11-2019

The trend in short selling and the cross section of stock returns

Zhaobo ZHU

Xinrui DUAN

Jun TU
Singapore Management University, tujun@smu.edu.sg

ANNALS OF ECONOMICS AND FINANCE **20-2**, 565–586 (2019)

The Trend in Short Selling and the Cross Section of Stock Returns

Zhaobo Zhu, Xinrui Duan, and Jun Tu*

This paper documents that stocks with a decreasing (increasing) trend in their short selling as proxied by the long-term change in short interest experience significant and positive (negative) abnormal returns. Moreover, the positive abnormal returns have larger absolute values and are more persistent. The return predictability of the trend in short selling is not subsumed by the level of short interest and other well-known determinants of stock returns. Investor sentiment does not affect the profitability of the trend strategy. Our results suggest that market participants underreact to public information on short interest and that short sellers are sophisticated investors.

Key Words: Short selling; Short interest; Underreaction; Short-Sale constraints.
JEL Classification Numbers: G11, G12, G14.

1. INTRODUCTION

The existing literature argues that short sellers are informed and sophisticated investors whose shorting activities provide information about future stock returns. Two strands of empirical studies on short interest provide some empirical evidence. The first and most popular empirical strand is that the high short interest predicts the subsequent negative returns (e.g., Desai et al. (2002) and Asquith, Pathak, and Ritter (2005)). These empirical studies are mainly motivated by Miller (1977), who argues that the combination of short-sale constraints and heterogeneous investor beliefs could lead to stock overpricing that generates low subsequent returns. The high level of short interest is used as a proxy for the binding

* Zhu: Shenzhen Audencia Business School, Shenzhen University, Shenzhen, China. Email: zb.zhu@szu.edu.cn; Duan: Corresponding author. Shenzhen Audencia Business School, Shenzhen University, Shenzhen, China. Email: xrduan@szu.edu.cn; Tu: Corresponding author. Lee Kong Chian School of Business, Singapore Management University, Singapore. Email: tujun@smu.edu.sg. We thank the seminar participants at Old Dominion University, Xian Jiaotong University, and Shenzhen University and Min Chen at San Francisco State University for their helpful comments.

1529-7373/2019

short-sale constraints in these studies. In addition, Boehmer, Huszar, and Jordan (2010) show that low short interest predicts positive abnormal returns, though they argue that short-sale constraints and limits to arbitrage cannot explain the good news in low short interest. This strand focuses on the return predictability of the level of short interest.

The second strand is motivated by Diamond and Verrechia (1987) who develop a rational expectation model in which rational investors already consider the effects of short-sale constraints on stock prices. They argue that, on average, stock prices are correct in the equilibrium and that an unexpected large increase in short interest signals bad news that is associated with low subsequent returns. Senchack and Starks (1993) provide some empirical evidence on the return predictability of the negative shock in short interest. Other related studies also show that an increase in short interest is related to subsequent unfavorable corporate announcements or firm fundamentals (e.g., Christophe, Ferri, and Angel (2004), Karpoff and Lou (2010), and Deshmukh, Gamble, and Howe (2015)). This strand focuses on the return predictability of the negative shock in short interest.

This paper contributes to the literature by generalizing the return predictability of the trend in short selling proxied by the long-term change in short interest. We show that the trend (long-term change) in short interest contains the incremental predictive information on returns beyond the current level of short interest in the cross section. Moreover, previous empirical studies such as Senchack and Starks (1993) focus on the return information contained in the short-term negative shocks in short interest during two consecutive announcements in a small sample of stocks. We differ from them because we focus on the return information contained in the long-term trend in short interest. In addition, we are more interested in the asymmetric return predictability of positive and negative trends in short selling because the asymmetry presents important implications.

