

## Review

# Dynamics of short selling: An empirical investigation

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**We examine short selling activities on the New York Stock Exchange (NYSE) from July to October 2007, a period during which the uptick rule was permanently removed by the Securities and Exchange Commission (SEC). Short sellers have a tendency to increase their trading following negative market returns and positive individual stock returns. Short sellers target stocks with positive returns and timing their trades when the market trends down. The results are robust after accommodating other factors that determine short selling, such as volatility, spreads, and stock turnover. Not all short sellers are capable of predicting future stock returns, only those who trade on private information can. We find that a long/short trading strategy with a holding period of two weeks and based on past abnormal short selling activity generates significant positive returns during the sample period.**

**Key words:** Short selling behavior, uptick rule, stock returns.

## INTRODUCTION

Short sellers borrow stocks and bonds and any other underlying instruments to be shorted in order to sell them at the prevailing market price, essentially betting that underlying instrument prices will fall before they need to buy back the borrowed shares. Academics and practitioners generally share the view that short selling benefits the market by aligning stock prices with fundamental value (Dechow et al., 2001; Boehme et al., 2008); providing liquidity when needed (Diether et al. 2002; 2009); improving informational efficiency of the market (Saffi and Sigurdsson, 2007; Boehmer and Wu, 2009; Zhao and Daves, 2008); and exposing corporate financial misconduct (Karpoff and Lou, 2008).

Meanwhile, opponents of short selling argue that short selling may be utilized as a device to manipulate stock prices in an abusive manner and can negatively impact investor's confidence (Shkilko et al., 2008; Schwab, 2008). The primary goal of this paper is to examine a variety of short selling behaviors on the NYSE from July to October, 2007, during which short sales were unleashed when the uptick rule restriction was revoked by the SEC. Such an investigation not only adds to the

literature by drawing a big picture on who short sellers are and how they acted when the uptick rule was removed, but also provides valuable information to the SEC and other policy makers regarding the short selling regulation.

We develop a holding period dynamic analysis based upon the calendar portfolio approach to examine if short selling activities can forecast future stock returns. Our finding is at odds with the general wisdom that short sellers are able to forecast future negative stock returns. Analyzing abnormal returns of a hedging portfolio with a short position in the most heavily shorted stocks and a long position in the least heavily shorted stocks for a variety of holding periods ranging from one day to one year, we do not find evidence that short selling activities have capability in forecasting either short-term or long-term stock returns. We hypothesize that this striking discrepancy between our study and the previous literature may be caused by the removal of the uptick rule, which mitigates the problem of stock overvaluation, thus providing reduced incentive to short sale.

We are not the first one examining dynamic short sellers' behaviors around the change of the uptick rule. Our study differs from previous studies in two ways:

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Firstly, previous studies investigate the role of the uptick rule on many aspects of market quality by using the regulation SHO data generated from a two-year pilot program, in which about 1000 so call pilot stocks were

exempted from the uptick rule restriction, and concluded that the uptick rule played no role in destabilizing the market and thus should be removed (SEC, 2007; Alexander and Peterson, 2008; Diether, Lee, and Werner, 2007; and Boehmer and Wu, 2009). However, “the pilot program may not be a clean experiment...” (Zhao and Daves, 2008), and SEC (2007) point out that it is possible that short sellers might be on good behavior if they believe that heightened scrutiny during the pilot program increases their chances of getting caught. In this paper we fill out this important gap by examining short selling behavior for a period when the uptick rule is permanently removed.

Secondly, previous studies only take a look at hedging strategies with either a very short or a very long holding period due to the methodology and data limitation. For example, Diether et al. (2008) only examine the hedging strategies with holding period of less than three days, ignoring the possibility that short sellers may hold on their shorting position for more than three days. On the other hand, Dechow et al. (2001) and Diether et al. (2002) conduct the calendar portfolio approach based on the monthly holding period, ignoring the short term feature of short selling. In this paper we develop a holding period dynamic analysis methodology based upon the calendar portfolio approach to study how short sellers time the market. High frequency short selling data we used in this study and the holding period dynamic analysis provide us great flexibility in choosing different holding periods. Computing portfolio abnormal returns for holding periods ranging from one day to one year (or 250 days), our paper is the first one to explore the timing of short selling strategies in a comprehensive manner.

