger than 2,000 shares and less than 5,000 shares, trading size equal to or larger than 5,000 shares. The summary shows that 45% of total short sale orders are taken by smallest trading size and totally almost 80% of total short sale orders are taken by two smallest trading sizes.

2.4 Results and Discussion

2.4.1 Single Sorting

In order to study the price impact of information-based short-selling, I adopt a portfolio approach, by which, non-linearity relationship between shorting activity and future returns is possible to be captured.

First, I use single sorting to see the relationship between the short-selling and future stock return. Each day, all stocks are sorted into quintiles based on shorting measure during the previous five trading days, with S1 represents the lowest quintile and S5 represents the highest quintile. After that, I skip one day and hold the equal weighted portfolio for next 5, 30, 60 days separately. By looking at the return difference between future returns for different horizons of lightest shorted and heaviest shorted stocks, I not only investigate the price impacts of different short-selling quintiles, but also for holding periods. Table 2.2 Panel A shows the result. The return difference for all horizons between the heaviest shorted stocks and lowest shorted stocks are significantly positive. This shows that short-selling has significant negative impact on future returns for all return horizons.

Table 2.2

Cumulative abnormal return, grouped in quintiles based on shorting measures and PIN

In Panel A, stocks are sorted into quintiles based on cumulative shorting measure over previous 5 days. Cumulative shorting measure is calculated as cumulative number of shares sold short divided by trading volume. Within each quintile, average cumulative abnormal return is calculated over 5 days, 30 days and 60 days holding periods respectively. S1 is the lowest quintile and S5 is the highest quintile. In Panel B, stocks are sorted into quintiles based PIN over previous 5 days. Within each quintile, average cumulative abnormal return is calculated over 5 days, 30 days and 60 days holding periods respectively. Cumulative shorting measure is calculated as cumulative number of shares sold short over total volume. P1 is the lowest quintile and P5 is the highest quintile. Parametric t-test is reported to test for the difference between cumulative short sales for highest quintile and lowest quintile. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

	5 days	30 days	60 days
Panel A			
S1	0.0023	0.0094	0.0225
S2	0.0013	0.0057	0.0151
S3	0.0007	0.0041	0.0127
S4	0.0007	0.0039	0.0104
S5	0.0008	0.0035	0.0088
S1-S5	0.0015	0.0059	0.0137
	(5.12)***	(8.27)***	(11.18)***
Pane B			
P1	0.0010	0.0033	0.0123
P2	0.0009	0.0040	0.0138
P3	0.0012	0.0043	0.0124
P4	0.0011	0.0052	0.0133
P5	0.0018	0.0089	0.0223
P1-P5	-0.006	-79E-5	-0.0100
	(-6.95)***	(-2.55)***	(-5.87)***

In order to test the relationship between PIN and future stock return, I also apply the portfolio approach. Each day, all stocks are sorted into quintiles based on PIN calculated over prior five days, with P1 represents the lowest quintile and P5 represents the highest quintile. Then, I skip one day and calculate the abnormal return for equal weighted portfolio for 5, 30, 60 days separately. Table 2 Panel B shows that, for stocks with higher PIN, the future return is higher for all horizons and the return difference for all horizons between the lowest PIN quintile and highest PIN quintile are positively significant. It is consistent with Easley, Hvidkjar and O'Hara (2002), assets with greater private information command a risk premium because asymmetric information creates a risk for uninformed traders.

2.4.2 Two Ways Sorting

In this part, I combine the effect of short-selling and PIN on future stock return to investigate the information content of short-selling. Although the previous result shows that short-selling is significantly negative related to future stock return for different horizons, it is not sufficient to prove that short sellers are informed of future stock. Short- selling itself can impose the downside price pressure, and decrease future stock return no matter it is informed or not. If short-selling on average is informed, then it maybe related to PIN. When PIN is higher, short-selling is more likely informed. So, if short-selling is informed, I expect that for high PIN group stocks, the return difference between the highest short-selling quintile and lowest short-selling quintiles are significantly negative, while for low PIN group stocks, this difference is not significant. For the heaviest shorted group, the return difference between the lowest PIN quintiles and the highest PIN quintiles is probably insignificant, or even become significantly positive. While for the lowest shorted groups, the return difference keeps to be significantly negative. If short-selling is informed of future stock return, the above result is expected to be more significant for future stock returns in the long run, since the price effect of fundamental trading is permanent and the short run stock price is easily to be strongly affected by the temporary price pressure from short-selling.

Stocks are sorted into quintiles based on cumulative shorting measures over previous 5 days and PIN independently. Within each quintile, average cumulative abnormal return is calculated over 5, 20 and 60 days. The return differences between the lightest shorted groups and the heaviest shorted groups in 5 different PIN groups and the return difference between the lowest PIN groups and the highest PIN groups in 5 different short-selling groups are reported in Table 2.3.

Table 2.3

Portfolio returns on shorting measures and PIN

Stocks are sorted into quintiles based on shorting measure over previous 5 days and PIN independently. Cumulative shorting measure is calculated as cumulative number of shares sold short over total volume. Within each quintile, average cumulative abnormal return is calculated over 5 days, 30 days and 60 days holding periods respectively. Abnormal return is calculated using one factor market model. P1 is the lowest PIN quintile and P5 is the highest PIN quintile. S1 is the lowest shorting measure quintile and S5 is the highest shorting measure quintile. Parametric t-test is reported to test for the difference between cumulative abnormal return S1 and S2 in the same information asymmetry measure, and the difference between cumulative abnormal return P1 and P5 in the same shorting measure quintile. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