The following simple and intuitive example illustrates that the level of short interest provides an incomplete picture of future stock returns and that the trend in short interest provides incremental predictive information. Consider two stocks with similar current levels of short interest but with different paths of short-selling activities over the previous year. Stock A experiences increasing short-selling activities due to more severe competition in its industry or a worse industrial environment. In contrast, stock B experiences decreasing short-selling activities due to its increasing competitive advantage in its industry or an improving industrial environment. The recent path of short-selling activities could reflect the change in a firm's fundamentals in a dynamic economic environment, which determines the future stock price. If we only consider the current level of short interest, we ignore the trend in short-selling activities. Then, we would ignore the improving prospects for firm B and the worse fundamentals for firm A.

In this case, we would expect stock B to outperform stock A because of the improving fundamentals after controlling for the current level of short interest.

The empirical results of this paper show that NYSE/AMEX stocks with large increases (decreases) in short interest over the past 1-year experience significant and negative (positive) abnormal returns. Significant positive abnormal returns generated by stocks with decreasing trends in their short selling are persistent in the subsequent three years, while negative abnormal returns generated by stocks with increasing trends in their short selling are significant only in the subsequent seven months. Specifically, stocks in the bottom (top) decile of the trend in short interest over the previous one year generate a significant average monthly return of 0.52% (−0.32%) after controlling for market returns, size, book-to-market ratio, and the momentum effect. The long-short strategy generates an average monthly risk-adjusted return of 0.84% ($t = 5.11$). Moreover, the relationship between the magnitude of the change in short interest and the magnitude of the cross-sectional stock returns is almost monotonic. The absolute value of the positive abnormal return of the bottom decile is often larger than the negative abnormal return of the top decile.

The return predictability of the trend in short selling is not subsumed by the recent level of short interest and other well-known return determinants such as size, book-to-market ratio and the momentum effect. The return spread of the long-short hedge portfolio is particularly large among small stocks, both value and growth stocks, and both past winners and past losers. The return predictability is robust based on the different formation and holding periods, price screens, microstructural concerns, and different measures of the change in short interest. Moreover, the hedge portfolio generates statistically and economically significant positive abnormal returns in nine among twelve calendar months.

Finally, we examine the effect of investor sentiment as a proxy for the systematic mispricing on this short-selling strategy. Stambaugh, Yu, and Yuan (2012) document that most market anomalies are more profitable following high sentiment periods in which most profits arise from short legs. In contrast, we find that this new short-selling strategy is not affected by investor sentiment. Moreover, the trend strategy seems more profitable following low sentiment periods, though the outperformance is not significant. These results suggest that short sellers are sophisticated investors who consider the effect of investor sentiment when they make shorting decisions. In addition, the results suggest that the trend strategy could provide a great hedge or complement to other anomaly-based strategies.

This paper makes several significant contributions to the literature and has several important practical implications. First, we are the first to systematically document a significant return predictability of the trend in

short selling proxied by the long-term change in short interest in the cross section. Second, in contrast to the asymmetry in other anomalies, stocks with decreasing trends in their short selling (the long leg) generate higher absolute value abnormal returns than stocks with increasing trends in their short selling (the short leg). The short-sale constraints and limits to arbitrage seem to fail to explain the large and persistent positive abnormal returns generated by the long-leg. The positive information seems to be incorporated into stock prices more slowly than the negative information. Though we do not explore this issue in this paper, these results show that short sellers have the ability to avoid shorting underpriced stocks. Third, the robustness of the return predictability of this trend strategy in different calendar months, following investor sentiment periods, and in the recent decade suggests that the information contained in the trend in short interest provides a great hedge or complement to other anomaly-based strategies. Professional investors would benefit from considering the incremental predictive information contained in the trend in short selling when constructing equity portfolios.