Nevertheless, our study is subject to several shortcomings. Firstly, our sample period is short. We only use four month high frequency short selling data. This limited our capacity to discern different short selling behavior, and our results may not be generalized to a longer time period. Secondly, due to the data limitation, only 1421 large U.S. stocks listed on the NYSE are examined in this paper. It is necessary to extend our study to a sample of NASDAQ listed company once the data become available. Thirdly, many discrepancies exist when we compare our results with those in Diether et al. (2009). Those discrepancies may be caused by the removal of uptick rules, yet no direct link has been established to support our conjectures. This limits our capability to make legitimate comments on the rationale to restore the uptick rule. Future studies addressing this issue would certainly yield fruitful contributions.

## HYPOTHESES

### **Short-sellers short sale stocks for various reasons. We summarize short selling behavior as follows:**

(1) Contrarian hypothesis: Short sellers tend to short

more when stock prices increase and reduce shorting position when stock prices decline. Theoretically, Miller (1978), Harrison and Kreps (1978) and Scheinkman and Xiong (2003) show that when short-sale constraints are binding, stock prices tend to be overvalued and short sellers are exploiting the gap between stock prices and the fundamental value. Empirically, Diether et al. (2009), examining daily shorting flow for 2005, show that US short sellers exhibit contrarian trading behavior with respect to short-term past returns. The contrarian hypothesis suggests a positive relation between short selling activities and past stock returns.

(2) Market-trend follower hypothesis: Investors may follow market trends and buy in a rising market and sell in a falling market (Sentana and Wadhvani, 1992). Jegadeesh and Titman (1993) show that there is a price momentum over a three to twelve month horizon, and that a strategy of buying recent stock price gainers and shorting recent stock price losers can yield an annual abnormal return of 12%. Ali and Trombley (2006) further show that this momentum return is positively related to restricted short selling due to short-sale constraints. A market-trend-followers hypothesis predicts a negative relationship between short selling activities and market returns.

(3) Trading liquidity provider hypothesis: When there is a significant and temporary order-imbalance market-dealers may step in and use short sale order to provide liquidity, when the buying pressure rebalanced, stock prices should fall to fundamental value and provide profits to market-dealers when they cover the short position (Stoll, 1978; Campbell et al., 1993). Diether et al. (2009) find that an unusually high level of short selling is associated with narrower spreads and lower short-term volatility on the NYSE. Diether et al. (2009) provide direct evidence that short-sellers act as a voluntary liquidity providers. The trading liquidity provider hypothesis expects a positive relation between short selling activities and liquidity measures, such as effective spread and stock turnover.

(4) Informed trader hypothesis: Negative private information motivates short selling activities. Diamond and Verrecchia (1987) hypothesize that short sellers are more likely to be sophisticated well-informed investors, and be more likely able to predict future returns of shorted stocks because short selling activities bear more costs and risks than long transaction. Existing literature mostly agree that there is a negative relation between short selling activities and future stock returns (Asquith and Meulbroek, 1996; Senchack and Starks, 1993; Dechow et al., 2001; Desai et al., 2002; and Boehmer et al., 2008, and Diether et al., 2009). Informed trader hypothesis predicts a negative relationship between short selling activities and future stock returns.

(5) Arbitrageur hypothesis: Stocks can be shorted for

Table 1. Summary statistics.

	n	Mean	Stderr*	Median	Min	Max
<b>Panel A: Short activities</b>						
Shorting volume (shares)	1421	348,216	2,124	148,331	100	24,380,685
No. of short transactions	1421	1396	5.54	830	1	45683
Short size (shares)	1421	197	0.28	175	3	2361
Shorting ratio (%)	1421	20.83	0.0003	19.57	0.19	0.98
Shorting ratio2 (%)	1421	0.23	0.06	0.16	0.001	10.49
<b>Panel B: Stock characteristics</b>						
Equity market value (\$ 1,000)	1421	10,383,266	93,073	2,696,492	90,312	527,172,220
Stock price(\$)	1421	41.45	0.13	34.39	5.18	849.00
Trading volume(shares)	1421	2,130,551	15,635	726,500	1,600	201,416,400
Common shares outstanding (1,000 shares)	1421	233,771	1,903	76,292	5,473	10,288,157
Stock price volatility (%)	1421	0.19	0.001	0.11	-0.35	7.01
Spread (%)	1421	3.35	0.007	2.78	0.07	65.63
Turnover (%)	1421	1.18	0.004	0.82	0.02	95.24

\*Stderr" is the standard error. Our balanced panel sample consists of 1421 stocks for 85 trading days. The sample period is from July 02 to October 31, 2007.

arbitrage purposes. For example, convertible arbitrage hedge funds and option market makers might short stocks as part of their hedging strategy, with little concern on if stock is overvalued or not.