		S1	S3	S5	S1-S5	
5 days	P1	0.0018	0.0009	0.0008	0.0010	(1.98)*
	P2	0.0025	0.0008	0.0004	0.0021	(4.22)***
	P3	0.0026	0.0007	0.0008	0.0018	(3.66)***
	P4	0.0039	0.0010	0.0007	0.0032	(6.42)***
	P5	0.0042	0.0014	0.0017	0.0024	(4.84)***
	P1-P5	-0.002	-52E-5	-92E-5		
		(-5.42)***	(-0.98)	(-1.61)		
30 days	P1	0.0042	0.0030	0.0193	0.0014	(1.31)
	P2	0.0071	0.0041	0.0214	0.0065	(5.65)***
	P3	0.0074	0.0036	0.0200	0.0061	(5.33)***
	P4	0.0116	0.0037	0.0178	0.0088	(7.58)***
	P5	0.0150	0.0062	0.0152	0.0085	(8.03)***
	P1-P5	-0.011	-0.003	-0.004		
		(-10.73)***	(-2.82)**	(-3.31)**		
60 days	P1	0.0094	0.0119	0.0096	-18E-5	(-0.01)
	P2	0.0227	0.0119	0.0072	0.0155	(5.78)***
	P3	0.0198	0.0114	0.0055	0.0143	(5.88)***
	P4	0.0279	0.0102	0.0075	0.0204	(6.08)***
	P5	0.0364	0.0166	0.0215	0.0149	(5.88)***
	P1-P5	-0.027	-0.01	-0.012		
		(-11.07)***	(-1.71)*	(-5.41)**		

P1 is the lowest PIN quintile and P5 is the highest PIN quintile. S1 is the lightest shorted groups and S5 is the heaviest shorted groups. The result shows that for P1 and P3, the return differences between the lightest shorted groups and heaviest shorted stocks are positively significant for all horizons. For S1 group, the return difference between the lowest PIN quintile and the highest PIN quintile is significantly negative for 5 days and insignificant for both 30 and 60 days. For S3 and S5 groups, the return difference for the lowest PIN quintile and the highest PIN quintile is not significant for 5 days and significantly negative for 30 and 60 days. This result shows that although in 5 days horizon, for high PIN stocks, higher shorted stocks have lower future stock returns, but in the 30 and 60 days horizon, the difference between the heaviest shorted groups and lightest shorted groups is still significantly negative. The result is a little puzzling, the stock return should be depressed in the long run, not only in the short run. So, I will continue to investigate this question in the remaining part of the paper.

2.4.3 Three Ways Sorting: Controlling for Size

Previous research has shown that size is an important determinant of excess returns, and Easley, Hvidkjaer, and O'Hara (2005) show that PIN and size are highly negatively correlated. It is also known that short sales are higher for stocks having higher market capitalization since the short sale constraints are relatively less binding. So in order to isolate the effects of information asymmetry measure, I examine the role of PIN in the relation between short-selling and future stock return after controlling for market capitalization.

Each day, stocks are sorted into 3 portfolios based on market capitalization in the end of the prior month. M1 represents the lowest size group and M3 represents the highest size group. Within each size group, stocks are sorted into quintiles based on PIN calculated over the previous 5 days, with P1 represents the lowest quintile and P5 represents the highest quintile. Then, within each size group, stocks are also independently sorted into quintiles based on shorting measure over previous 5 days, with S1 represents the lowest quintile and S5 represents the highest quintile. Within each size portfolio, the stocks at the intersection of the sort of PIN and the sort of past 5 days short-selling measure are grouped together to form portfolios. Table 2.4 shows the result for the lowest market capitalization group and highest market capitalization group. In the lowest market capitalization group, the return difference between the lowest short selling quintile and the highest short selling quintile is insignificant for P1 and significantly positive for P3 and P5 for 5 days. The return difference between the lowest short-selling quintile and the highest short-selling quintile is significantly positive for all PIN quintiles for 30 and 60 days horizon. This may explain that why PIN plays a more important role in the relationship between short-selling and future return. It is also not surprising that the return difference between the lowest PIN quintile and the highest PIN quintile is significantly negative in 40 and 60 days for all short-selling quintiles. When looking at highest market capitalization group, results show some difference. The return difference between the lowest short-selling quintile and the highest short-selling quintile is significantly positive for P3 and P5 group in 5 and 30 days horizon, and insignificant for P3 group for 60 days horizon. When looking at the return difference between the lowest PIN quintile and the highest PIN quintile, we can see that it keeps insignificant for S2 for all three horizons, and becomes significantly positive for 60 days horizon. It shows that when the short selling constraint is less binding, the price effect of informed shorting is more significant.

Table 2.4

Portfolio returns by market capitalization, PIN and shorting activity

Stocks are sorted into 3 groups based on market capitalization. Within each group, stocks are sorted into quintiles based on shorting measure over previous 5 days and PIN independently. Cumulative shorting measure is calculated as cumulative number of shares sold short over total volume. Within each quintile, average cumulative abnormal return is calculated over 5 days, 30 days and 60 days holding periods respectively. Abnormal return is calculated using one factor market model.M1 is the lowest market capitalization group, while M3 is the highest market capitalization group. P1 is the lowest PIN quintile and P5 is the highest PIN quintile. S1 is the lowest shorting measure quintile and S5 is the highest shorting measure quintile. Parametric t-test is reported to test for the difference between cumulative abnormal return S1 and S2 in the same information asymmetry measure, and the difference between cumulative abnormal return P1 and P5 in the same shorting measure quintile. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