2. DATA AND METHODOLOGY

2.1. Data

The monthly short interest data for the stocks listed in NYSE/AMEX/NASDAQ are from Compustat. The sample period for the NYSE/AMEX stocks is from January 1988 to December 2014. The sample period for NASDAQ stocks is from July 2003 to December 2014 because Compustat does not cover short interest data for NASDAQ stocks before July 2003. In the main analysis of this paper, we use the NYSE/AMEX short interest data because of the longer sample period. NADSAQ short interest data are used in robustness tests. The short interest for a specific stock in month t is the number of uncovered shares that are sold short around the 15th of each month. The short interest ratio (SIR_t) in month t, which is called the normalized short interest, refers to the ratio of short interest to the total shares outstanding in month t. The normalized short interest (SIR) is used to minimize the potential bias caused by the firm size.

The sample consists of only common stocks (with a share code of 10 or 11 in the CRSP) listed on the NYSE, AMEX, and NASDAQ. We exclude stocks without monthly short interest data. Data about stock prices, the number of shares outstanding, and the trading volume are from the CRSP. The financial variables used to calculate book-to-market ratios are from Compustat. We also exclude stocks that are less than \$1 (\$5) at the end of the formation period in the main analysis (the robustness test).

2.2. The Measure of the Trend in Short Selling

We use the cumulative percentage changes in the short interest ratios in a given time period to measure the short selling trend (SST):

$$SST_{t-j:t} = \sum_{t,t-j}^{j} \frac{SIR_t - SIR_{t-1}}{SIR_{t-1}} \tag{1}$$

where SST refers to the long-term change in short interest, which is the cumulative growth rates in the short interest ratio over the past j months; and j is the length of the formation period.

We construct the SST measure in this way based on two main reasons. First, this trend measure tries to capture the information in each short period in the whole formation period. Thus, we calculate the percentage change in the short interest in each period and then summarize them. A simple $\%\Delta SIR\left(\frac{SIR_t - SIR_{t-j}}{SIR_{t-j}}\right)$ could be noisy. Da, Gurun, and Warachka (2014) document a significant effect of continuous information in momentum. The SST follows their reasoning. Second, when capturing the short-term change in short selling for each period, our SST adopts the percentage change in short interest rather than the simple difference between the SIR_t and $SIR_{t-1}(\Delta SIR)$. Compared to the simple difference in the SIR, the percentage change in short interest seems more reasonable because it captures more information. For example, if stock A's SIR increases from 2% to 4% and stock B's SIR increases from 1% to 3%, the increases in the short interest for both stocks are 2% based on the simple difference in the SIRs. However, stock A experiences a 100% increase in its SIR and stock B experiences a 200% increase in its SIR based on the %?SIR. Intuitively, stock B experiences more severe short sales than stock A based on the $\%\Delta SIR$.

3. THE TREND IN SHORT SELLING AND THE CROSS SECTION OF STOCK RETURNS

3.1. Portfolio Analysis

3.1.1. Univariate Analysis

Following the portfolio method in Jegadeesh and Titman (1993), we sort the NYSE/AMEX stocks equally into ten groups each month based on the magnitude of the SST defined above. The stocks in the top (bottom) SST decile experience the largest (smallest) magnitudes of cumulative positive changes in short interest over the past 12 months. We do not skip one month between the formation period and the holding period because the latest short interest data is available to many investors (especially institutions) around the middle of each month and portfolios are formed at the end of each month. However, we skip one month in the robustness test.

In the main analysis, the long-leg and short-leg portfolios are held for one month.

Table 1 reports the average equally weighted monthly raw returns and Fama-French-Carhart alphas for these portfolios. There are four interesting empirical findings. First, the stocks in the bottom SST decile generate significant positive average abnormal returns of 0.52% ($t = 3.15$) in the subsequent one month. Second, the stocks in the top SST decile generate significant negative average abnormal returns of -0.32% ($t = -2.86$) in the subsequent 1 month. Third, the long-short strategy that buys the bottom decile and sells the top decile generates an average monthly risk-adjusted return of 0.86% ($t = 5.11$). Fourth, the relationship between the magnitude of the trend in short interest and the magnitude of the cross-sectional stock returns is almost monotonic.