## DATA AND SAMPLE

We obtained tick-by-tick short sale data from the NYSE data service for a four-month period from July to October 2007. The data include date, time, the ticker, shorting volume, and short prices for all short sales occurred on the NYSE, and cover an 85-trading-day period from July 2 to October 31, 2007. Obviously, one shortcoming of this data is that the sample period is short. But, this four-month period is important, because this is the only time period when the market is relatively stable after the SEC removed the uptick rule. During our sample period, the S and P 500 return is -1.37%. The stock market began to crash after then. The four-month S and P 500 return is -11.86% from November 2007 to February, 2008; it is -5.1% from March to June 2008; it is -23.3% from July to October 2008; and it is -29.4% from November 2008 to February 2009.

This study focuses on NYSE listed stocks. We limit our sample as all NYSE stocks that appear in the Center for Research in Security Prices (CRSP) data with share code of 10 or 11 (common stock). Daily data on stock returns, prices, shares outstanding, trading volume, bid and asks quote at the closing, and S&P 500 index returns are obtained from CRSP for a period from June 2007 to October 2008. Stocks with less than \$5 prices are likely subject to more short sale restrictions. To minimize the

impact of short sale constraints on our study and conform to the previous literature, we filter the sample by excluding common stocks with prices less than \$5. We then merge NYSE stock data with daily short sale data, resulting in our final sample which consists of 1241 stocks. In addition, we obtain quarterly stock book value data from COMPUSTAT.

Table 1 presents the summary statistics for our sample. Panel A of Table 1 provides descriptive statistics for our daily short selling data. We use four different variables to describe daily short selling activities. The first measure is the shorting volume, which is defined as the total number of shares sold short in a stock on a given day. The second measure is the number of short selling transactions for a stock on a given day. The third measure is short selling ratio, the proportion of share volume associated with short selling for a stock on a given day. The final measure is the short selling ratio 2, the proportion of shares outstanding associated with short selling. Panel A of Table 1 shows that each day on average 348,216 shares (median=148,331 shares) are sold short on a stock. This accounts for 20.83% (median=19.57%) of trading volume. In other words, approximately one in five shares traded on the NYSE involves short selling. In addition, on average, 0.23% (median=0.16%) of common shares outstanding are sold short on a typical trading day.

Panel B of Table 1 summarizes the characteristics of the sample. A typical NYSE stock in our sample has an equity market value of \$10.4 billion, a price of \$41.45, a daily trading volume of 2.13 million shares, and 233 million shares outstanding. Following Diether et al. (2009), stock price volatility is computed as the difference

between day high and day low divided by day high, spread is calculated as the difference between the closing ask quote and the closing bid quote, scaled by stock prices.

**MOTIVES OF SHORT SELLING**

To test the contrarian hypotheses, we follow Diether et al. (2009) and adopt a simple penal regression model to examine the relationship between short selling activities and past stock returns. Short selling activities are measured as the individual stock short selling ratio on day t, and past stock returns are measured as an accumulative return for a five-day period preceding the day of short sales. The regression model is specified as the following:

$$ssr_{i,t} = \alpha + \beta \cdot ret_{i,(t-5,t-1)} + \epsilon_{i,t} \tag{1}$$

Where

$ssr_{i,t}$  is the short selling ratio for the  $i^{th}$  stock during day t,  $ret_{i,(t-5,t-1)}$  is the cumulative stock return for a five day period from day (t-5) to day (t-1) for the  $i$ th stock. The penal regression includes both stock-fixed and day-fixed effects. We expect to find a positive coefficient for this regression.