		S1	S3	S5	S1-S5	
		M1				
5 days	P1	0.0026	0.0017	0.0013	0.0012	(0.90)
	P3	0.0031	0.0012	0.0015	0.0017	(1.87)*
	P5	0.0048	0.0019	0.0027	0.0021	(3.33)***
	P1-P5	-0.0020	-19E-5	-0.0010		
		(-2.09)*	(-0.18)	(-1.34)		
30 days	P1	0.0116	0.0073	0.0023	0.0093	(5.12)***
	P3	0.0167	0.0041	0.0047	0.0120	(6.22)***
	P5	0.0178	0.0161	0.0141	0.0037	(2.64)***
	P1-P5	-0.006	-0.009	-0.009		
		(-3.79)***	(-4.91)***	(-7.44)***		
60 days	P1	0.0308	0.0188	0.0145	0.0163	(4.79)***
	P3	0.0445	0.0130	0.0105	0.0339	(8.60)***
	P5	0.0497	0.04179	0.0418	0.0079	(2.85)***
	P1-P5	-0.019	-0.023	-0.027		
		(-6.25)***	(-6.01)***	(-8.60)***		
		M3				
5 days	P1	0.0038	0.0017	0.0007	0.0021	(1.27)
	P3	0.0056	0.0011	0.0010	0.0019	(3.68)***
	P5	0.00482	0.0034	0.0037	0.0011	(1.82)*
	P1-P5	0.0002	-18E-5	0.0004		
		(0.27)	(-0.28)	(0.63)		
30 days	P1	0.0100	0.0052	0.0021	0.0020	(1.51)
	P3	0.0074	0.0048	0.0027	0.0039	(3.25)***
	P5	0.0083	0.0022	0.0032	0.0039	(3.03)**
	P1-P5	-0.003	-0.001	-0.001		
		(-2.60)**	(-1.02)	(-0.77)		
60 days	P1	0.0050	0.0028	0.0085	-0.0040	(-1.43)
	P3	0.0111	0.0055	0.0072	-0.0010	(-0.51)
	P5	0.0174	0.0077	0.0025	0.0049	(1.83)*
	P1-P5	-0.012	-0.005	0.006		
		(-5.24)***	(-2.27)**	(2.42)**		

2.4.4 Three Ways Sorting: Controlling for Institutional Ownership

Chen, Hong and Stein (2002) use the breath of ownership to measure the shorting constraint, and find that stocks experiencing declines in breath of ownership subsequently underperform those for which breath has increased. Nagel (2005) argue that short sale constraints mainly affect stocks with low institutional ownership and the forecasting power of several cross-sectional return predictors is most pronounced when institutional ownership is low. Therefore, I use institutional ownership to control for the availability of loadable shares. Short sale constraints are expected to be less binding when institutional holding are higher. So in order to isolate the effects of short sale constraints, I examine the role of PIN in the relation between short-selling and future stock return after controlling for institutional ownership. Each day, stocks are sorted into 3 portfolios based on institutional ownership in the end of the prior month. I1 represents the lowest institutional ownership portfolio and I3 represents the highest institutional ownership portfolio. Within each institutional ownership group, stocks are sorted into quintiles based on PIN, with P1 represents the lowest quintile and P5 represents the highest quintile. Meanwhile, within each institutional ownership group, stocks are independently sorted into quintiles based on shorting measure over previous 5 days, with S1 represents the lowest quintile and S5 represents the highest quintile. Within each institutional ownership group, the stocks at the intersection of the sort of PIN and the sort of past 5 days shorting measure are grouped together to form portfolios. Table 2.5 shows the result. For the lowest institutional ownership group, the return difference for the lightest shorted quintile and the heavily shorted quintile are significantly positive for all PIN quintiles, and the return difference for the lowest PIN quintile and the highest PIN quintile are significantly negative for all shorting quintiles. In the lowest institutional ownership group, the return difference between the lowest short selling quintile and the highest short selling quintile is not significant for 5 days horizon, but positively significantly for 30 and 60 days horizons.

Table 2.5

Portfolio returns by institutional ownership, PIN and shorting activity

Stocks are sorted into 3 groups based on institutional ownership. Within each group, stocks are sorted into quintiles based on shorting measure over previous 5 days and PIN. Cumulative shorting measure is calculated as cumulative number of shares sold short over total volume. Within each quintile, average cumulative abnormal return is calculated over 5 days, 30 days and 60 days holding periods respectively. I1 is the lowest institutional ownership group, while M3 is the highest institutional ownership group. P1 is the lowest PIN quintile and P5 is the highest PIN quintile. S1 is the lowest shorting measure quintile and S5 is the highest shorting measure quintile. Parametric t-test is reported to test for the difference between cumulative abnormal return S1 and S2 in the same information asymmetry measure, and the difference between cumulative abnormal return P1 and P5 in the same shorting measure quintile. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

		S1	S3	S5	S1-S5	
		I1				
5 days	P1	0.0028	0.0020	0.0014	0.0014	1.49
	P3	0.0040	0.0012	0.0011	0.0030	(3.05)***
	P5	0.0023	0.0006	0.0001	0.0022	(2.71)***
	P1-P5	0.0003	0.0016	0.0014		
		(0.34)	(1.63)	(1.39)		
30 days	P1	0.0064	0.0076	0.0087	-0.002	-1.27
	P3	0.0105	0.0079	0.0047	0.0057	(3.18)***
	P5	0.0111	0.0015	0.0004	0.0107	(5.77)***
	P1-P5	-0.005	0.006	0.0083		
		(-2.86)**	(3.06)***	(4.09)***		
60 days	P1	0.0162	0.0222	0.0208	-0.0050	(-1.75)*
	P3	0.0225	0.0217	0.0103	0.0122	(3.97)***
	P5	0.0213	0.0088	0.0034	0.0178	(5.28)***
	P1-P5	-0.0050	0.0134	0.0174		
		(-1.82)*	(3.84)***	(5.30)***		
		I3				
5 days	P1	0.0038	0.0017	0.0007	0.0021	(1.27)
	P3	0.0056	0.0011	0.0010	0.0019	(3.68)***
	P5	0.00482	0.0034	0.0037	0.0011	(1.82)*
	P1-P5	0.0002	-18E-5	0.0004		
		(0.27)	(-0.28)	(0.63)		
30 days	P1	0.0100	0.0052	0.0021	0.0020	(1.51)
	P3	0.0074	0.0048	0.0027	0.0039	(3.25)***
	P5	0.0083	0.0022	0.0032	0.0039	(3.03)**
	P1-P5	-0.003	-0.001	-0.001		
		(-2.60)**	(-1.02)	(-0.77)		
60 days	P1	0.0050	0.0028	0.0085	-0.0040	(-1.43)
	P3	0.0111	0.0055	0.0072	-0.0010	(-0.51)
	P5	0.0174	0.0077	0.0025	0.0049	(1.83)*
	P1-P5	-0.012	-0.005	0.006		
		(-5.24)***	(-2.27)**	(2.42)**		

The return difference of the lowest PIN quintile and the highest PIN quintile is significantly positive for S3 and S5 in 30 and 60 days horizons. This result shows that short sale constraint plays an important role in the information discovery. Short-selling is more informed of future stock return when short sales constraint is more binding.