These empirical results suggest that the market seems to underreact to information contained in public short interest data. The positive information seems to be incorporated into stock prices more slowly than negative information. This asymmetric speed of price adjustment seems to contradict the implication of short-sale constraints. In addition, the significant and persistent positive abnormal returns from the long leg also contradict the implication of the limits to arbitrage proposed by Shleifer and Vishny (1997). The limits to arbitrage cannot explain the persistent and positive abnormal returns. Interestingly, the persistent and positive abnormal returns generated by stocks with large decreases in short interest complement "the good news in low short interest" in Boehmer et al. (2010), though the decrease in short interest differs from the low short interest. The predictive information contained in the trend in short interest is not contrary to the market efficiency. The return predictability of the trend in short selling provides some new evidence that short sellers have the ability to avoid shorting underpriced stocks and to target overpriced stocks.

3.1.2. Controlling for Other Variables

In this subsection, we use two-way sorting to examine the return predictability of the trend in short interest, controlling for other well-known determinants of stock returns such as firm size, book-to-market ratio, the momentum effect, and the level of short interest (Fama and French, 1992; 1996; Asquith et al., 2005). For example, when we examine the size effect, we first sort stocks into quintiles each month based on their market capitalizations at the end of the prior month. Then, we sort stocks into quintiles

TABLE 1.

The Trend in Short Selling and Stock Returns: Univariate Sorting

Portfolio	Raw	CAPM	FF3	FF4
1	1.40	0.56	0.38	0.52
	(4.38)	(2.84)	(2.45)	(3.15)
2	1.33	0.41	0.19	0.35
3	1.15	0.22	0.02	0.16
4	1.22	0.29	0.1	0.24
5	1.18	0.25	0.07	0.17
6	1.16	0.24	0.07	0.17
7	1.06	0.13	−0.05	0.09
8	1.01	0.05	−0.14	−0.01
9	0.85	−0.1	−0.3	−0.17
10	0.74	−0.26	−0.49	−0.32
	(2.07)	(−1.37)	(−4.01)	(−2.86)
1-10	0.66	0.82	0.87	0.84
	(4.32)	(5.37)	(5.68)	(5.11)

This table presents average monthly raw and risk-adjusted returns for portfolios of stocks sorted on the trend in short interest (SST) over past 1-year. Each month, common stocks listed in NYSE/AMEX are first sorted in ascending order based on their past 12-month cumulative percentage changes in short interest. We then assign these sorted stocks into deciles. The top (bottom) decile includes stocks with the largest (smallest) magnitudes of cumulative percentage changes in short interest ratio. The top decile is the buy portfolio (Portfolio 1). The bottom decile is the sell portfolio (Portfolio 10). Each portfolio is held for 1-month and portfolio returns are equally weighted. We exclude stocks with prices less than $1 at the end of formation period. Fama-French-Carhart 4-factors are market premium, firm size, book-to-market ratio, and momentum. Average returns are presented in percentages. The Newey-West (1987) t-statistics are in parentheses. The sample period is from January 1988 to December 2014.

based on their changes in short interest within each size quintile to form 25 (5x5) portfolios.[1]

Panel A of Table 2 reports the average monthly raw returns for 25 portfolios and the raw and risk-adjusted returns for the long-short portfolios based on the SST while controlling for the stock's market capitalization (size effect). The empirical results show that the long-short portfolio based

[1]We get similar results when two-way independent sorting is used.

TABLE 2.