To test dynamic short selling behavior hypotheses, we use the refined penal regression model that is specified in Equation (2).

$$ssr_t = \alpha + \beta_1 ret_{(t-5,t-1)} + \beta_2 ret_t + \beta_3 ssr_{(t-5,t-1)} + \beta_4 vol_t + \beta_5 vol_{(t-5,t-1)} + \beta_6 spread_t + \beta_7 spread_{(t-5,t-1)} + \beta_8 turnover_t + \beta_9 turnover_{(t-5,t-1)} + \beta_{10} size \tag{2}$$

Where

$ret_{i,t}$  is the contemporaneous stock return,  $ssr_{(t-5,t-1)}$  is the cumulative short selling ratio during a five-day period preceding the short sale day t,  $vol_t$  and  $vol_{(t-5,t-1)}$  are current and past stock price volatilities,  $spread_{i,t}$  and  $spread_{i,(t-5,t-1)}$  are current and past stock level effect spreads, size is the firm size measured as the natural log of equity market value.

To account for the contemporaneous relationship between short selling and stock returns, we include contemporaneous stock return,  $ret_{i,t}$ , in the regression. Blau et al. (2008) document the serial correlation in short

sales. The existence of serial correlation in short sale may distort the empirical results we find in Equation (1). To fix this issue we include past short selling activities, measured as the cumulative short selling ratio during a

five-day period preceding the short sale day t,  $ssr_{(t-5,t-1)}$ , in our regression.

In the periods of high uncertainty, short sellers may step in providing opportunistic risk bearing capacity (Ho and Stoll, 1983; Biais, 1993; Harris and Raviv, 1993). Therefore, we include contemporaneous and past stock

price volatilities,  $vol_t$  and  $vol_{(t-5,t-1)}$ , as proxies of the short-term stock price volatility and recent past stock price volatility in the regression to test if short sellers are bearing opportunistic risk. The stock price volatility is defined as the difference between the stock price day high and day low, scaled by the closing stock price.

Similar to Deither et al. (2009), we also include  $spread_{i,t}$

and  $spread_{i,(t-5,t-1)}$ , current and past stock level effect spreads, to discern if the uncertainty is associated with asymmetric information or with differences of opinions. If the high level of short selling is associated with high volatility and low spreads, then the uncertainty would be associated with differences of opinions (Varian, 1985).

To test the liquidity provider hypothesis, we include the current and recent past stock level turnovers,  $turnover_{i,t}$

and  $turnover_{(t-5,t-1)}$ , to examine the relation between short sales and liquidity. If short sellers act as voluntary liquidity providers suggested by Diether et al. (2009), then we would expect that short selling is positively related to current stock turnover and negatively related to recent past stock turnover. In addition, stock turnover can also be a proxy for the firm-specific information flow, and used to test the informed trader hypothesis.

Previous literature suggests that short sale constraints restrict short selling activities (Chen et al., 2002; Jones and Lamont, 2002; Cohen et al., 2007). Typically, it is easier to short sale stocks in large firms than in small firms. To address this issue, we include the firm size, measured as the log of equity market value, in the regression to account for the short sale constraint effect.

To test for the market trend follower hypothesis, we include both current and past S and P 500 index returns into the regression model specified in Equation (3). The stock-fixed effect is estimated in this regression.

$$ssr_t = \alpha + \beta_1 ret_{(t-5,t-1)} + \beta_2 ret_t + \beta_3 ssr_{(t-5,t-1)} + \beta_4 vol_t + \beta_5 vol_{(t-5,t-1)} + \beta_6 spread_t + \beta_7 spread_{(t-5,t-1)} + \beta_8 turnover_t + \beta_9 turnover_{(t-5,t-1)} + \beta_{10} size + \beta_{11} S \& P_t + \beta_{12} S \& P_{t-5,t-1} \tag{3}$$

Regression results are presented in Columns (1), (2), (3) in Table 2. The coefficient estimated in Column (1) indicates that a 10% increase in five-day period