2.4.5 Two Ways Sorting: Different Trading Size

Barclay and Warner (1993) and Chakravarty (2001) find that medium-size orders are the most informed, while Boehmer, Jones and Zhang (2005) investigate shorting measure, and find large short sale orders are the most informative. In order to see exactly which size of shorting is informative, I compare the informativeness of large short sales and small short sales. Short sale orders are partitioned into 4 size categories: less than 500 shares, 500 to 1,999 shares, 2,000 to 4,999 shares, and orders of at least 5,000 shares. Each day, stocks are sorted into quintiles by shorting measure of different sizes, and then are sorted into quintiles by PIN. Table 2.6 shows the result. Two smallest size shorting are the most informed, since the return difference between the lowest PIN quintile and the highest PIN quintile is significantly positive for 30 days horizon.

Table 2.6

Portfolio returns by PIN and shorting activity at various order size

Stocks are sorted into 4 groups based on different order size. Within each group, stocks are sorted into quintiles based on shorting measure over previous 5 days and PIN.. P1 is the lowest PIN quintile and P5 is the highest PIN quintile. S1 is the lowest shorting measure quintile and S5 is the highest shorting measure quintile. Parametric t-test is reported. '***', '**' and '*' represent significance at the 1%, 5% and 10% level respectively.

			S1	S5	S1-S5	
1-499 shares	5 days	P1	0.0010	0.0012	-15E-5	(-0.31)
		P5	0.0030	6.76E-05	0.003	(5.21)***
		P1-P5	-0.002	0.0011		
			(-4.05)***	(1.93)*		
	30 days	P1	0.0016	0.0039	-0.002	(-2.23)**
		P5	0.0114	0.0016	0.0098	(8.00)***
		P1-P5	-0.01	0.0023		
			(-8.24)***	(2.13)*		
	60 days	P1	0.0049	0.0101	-0.005	(-2.44)**
		P5	0.0373	0.0023	0.0350	(13.68)***
		P1-P5	-0.0320	0.0078		
			(-12.91)***	(3.58)***		
500-1,999 shares	5 days	P1	0.0020	0.0126	0.0011	(1.82)*
		P5	0.0029	0.0083	0.0032	(5.81)***
		P1-P5	-87E-5	0.0012		
			(-1.85)*	(1.72)*		
	30 days	P1	0.0048	0.0029	0.0019	(1.42)
		P5	0.0104	0.0018	0.0086	(6.29)***
		P1-P5	-0.006	0.0011		
			(-5.14)***	(0.74)		
	60 days	P1	0.0161	0.0140	0.002	(0.76)
		P5	0.0205	0.0093	0.0112	(3.56)***
		P1-P5	-0.004	0.0048		
			(-1.45)	(1.75)*		
2,000-4,999 shares	5 days	P1	0.0023	0.0005	0.0018	(3.19)***
		P5	0.0027	-0.0001	0.0027	(5.22)***
		P1-P5	-37E-5	0.0001		
			(-0.71)	(1.08)		
	30 days	P1	0.0058	0.0013	0.0046	(4.08)***
		P5	0.0094	0.0017	0.0078	(6.73)***
		P1-P5	-0.004	-43E-5		
			(-3.34)***	(-0.36)		
	60 days	P1	0.0197	0.0075	0.0122	5.20
		P5	0.0196	0.0092	0.0104	3.43
		P1-P5	0.0001	-0.002		
			(0.01)	(-0.57)		
5,000- shares	5 days	P1	0.0023	0.0004	0.0018	(3.46)***
		P5	0.0017	0.0005	0.0012	(2.28)**
		P1-P5	0.0006	-51E-6		
			(0.98)	(-0.11)		
	30 days	P1	0.0053	0.0014	0.0055	(4.87)***
		P5	0.0073	0.0012	0.004	(3.46)**
		P1-P5	-0.002	0.0002		
			(-1.72)*	(0.15)		
	60 days	P1	0.0174	0.0065	0.0107	(4.57)***
		P5	0.0149	0.0056	0.0093	(3.17)***
		P1-P5	0.0022	0.0009		
			(0.87)	(0.34)		

2.5 Conclusion

Although there are several papers about the information content of short sales, the understanding of whether short sellers are informed about future stock returns is mixed. This paper combines detailed short sales transaction data and the Probability of Information-based Trading (PIN) from microstructure literature to examine the information role in the relationship between short sale and future stock return.

I find that short sales are negatively related to future stock return, no matter which return horizon I choose. For stock with high information asymmetry, the return difference between heavily shorted stocks and lightly shorted stocks are positively significant. Short-selling is more informed for stocks with low market capitalization and stocks having low institutional ownership. In other words, short-selling is more informed when the short sale constraint is more binding. When looking at the information content of short-selling in different trading sizes, I find that small size shorting is more informed of future stock return, which is consistent with the stealth trading hypothesis by Chakravarty (2001) and Barclay and Warner (1993).

In summary, this paper gives evidence that short sellers are informed about future stock returns.

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CHAPTER 3

Short-selling Prior to Merger and Acquisition Announcements

3.1 Introduction

Corporate mergers and acquisitions have generated a great deal of academic interest over decades. Since mergers and acquisitions involve a potential change of control, they usually have significant impacts on the share price for both acquirers and target firms. Previous research show that immediately after merger and acquisition announcements, excess returns to targets increase significantly (Meulbroek (1992), Schwert (1995), et al.), which acquirers experience non-negative abnormal return (Bradley, Desai, and Kim (1988), Mulherin and Boone (2000), et al.). It has been well documented that stock acquirers experience announcement period significant negative abnormal return. Conversely, cash acquirers experience flat to slightly positive abnormal returns (Travlos (1987), Mitchell, Pulvino, and Stafford (2004), Andrade, Mitchell, and Stafford (2001)). Therefore, there is a large incentive for informed short sellers to exploit their information prior to merger and acquisition announcements.