**Table 2.** Panel regression: The relation between daily short selling activities and past 5-day stock returns.

	shorting ratio(t)		(3)	(4)	shorting ratio 2(t)		abnormal shorting(t)		
	(1)	(2)			(5)	(6)	(7)	(8)	(9)
RET(t-5,t-1)	0.117 (25.3)	0.075 (16.0)	0.081 (16.9)	0.0016 (13.2)	0.0009 (12.4)	0.001 (13.2)	0.596 (26.3)	0.375 (16.5)	0.403 (17.3)
RET(t)		0.158 (17.0)	0.12 (12.6)		0.0023 (16.1)	0.0019 (12.6)		0.868 (19.2)	0.689 (14.8)
SSR (t-5,t-1)		0.097 (100.8)	0.098 (102.5)						
SSR2 (t-5,t-1)					0.106 (110.6)	0.106 (112.4)			
ABSS (t-5,t-1)								0.095	0.096
VOL (t)		0.174 (12.5)	0.081 (6.1)		0.009 (43.0)	0.009 (44.3)		0.909 (13.4)	0.497 (7.7)
VOL(t-5,t-1)		-0.036 (-7.13)	-0.053 (-12.5)		-0.0014 (-16.9)	-0.0017 (-26.2)		-0.182 (-7.31)	-0.27 (-13.0)
spread(t)		-0.09 (-1.46)	-0.069 (-1.09)		-0.00006 (-0.06)	0.001 (0.97)		-0.358 (-1.19)	-0.254 (-0.81)
spread(t-5,t-1)		-0.065 (-2.31)	-0.031 (-1.08)		-0.00064 (-1.44)	-0.0003 (-0.58)		-0.312 (-2.29)	-0.135 (-0.96)
turnover(t)		-0.982 (-41.7)	-1.025 (-42.4)		-0.116 (311.8)	-0.1165 (308.8)		-4.983 (-43.5)	-5.18 (-43.8)
turnover(t-5,t-1)		0.15 (20.2)	0.141 (18.3)		0.011 (60.8)	0.011 (60.9)		0.74 (20.0)	0.685 (18.1)
SIZE		-0.004 (-1.44)	0.0003 (0.91)		0.0003 (0.68)	0.0004 (1.05)		-0.003 (-0.25)	0.013 (0.96)
S and P 500(t)			-0.947 (-45.1)			-0.013 (-40.2)			-4.711 (-45.8)
S and P 500(t-5,t-1)			-0.259 (-22.0)			-0.005 (-28.4)			-1.324 (-23.0)
R square	0.909	0.919	0.785	0.742	0.909	0.682	0.116	0.212	0.14
stock fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
day fixed effects	Yes	Yes		Yes	Yes		Yes	Yes	

accumulative stock return results in an increase in short selling ratio by 1.17% points (or a 6.8% increase in short sale volume). The result here is consistent with the hypothesis that short sellers are trading on short-term stock overvaluation.

Results of regression based on Equation (2) are presented in Column (2) in Table 2. There are several important findings. Firstly, short selling activities are auto-correlated; a high level of short selling tends to persist in the short-run. This finding is consistent with Blau et al. (2008). Secondly, after controlling for autocorrelation in short selling, the coefficient of past stock return remains positive and significant, confirming that short seller are contrarians who short more when stock price increases. Thirdly, short selling is positively correlated with contemporaneous stock price volatility. By contrast, past volatility is negatively correlated to short selling. We infer that instead of bearing opportunistic risk as suggested by

Diether et al. (2009), short sellers may utilize short selling as a means of volatility arbitrage. Specifically, arbitrageurs construct a hedging strategy consisting of a long position in call options and a short position in stocks when stock price volatility is low. When price volatility increases as they expect in the future, arbitrageurs sell call options for profit and cover the short position in stocks.

We run regressions of daily short selling activities on stock five-day cumulative past return and other control variables. We use three difference measures for short selling activities. The first one is shorting ratio, the ratio of daily short sales to daily trading volume. The second measure is shorting ratio 2, the ratio of daily short sales to the number of common shares outstanding. The third one is the abnormal shorting, measured as the ratio of daily short sales to the average daily short sales minus one. Two-way fixed effects are estimated for regressions in Columns of [1] and [2]. One-way fixed effects are

**Table 3a.** Hypotheses testing results summary.

Hypothesis	Proxy	Expected sign	Coefficient sign	Results
Contrarian hypothesis	ret (t-5,t-1)	+	+	supportive
	ret(t)	+	+	
Liquidity provider hypothesis	spread (t-5,t-1)	+	N/A	not supportive
	spread(t)	+	-	
Informed trader hypothesis	turnover(t-5,t-1)	+	+	supportive
Arbitrageur hypothesis	vol(t-5,t-1)	-	-	supportive
	vol(t)	+	+	

estimated for regressions in Columns of [3]. Our balanced panel sample consists of 1241 stocks for 81 trading days. The sample period is from July 02 to Oct 31 2007. The t-statistics are adjusted for autocorrelation using the Newey-West (1987) procedure and are presented in parentheses.