Meanwhile, there is a large of body of literature examines whether short sellers are informed traders. Prior to the availability of Reg SHO intraday transaction data, most researchers use monthly interest as the proxy for short-selling, and predominantly agree that short sellers possess information about the future levels of stock prices. After the Reg SHO data is available, results become mixed. Diether, Lee and Werner (2006) show that short sellers are mostly contrarian, and they exploit price overreactions and trade against noise demand when profitable opportunities arise, while Boehmer, Jones and Zhang (2005) find that short sellers are extremely well-informed with institutional orders being the most informative.

I organize the paper around several questions. First, the paper investigates whether there is usual level of short-selling in the days leading up to merger and acquisition announcements for acquiring firms. After showing that there is a sharp difference of short-selling for acquiring I ask the following questions. Does the abnormal short-selling prior to announcements reflect the inside information owned by short sellers? Is the predictive ability of pre-announcement short-selling related to the concentration of informed traders? Is usual level of short-selling for acquiring firms prior to merger and acquisition announcements related to firms' characteristics? Can unusual level of short-selling for acquiring firms prior to merger and acquisition announcements predict the result of the outcome of mergers and acquisitions? Which size of shorting is more informed, small size or large size?

My main findings are the following. Short-selling increases 30 days prior to merger and acquisition announcements for acquiring firms. After I partition all firms into stock-financed and cash-financed (or combined-financed) firms, I find short-selling keeps indifference as the days when there is no announcement for acquiring firms prior to cash-financed mergers and acquisitions, while it increases significantly prior to stock-financed mergers and acquisitions. Short-sellers are not only informed of the mergers and acquisitions, but also informed of the methods of payment. However, they can not predict the outcome of mergers and acquisitions. For stocks having higher information asymmetry, the predictive ability of future stock return is higher. Short-selling prior to merger and acquisition announcements concentrates in larger firms, firms with higher liquidity, lower book to market ratio and higher institutional ownership for acquiring firms. There is more information content in small and medium size short-selling than large size short-selling for acquiring firms.

The rest of the paper is organized as follows. Section 2 briefly reviews related literature. Section 3 describes the data and methodology. Section 4 presents empirical results and discusses potential explanations. Section 5 summarizes the paper.

3.2 Literature Review

Whether short sellers are informed becomes an interesting topic for a long time. Diamond and Verrecchia (1987) show that uninformed market participants are discouraged from shorting because it is prohibitive and restrictive. The former include the inability of certain institutions to engage in short-selling, inadequate supply of stocks that can be borrowed for shorting purposes, and the tick rules imposed on short sales. Later on, a lot of empirical paper investigates whether short sellers possess information about future prices from different aspects of views and the results are mixed. Christophe, Ferri, and Angel (2004) examine short sale transactions five days prior to earnings announcements of a sample of NASDAQ stocks in the fall of 2000, and demonstrate that abnormal short-selling before earnings announcements is negatively related to subsequent stock returns. Desai, Krishnamurthy, and Venkataraman (2005) study the behavior of short sellers around earnings restatements and find that short sellers are able to anticipate earnings restatements. Aitken et al. (1998) show that stock prices fall rather quickly after executions of observable short sales. The recent availability of the Reg SHO intraday transaction data allows researchers to investigate the topic of informativeness of shorted order flow using more detailed data. Boehmer, Jones, and Zhang (2005) show that institutional short sale transactions predict future stock return well, so that short sellers are well-informed. Daske, Richardson, and Tuna (2005) examine a sample of NYSE stocks for April 2004 through March 2005 and find no robust evidence that short sale transactions are concentrated prior to bad news disseminated by scheduled earnings announcements, unscheduled voluntary disclosure, or substantial stock price declines. Richardson (2002) uses a sample of US traded firms from 1990 to 1998 to examine whether investors short securities with high accruals, and finds no evidence that short sellers trade on the basis of information contained in accruals. Diether, Lee, and

Werner (2005) come to the conclusion that short sellers are not as much informed, as they are contrarian investors and trade to exploit market overreaction.

The paper also relates to literature about stock performance around merger and acquisition announcements for acquiring firms and the informed trading prior to announcements. Mulherin and Boone (2000) study acquisition and divestiture activity and find that an average target returns of 20.2 percent in the three-day window around the merger and acquisition announcements. Fuller, Netter and Stegemoller (2002) find that bidders have significantly negative returns when buying public targets or they offer stock instead of cash. Chang (1998) examines bidder returns to firms acquiring 281 privately held targets, and find no significant abnormal return for a two-day window for bidders who acquire private targets with cash, but a significant negative abnormal return for bidders who buy private targets with stock. Meulbroek (1992) shows that daily stock returns are correlated with the pre-takeover trading activities of insiders when the Securities and Exchange Commission successfully prosecuted insider trading, although insiders traded on a small subset of the days in the run-up period. Cao, Chen and Griffin (2005) examine the information embedded in stock and option markets prior to merger and acquisition announcements and get the conclusion that, with pending extreme informational events, the options market plays an important role in price discovery. Mitchell, Pulvino and Stanfford (2004) show that nearly half of the negative announcement period stock price reaction for acquirers in stock-financed mergers reflects downward price pressure caused by merger arbitrage short-selling.

This paper contributes to the literature by combining detailed short sales transaction data and merger and acquisition announcements to investigate the information content of short-selling prior to merger and acquisition announcements.

3.3 Data and Sample

The merger and acquisition data is obtained from the Securities Data Corporation (SDC) Mergers and Acquisitions database provided by Thomson Financial. The sample is restricted to mergers and acquisitions from January 1st, 2005 to December 31st, 2007, and acquirers intend to take full control of the target. I exclude all closed-end funds, American Depository Receipts (ADRs), Real-Estate Investment Trusts (REITs), and any stock not traded on the NYSE. Furthermore, I exclude any event that is confounded by another merger and acquisition event within 90 days before the announcement. Stock return, price, volume, book value, market capitalization, number of shares outstanding are available from CRSP/COMPUSTAT. Short sales transaction data comes from NYSE Reg SHO. Stock price, volume and beta excess return are taken from CRSP.