Fourth, results provide mixed evidence for our liquidity provider hypothesis; while short selling is positively related to the current effective spread, it is negatively related to past effective spread. We explain this as the natural consequence of the removal of the uptick rule. When the uptick rule is bidding, short sales are constrained, leading to the buy-order-imbalance. Market-dealers step in the market and use unrestricted (uptick rule exempt) short selling order as a means to provide liquidity and facilitate trading. In our sample period, the uptick rule no longer restrains short selling. Therefore, the liquidity demand for market dealer to submitting exempt short selling order reduced significantly, resulting in an ambiguous relationship between short selling and liquidity.

Fifth, the coefficient on past stock turnover is negative, indicating that short selling has information content because we use stock turnover as a proxy for firm-specific information flows. This provides evidence that short sellers are trading on the firm information flows.

When we use S and P index returns as the benchmark of market returns in our analysis, as shown in column of Table 2, we find that short selling is negatively related to both past and current market returns. Specifically, a 10% decline in S and P index during a five-day period prior to the short sale day results in an increase in short selling ratio of 2.57% points (or 12.85% increase in short selling volume). More importantly, the effect of the contemporaneous market return on short selling is strikingly greater than we expected. A 10% decline in contemporaneous S and P index is related to 9.4 points increase in short selling ratio (or 47% increase in short selling volume). Results here clearly show that short sellers follow market trends; when the market declines short seller increase their short selling, supporting our market trend follower

hypothesis.

As a robustness test, we use two alternative short selling measures, shorting ratio 2 and abnormal shorting ratio, to run the regression. Results are presented in columns from (4) to (9) in Table 2, and are similar to what we find previously. Regression results are summarized in Table 3a.

## STOCK RETURN FORECASTING POWER OF SHORT SALES

Previous studies suggest that short sellers are informed traders because they have capabilities of forecasting future negative stock returns. For example, Seneca (1967) finds that market wide short interest leads to lower returns for the S and P 500. Figlewski (1981) finds that short interests are negatively related to future excess returns by sorting stocks into portfolios based on monthly short interests. Further, Senchark and Starks (1993) find the short-term abnormal stock returns followed abnormal short interests. More recently, Diether et al. (2009) show that a trading strategy based on daily short-selling activities generates significant positive return. We cannot determine directly whether short sellers' trades are profitable. However, we can test the profitability of short selling by adopting a calendar portfolio approach, in which we create a long-short trading strategy based on past short selling activities. The calendar portfolio approach has been widely used in the literature to examine the relation between short selling activities and stock returns. (Diether et al., 2002; Boehme et al., 2008). The calendar-time portfolio approach is less susceptible to the misspecified model problem in the context of cross-sectional dependence among stocks.

The disadvantage of the calendar portfolio method is the choice of the stock returns period. Previous studies using monthly short interest have been unable to investigate the short-term dynamics on how stock overvaluation is corrected as uncertainty resolves over time. Indeed, previous literature that calculates one month or one year

**Table 3b.** Calendar portfolio approach (value weighted, skip one-day, shorting ratio -5, 1).

Holding period	Low (%)	2 (%)	3 (%)	4 (%)	High (%)	(L-H) (%)	t-value	Monthly return (%)
1-day	-0.01	0.00	-0.01	-0.04	-0.02	0.01	0.07	0.28
1-week	-0.13	-0.08	-0.24	-0.34	-0.29	0.17	0.44	0.70
2-weeks	-0.38	-0.22	-0.72	-0.89	-0.69	0.31	0.41	0.65
1-month	-1.01	-0.21	-1.02	-1.33	-1.21	0.20	0.15	0.20
3-month	-2.93	-1.26	-2.56	-3.47	-4.40	1.48	1.93	0.49
6-month	-10.44	-6.01	-6.90	-8.34	-9.77	-0.67	-1.24	-0.11
1 year	-22.10	-16.71	-17.34	-16.99	-16.28	-5.82	-3.85	-0.49

portfolios' returns yields conflicting results. For example, Boehme et al. (2006) find that during the period 1988-2002, the monthly holding period abnormal returns for stocks with the most short sale constraints and opinion dispersion are significantly negative. In contrast, covering the period from 1983 to 2001 and using similar proxies for short sale constraints and dispersion, Doukas et al. (2006) adopt a similar monthly holding period portfolio construction approach, but fail to draw a significant statistical inference for negative abnormal returns for high-dispersion stocks.