I have two shorting flow measures. The first one is the daily shorting shares and the second one is daily shorting shares divided by daily trading volume. The non-announcement period is (-90, -31) before earnings announcements. Daily abnormal shorting flow is the difference between daily shorting flow and mean daily shorting flow over the non-announcement period, divided by the standard deviation of shorting flow over the non-announcement period. I use the same method to calculate abnormal trading volume. Abnormal return around the announcement period is calculated based on the market model.

Quote and trade data are obtained from the NYSE Trade and Quotation (TAQ) database. I use the algorithm of Lee and Ready (1991) to classify buyer- and seller-initiated transactions. For each trade, if the trading price is below the midpoint of bid-ask prices, it is classified as a seller-initiated trade, if the trading price is above the midpoint of bid-ask prices, it is classified as a buyer-initiated trade. For a trade at the bid-ask midpoint, it is seller-initiated if the trading price is lower than its preceding trading price and buyer-initiated if the trading price is higher. For the daily trading imbalance, first, I calculate the difference between buyer-initiated trading volume and seller-initiated trading volume, and then divide that by the summation of total trading volume. Daily abnormal trading imbalance is the difference between daily trading imbalance and mean daily trading imbalance over the non-announcement period, divided by the standard deviation of daily trading imbalance over the non-announcement period.

I get the direction of each shorting by merging TAQ trade data and NYSE Reg SHO data. Both trades are executed in the same conditions, at the same price and have identical timestamps. After getting the direction of each shorting, I calculate the daily 'shorting imbalance' by using the same method as the calculating the trading imbalance. For the 'shorting imbalance', first, I calculate the difference between buyer-initiated shorting volume and seller-initiated shorting volume, and then divide that by the total shorting volume. Daily abnormal shorting imbalance is the difference between daily shorting imbalance and mean daily shorting imbalance over the non-announcement period, divided by the standard deviation of daily shorting imbalance over the non-announcement period.

Table 3.1 provides descriptive statistics for these firms. There are 2316 acquiring firms which announced mergers and acquisitions from January 2005 through December 2007 which meet the criteria above.

Panel A of table 1 reports the summary of the firms' characteristics. I first average the variables over all trading days for each firm and then report distributional information for these firm averages.

Panel B presents summary information on the overall pattern of short-selling for sample firms. I measure shorting flow in two different ways. First measure is the total number of shares sold short in a given stock on a given day. It is possible that high shorting flow is due to unusually high or low trading volume, with short selling as a percentage of trading volume remaining relatively constant. Last measure is the fraction of volume for a given stock on a given day.

Table 3.1

The sample consists of 2316 companies listed on the NYSE which announced to acquire other companies from Jan 2005 through Dec 2007. All shorting flow measure is aggregated per stock per day during non-announcement dates. Reported figures are time-series averages of cross-sectional statistics.

	mean	Std. Deviation
Panel A : Firms Characteristics		
Share outstanding	302426.4434	705534.9930
turnover	7.3161	4.6959
Share price	37.4711	24.4637
Trading volume	1669036.7836	3710001.2324
Panel B: Shorting Flow Measures		
Shares sold short	271409.09	461829.63
Shorting share of volume	9.57%	74.8%

3.4 Empirical Estimations and Results

3.4.1 Abnormal Short-selling prior to Announcements

I use standard event study method to investigate abnormal short-selling before merger and acquisition announcements for acquiring firms. The non-announcement period is from -90 to -31, announcement date is 0, and preannouncement dates are from -30 to -1. Abnormal shorting flow measures are calculated as the difference between daily shorting flow and the mean daily shorting flow over non-announcement period, and then normalized by mean shorting flow over non-announcement period. I use the same method to calculate abnormal trading volume. Abnormal return around the announcement period is calculated based on the market model.

Table 3.2 shows the average abnormal shorting flow and abnormal shorting flow in days (-30,-21), (-20,-11), (-10,-1) prior to merger and acquisition announcements for acquiring firms. T-test is use to test the significance. I use a multi-day pre-announcement interval because it is likely that informed investors will distribute their short-selling over several days prior to announcements. In addition, Reed (2001) shows that equity lending market typically last from one to several days. The result shows that there is abnormal short-selling prior to merge and acquisition announcements for acquiring firms.

Table 3.2

Even study results prior to earning announcement dates

The table reports the event-study results for the sample prior to merger and acquisition announcements. Two abnormal shorting flow measures are calculated: abnormal number of shares and abnormal number of shares divided by trading volume. Daily abnormal shorting flow measures and abnormal trading volume are calculated as the difference between daily shorting flow and the mean daily shorting flow over non-announcement period, and then normalized by mean shorting flow over non-announcement period. Abnormal return is calculated based on the market model. Cumulative abnormal shorting measure is the sum of daily abnormal shorting measure. Cumulative abnormal volume is the sum of daily abnormal volume, and cumulative abnormal return is the sum of daily abnormal return. Parametric t-test is reported to test for the difference. '***', '**' and '*' represent significance ant the 1%, 5% and 10% level respectively.

	Cumulative number of shares	Cumulative abnormal short/volume	Cumulative abnormal volume	Cumulative abnormal return
[-30, -21]	0.1471	0.0987	0.101963	0.000036
	(3.58)***	(2.47)**	(2.71)**	(0.23)
[-20, -11]	0.10420	0.1451	0.080257	-0.000001
	(3.05)***	(2.28)**	(2.60)**	(-0.01)
[-10, -1]	0.1471	0.0987	0.144255	-0.000066
	(3.72)***	(1.82)*	(4.02)***	(-0.37)

Then, I turn to look at the short-selling for stock-financed and cash-financed announcements separately. If short-sellers are informed not only the announcements, but also the methods of payment, short-selling is expected to increase shorting prior to stock-financed announcements, not cash-financed announcements.

Table 3.3 shows the results. All announcements are partitioned into 2 groups according to the methods of payment. The result shows that short-selling increases around 20 days prior to stocks-financed merge and acquisition announcements. However, abnormal short-selling is negative and insignificant prior to cash-financed merge and acquisition announcements. This result supports the argument that short sellers are informed of not only the merge and acquisition announcements, but also the methods of payment.

Table 3.3

Even study results prior to earning announcement dates

The table reports the abnormal shorting flow for acquiring firms prior to cash-financed and stock-financed merger and acquisition announcements separately. Daily abnormal shorting flow measures and abnormal trading volume are calculated as the difference between daily shorting flow and the mean daily shorting flow over non-announcement period, and then normalized by mean shorting flow over non-announcement period. Cumulative abnormal shorting measure is the sum of daily abnormal shorting measure. Daily shorting measure is daily shorting shares divided by daily trading volume. Parametric t-test is reported to test for the difference. '***', '**' and '*' represent significance ant the 1%, 5% and 10% level respectively.

	Cash-financed	Stock-financed
[-30, -21]	-0.0213	0.0125
	(-0.67)	(2.64)***
[-20, -11]	-0.0048	0.0627
	(-0.17)	(2.72)***
[-10, -1]	-0.0129	0.0529
	(-0.67)	(0.55)

3.4.2 Abnormal Short-selling prior to Announcements

One implication of the informativeness of short-selling prior to merger and acquisition is that, if short sellers have private information and trade according to the private information prior to cash-financed mergers and acquisitions, the trading imbalance for short-selling is expected to be different from the trading imbalance for the all trades. On the contrary, the trading imbalance for short-selling prior to cash-financed is expected to be the same as the trading imbalance for all trades.

In order to test this, I construct the trading imbalance for short-selling. I match all short sale transactions with trades from TAQ. After getting the direction of each short sales transaction, I calculate the daily trading imbalance for short-selling by using the same method as the trading imbalance. Then, I calculate the abnormal shorting imbalance by divide the difference between daily shorting imbalance and the mean daily shorting imbalance over the non-announcement period by the standard deviation of daily shorting imbalance over the non-announcement period. I compare the shorting imbalance and the trading imbalance for cash-financed and stock-financed mergers and acquisitions separately.

Table 3.4

Even study results prior to earning announcement dates

The table reports the abnormal trading imbalance and abnormal shorting imbalance for acquiring firms prior to cash-financed and stock-financed merger and acquisition announcements separately. Cumulative abnormal trading imbalance and shorting imbalance is the sum of daily abnormal trading imbalance and shorting imbalance. Daily shorting measure is daily shorting shares divided by daily trading volume. Parametric t-test is reported to test for the difference. '***', '**' and '*' represent significance ant the 1%, 5% and 10% level respectively.

	Shorting imbalance	Trading imbalance	Difference	Difference
	Stock-financed			
[-30, -21]	0.0672	0.1794	-0.129	(-2.14)**
[-20, -11]	0.0879	0.2284	-0.141	(-2.69)***
[-10, -1]	0.0554	0.1962	-0.124	(-2.01)**
	Cash-financed			
[-30, -21]	0.0434	0.1457	-0.084	(-1.29)
[-20, -11]	0.0604	0.1702	-0.110	(-1.43)
[-10, -1]	0.0908	0.1752	-0.102	(-1.34)

Table 3.4 shows the results. The significantly negative difference between shorting imbalance and trading imbalance prior to stock-financed mergers and

acquisitions, and the indifference between shorting imbalance and trading imbalance prior to cash-financed mergers and acquisitions support the argument that short-sellers are informed.

3.4.3 Abnormal Short-selling and Announcement Return

If short sellers engage in informed trading prior to merger and acquisition announcements, there should be a significant relationship between abnormal short-selling flow prior to the announcement and the immediate stock price reaction once the merger and acquisition announcement is announced.

The model for testing whether abnormal short-selling could predict the abnormal return immediately after merger and acquisition announcements has the following form:

$$CAR\,(0, +2) = \alpha 0 + \alpha 1 \times ABSHARE\,(-10, -1) + \alpha 2 \times ABVOL\,(-10, -1) + \delta \qquad (1)$$

$$CAR\,(0, +2) = \alpha 0 + \alpha 1 \times ABREL\,(-10, -1) + \delta \qquad (2)$$

Where RET (0, +2) is average daily abnormal return around announcement dates, ABSHARE (-10,-1) is average daily abnormal short shares of day -10 to -1, ABREL (-10,-1) is the average daily abnormal short shares/volume of day -10 to -1, ABVOL (-10,-1) is the average abnormal volume of day -10 to -1. The interaction of short-selling measure and PIN is also included in both regressions.

Table 3.5 shows the result of the regression for stock-financed acquiring firms. In all specifications, the coefficient for abnormal short selling flow is significantly negative, which implies that the short seller can predict the upcoming merger and acquisition announcements for acquiring firms no matter which shorting measure is used. The result indicates that when there are more informed traders, the short-selling prior to announcements is more informed of announcement stock return.

Table 3.5

Cross-sectional regression to explain the predictability of abnormal short-selling prior to stock-financed mergers and acquisitions

Average daily cumulative abnormal return over (0, +2) is regressed on explanatory variable including ABSHARE, ABREL, ABVOL and the interaction between short-selling measure an PIN. "***", "**" and "*" represent significance at the 1%, 5% and 10% level respectively. All tests are White heteroskedasticity consistent.

$$CAR\ (0, +2) = \alpha 0 + \alpha 1 \times ABSHARE\ (-10, -1) + \alpha 2 \times ABVOL\ (-10, -1) + \delta \qquad (1)$$
$$CAR\ (0, +2) = \alpha 0 + \alpha 1 \times ABREL\ (-10, -1) + \delta \qquad (2)$$

	(1)	(2)
intercept	0.00197	0.00187
	(2.21)*	(2.30)**
ABSHARE	-0.00113	
	(-1.96)*	
ABREL		-0.00103
		(-1.97)*
ABVOL	0.00043	
	(0.67)	
Adj R square	0.0151	0.0181

3.4.4 Abnormal Short-selling and Characteristics of Firms

The next issue we examine is whether short sellers use fundamental analysis of publicly available data in choosing their targets. Or in other words, will the short sellers' pre-announcement transactions are partially influenced by fundamental attributes of firms.