To conduct the holding period dynamic analysis based upon the calendar-time portfolio approach, each day, we sort stocks in our sample into five quintiles based upon previous five-day short selling activities. We then allow one day to constructing the portfolios. Skipping one day can also help to mitigate the problem induced by bid-ask bounce in CRSP data (Kaul and Nimalendran, 1990). We then compute size and book-to-market adjusted returns based on the standard 25 value-weighted portfolios (Fama and French, 1993) for each portfolio. To compute returns for these 25 standard value-weighted Fama-French portfolios, we first sort stocks by the market value of equity and book to market ratios on the first day of 2007. Next, we use the market value and book-to-market ratio breakpoints to allocate all CRSP stocks into the market value deciles and book-to-market quintiles. We then form 25 size and book-to-market portfolio using all stocks with lagged prices greater than or equal to \$5.

Here we distinguish two types of short sellers by using two measures of short selling activities: short sale ratio and abnormal short sale ratio. While short sale ratio measures general short selling activities, the abnormal short sale ratio measures the change in short selling activities and represents information-driven short sales. For example, Christophe et al. (2004) show that short selling has information content of forthcoming earnings announcements. Moreover, Christophe et al. (2008) and Zhao and Daves (2008) find that abnormal short selling is motivated by forthcoming analyst recommendation downgrades.

The results are presented in Table 3b. In contrast to Deither et al. (2009) that find economically significant monthly return based on the identical portfolio

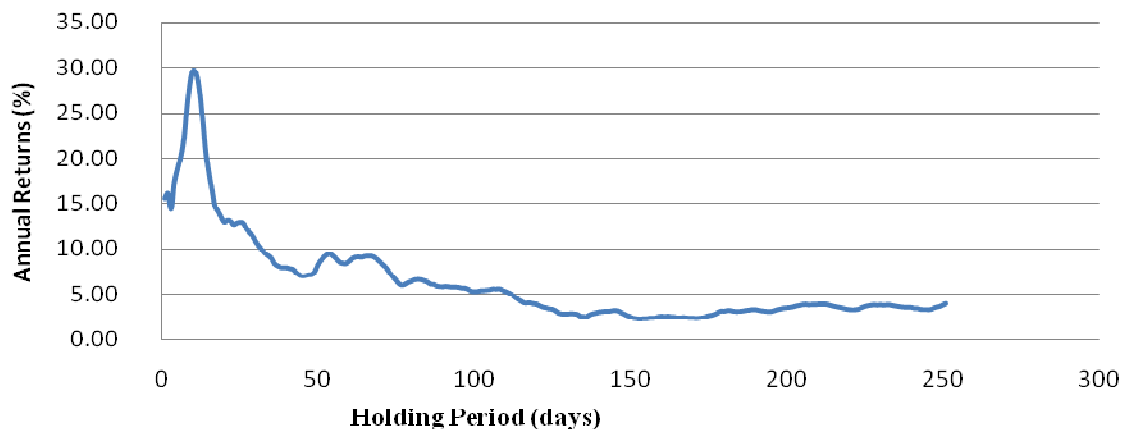
constructing method, we show that a hedging portfolio consisting of a short position in most heavily shorted stocks and a long position in least heavily shorted stocks is not profitable across all holding periods from one day to one year. This surprising results show that generally short sellers are not capable of forecasting future negative stock returns after exploring different portfolio holding periods during our sample period. However, we should be cautious interpreting the results because our sample period is short. The results shown here may be pure accidental and should not be generalized to other longer period.

Indeed, short sellers are not alike. It is more likely that informed traders have more chance to forecast the future negative returns. To explore this possibility, we use abnormal short selling ratio in our portfolio approach analysis. Previous literature establishes a strong link between abnormal short selling and various form of information. For example, Christophe et al. (2004) show that abnormal short selling has forthcoming earnings announcement information. Similarly, Fransic et al. (2008) and Zhao and Daves (2009) show that abnormal short selling contains forthcoming buy-side analyst recommendation change information. Abnormal portfolio returns based on abnormal short selling activities are presented in Table 4. It shows that the long-short portfolio strategies built upon the past abnormal short selling activities are able to generate statistically significant returns for holding periods longer than 2 weeks. Unfortunately, returns on most of those strategies are not economically significant. The exception is a strategy with a two-week holding period, which can generate a 2.2% monthly return (or 25% annual return).

The average return on our two-week holding period long-short strategy seems very attractive. Yet, our sample period is short; it only lasts for four month. Back-testing with a longer sample period is required to test the feasibility of this strategy. Another concern is that rebalancing and transaction costs, along with the significant costs of short selling, may wipe out the seemingly attractive profit. Based the estimation in Cohen et al. (2007), the transaction and rebalancing costs would be roughly 0.64% per month. Diether et al. (2009) consider additional short selling costs and estimate that the costs

**Table 4.** The calendar portfolio approach (value weighted, skip one-day, abss05).

Holding period	Low (%)	2 (%)	3 (%)	4 (%)	High (%)	(Low-High) (%)	t-value	Monthly returns (%)
1day	0.03	0.00	0.01	-0.05	-0.03	0.06	0.30	1.22
1 week	-0.06	-0.10	-0.14	-0.21	-0.40	0.34	1.37	1.45
2 weeks	-0.13	-0.30	-0.34	-0.48	-1.17	1.04	3.53	2.20
1 month	-0.73	-0.35	-0.48	-0.57	-1.76	1.03	3.08	1.04
3 month	-2.14	-1.69	-2.19	-2.34	-4.33	2.19	5.85	0.73
6 month	-8.68	-7.73	-7.67	-7.82	-10.32	1.64	4.05	0.28
1 year	-17.50	-18.32	-18.27	-18.64	-21.38	3.88	8.90	0.32

**Figure 1.** Low-High Portfolio Annual Returns for Different Holding Period Strategies

would be 1.35% per month. Thus, the success of this two-week holding period long-short strategy relies on the success of transaction costs management.

Figure 1 shows the annual return profile for the low-high portfolio with different holding period ranging from one day to one year. It suggests that the portfolio return increases with holding period until it reaches ten trading days or two weeks, then it declines quickly to a low level.

## CONCLUSIONS

In this paper we examine a variety of short seller behaviors during a period from July to October 2007, during which short sales were unleashed when the uptick rule permanently removed the SEC. Our tests yield a couple of interesting findings. Firstly, short sellers are not all alike. Short sellers represent a much more diversified investor group than we previously thought. They are market trend followers who short more when the market declines; they are contrarians who short more following negative past returns; they were liquidity providers, with no intention to profit from the shorting position; they may be relative-value traders focusing on outperforming stocks when the market is trending down; they are

information driven traders who are taking advantage of various type of private information. Secondly, not all short selling activities have the capability of forecasting future negative stock returns. Thirdly, when we construct hedging portfolio based upon abnormal short selling activities, we find that the strategy with the holding period of two weeks can deliver a meaningful monthly return of 2.2% (or an annual return of 25%), suggesting that information-driven short selling are able to forecast future stock returns up to two weeks. After considering rebalancing and transaction costs, this strategy remains profitable.

Despite ample evidence we generated in revealing who short sellers were and what they were doing when the uptick rule was revoked by the SEC, little has been said on whether unleashed short selling contributed to the stock market collapse during a period from November 2007 to February 2009. Furthermore, comparing our results with Diether et al. (2009), the major differences are:

- (1) Short sellers no longer play the role of liquidity providers.
- (2) Short sellers act more like market trend followers than contrarians.
- (3) Short sellers as an aggregated entity are not able to



forecast future returns.

Are these discrepancies caused by the removal of the uptick rule or other unknown factors? Future studies addressing these issues would certainly yield fruitful outcomes that are not only valuable to the academia but also important to regulators and policy makers.

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