I further separate our sample into quintiles based on average book-to-market ratio, liquidity, institutional ownership and market capitalization during non-announcement dates. Then I run the regression for the lowest quintile and highest quintile to see whether there is difference in predictive power of the short-selling in different quintiles. The results are presented in table 3.6. Separate regressions are run for different categories of stocks.

Table 3.6

Cross-sectional regression to explain the predictability of abnormal short-selling of different categories prior to stock-financed mergers and acquisitions

Average daily cumulative abnormal return over (0, +2) is regressed on explanatory variables including ABSHARE, ABREL, and ABVOL. Separate regressions are run for Quintile 1 and Quintile 4 for different categories of stocks. Panel A groups stocks by illiquidity, panel B groups stocks by market capitalization, panel C groups stocks by book to market ratio. RET (0, +2) is average daily abnormal return around announcement dates, ABSHARE is average daily abnormal short shares of day -10 to -1, ABREL is the average daily abnormal short shares/volume of day -10 to -1, ABVOL is average daily abnormal trading volume of day -10 to -1.

	(1)		(3)	
	Q1	Q5	Q1	Q5
Panel A: Illiquidity				
Intercept	0.00031	0.00153	0.00112	0.0015
	(0.46)	(1.17)	(1.40)	
ABSHARE	-0.00132	-0.00055		
	(-1.33)	(-0.48)		
ABREL			-0.00110	-0.00035
			(-1.06)	(-0.21)
ABVOL	-0.00034	0.00040		
	(-0.30)	(0.23)		
Adj R square	0.0288	0.0013	0.0064	0.0003
Panel B: Market Capitalization				
intercept	0.00151	0.00014	0.00145	0.00007
	(1.10)	(0.24)	(1.04)	(0.13)
ABSHARE	-0.00058	-0.00142		
	(-0.48)	(-1.68)*		
ABREL			-0.00033	-0.00142
			(-0.18)	(-2.12)*
ABVOL	0.00017	0.00086		
	(0.09)	(0.92)		
Adj R square	0.0016	0.0168	0.0002	0.0253
Panel C: Book- to- market ratio				
intercept	0.00137	-0.00004	0.00133	-0.00007
	(1.59)	(-0.04)	(1.62)	(-0.08)
ABSHARE	-0.00195	-0.00013		
	(-1.86)*	(-0.18)		
ABREL			-0.00267	0.00124
			(-2.68)**	(0.66)
ABVOL	0.00102	0.00042		
	(1.02)	(0.40)		
Adj R square	0.0213	0.0010	0.0419	0.0027

Panel A groups stocks by illiquidity. Although all coefficients for the short-selling measure are significant, it is obvious that low liquidity stocks are more negatively correlated to the abnormal return immediately after merger and acquisition announcements. Panel B groups stocks by market capitalization; Panel C groups stocks by book-to-market ratio. The result confirms that for stocks in the lowest book-to-market and highest book-to-market quintile, shorting activity does have strong predictive power for the abnormal returns after merger and acquisition announcements.

3.4.5 Abnormal Short-selling and the Outcome of Announcements

Next, I turn to examine if short-selling prior to stock-financed merger and acquisition announcements is informative of future deal outcomes. If short sellers are not only informed of the timing of merger and acquisition announcement, but also the ultimate outcome, then, the short-selling activity would be indicative of the future outcome.

The model for testing whether abnormal short-selling can predict the outcome of merger and acquisition announcements has the following form:

$$\text{OUTCOME}=a0+a1\times\text{ABSHARE}\ (-10,-1)+a3\times\text{ABVOL}\ (-10,-1)+\delta \quad (3)$$

$$\text{OUTCOME}=c0+c1\times\text{ABREL}\ (-10,-1)+\delta \quad (4)$$

Where OUTCOME is the dummy variable, which equals to 1 if the outcome is succeed, equals to 0 if the merger or acquisition is withdrawn. ABSHARE (-10,-1) is average daily abnormal short shares of day -10 to -1, ABREL(-10,-1) is average daily abnormal short shares over total trading volume. ABVOL (-10,-1) is the average abnormal volume of day -10 to -1.

The results are presented in Table 3.7. All coefficients for abnormal shorting measures are insignificant, which imply that the short-selling prior to announcements can not foreshadow the ultimate outcome of the stock-financed mergers and acquisitions.

Table 3.7

Cross-sectional regression to explain the predictability of the outcome of the merger and acquisition of abnormal short-selling prior to announcements

Dummy variable of the outcome of the merger and acquisition is regressed on explanatory variables including ABSHARE, ABREL, and ABVOL. Dummy variable equals to 1 if the merger and acquisition is succeed, otherwise it equals to 0. ABSHARE is average daily abnormal short shares of day -10 to -1, ABREL is the average daily abnormal short shares/volume of day -10 to -1, ABVOL is average daily abnormal trading volume of day -10 to -1.

$$OUTCOME=a0+a1\times ABSHARE\ (-10,-1)+a3\times ABVOL\ (-10,-1)+\delta \quad (3)$$
$$OUTCOME=c0+c1\times ABREL\ (-10,-1)+\delta \quad (4)$$

	(3)	(4)
INTERCEPT	0.96450	0.95913
	(126.11)***	(130.23)***
ABSHARE	-0.00418	
	(-0.59)	
ABREL		-0.00289
		(-0.32)
ABVOL	-0.00702	
	(-2.32)**	
Adj R square	0.0086	0.0001

3.5 Summaries and Conclusions

There are a lot of discussions about the informativeness of short sellers. In this paper I examine the information content in short sale transactions prior to merger and acquisition announcement of acquiring firms for NYSE securities from January 1, 2005 to December 31, 2007.

I find that short-selling increases for acquiring firms prior to stock-financed, not cash-financed mergers and acquisitions. There is a significant negative relationship between abnormal short sales prior to merger and acquisition announcements and return after announcements for stock-financed acquiring firms. Short-sellers are informed of the methods of payment (cash financed or stock financed). However, there is no evidence that they are able to predict the outcome of the mergers and acquisitions (succeed or withdrawn). Short-selling prior to merger and acquisition announcements is higher for larger firms, firms with higher liquidity, lower book-to-market ratio and higher institutional ownership for acquiring firms.

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