The Trend in Short Selling and Stock Returns: Controlling for Other Variables

Panel A: Controlling for Firm Size								
	SST					Raw	FF3	FF4
Size	1	2	3	4	5	1-5	1-5	1-5
1	1.40	1.26	1.07	1.01	0.45	0.95	1.21	1.07
						(3.91)	(5.30)	(4.67)
2	1.21	1.29	1.36	1.20	0.96	0.25	0.38	0.19
						(1.34)	(2.27)	(1.05)
3	1.48	1.23	1.16	1.16	1.05	0.43	0.57	0.43
						(2.96)	(4.32)	(2.92)
4	1.22	1.19	1.01	0.95	0.27	0.27	0.38	0.23
						(1.89)	(2.96)	(1.56)
5	1.07	1.14	1.01	1.03	0.74	0.33	0.47	0.32
						(2.54)	(3.61)	(2.36)
Panel B: Controlling for Book-to-Market Ratio (BM)								
	SST					Raw	FF3	FF4
BM	1	2	3	4	5	1-5	1-5	1-5
1	1.14	1.05	0.92	0.89	0.47	0.67	0.69	0.71
						(3.88)	(4.00)	(3.91)
2	1.13	1.07	1.18	1.10	0.82	0.31	0.43	0.39
						(2.45)	(2.68)	(2.35)
3	1.38	1.21	1.21	1.09	1.13	0.25	0.37	0.33
						(1.67)	(2.49)	(2.34)
4	1.35	1.19	1.40	1.10	1.15	0.20	0.30	0.24
						(1.25)	(1.85)	(1.50)
5	1.74	1.63	1.53	1.33	1.20	0.55	0.83	0.75
						(2.29)	(3.59)	(3.02)

on SST generates economically and statistically significant profits in at least three size groups. For example, using two-way dependent sorting, the hedge portfolio generates an average raw return of 0.95% per month ($t = 3.91$) among the smallest stocks and an average raw return of 0.33% per month ($t = 2.54$) among the largest stocks. The 3-factor alphas for these hedge portfolios are significant at 1.21% and 0.47%, respectively, among the smallest and largest stocks. Then, the return predictability of the SST is not limited to small stocks.

Panel B of Table 2 reports returns for these hedge portfolios based on the SST and controlling for the book-to-market ratio. The empirical results show that the long-short hedge portfolio earns economically and statisti-

TABLE 2—*Continued*

Panel C: Controlling for Past 6-month Returns (Momentum)								
	SST					Raw	FF3	FF4
MOM	1	2	3	4	5	1-5	1-5	1-5
1	1.35	1.18	1.38	0.99	0.52	0.84	1.05	0.92
						(3.71)	(4.35)	(3.59)
2	1.13	1.30	1.25	1.14	0.91	0.22	0.29	0.30
						(1.50)	(2.04)	(1.89)
3	1.22	1.22	1.14	1.09	0.96	0.26	0.30	0.25
						(1.94)	(2.12)	(1.76)
4	1.19	0.96	1.00	0.93	0.91	0.28	0.37	0.37
						(1.94)	(2.48)	(2.39)
5	1.65	1.06	1.18	0.99	0.87	0.78	0.87	0.96
						(4.40)	(4.72)	(5.18)
Panel D: Controlling for the Level of Short Interest (SIR)								
	SST					Raw	FF3	FF4
SIR	1	2	3	4	5	1-5	1-5	1-5
1	1.41	1.47	1.22	1.34	1.12	0.29	0.28	0.32
						(1.68)	(1.62)	(1.72)
2	1.38	1.16	1.42	1.15	0.92	0.46	0.37	0.46
						(3.10)	(2.71)	(3.00)
3	1.40	1.16	1.24	1.08	1.00	0.41	0.33	0.38
						(3.32)	(2.27)	(2.55)
4	1.21	1.09	1.21	1.01	0.98	0.23	0.14	0.23
						(1.41)	(0.93)	(1.46)
5	0.94	0.78	0.87	0.64	0.53	0.41	0.36	0.43
						(2.16)	(1.81)	(2.02)

cally significant alphas in at least four BM groups. Moreover, the return predictability of the SST is the strongest among value and growth stocks. Panel C of Table 2 reports the results after controlling for the momentum effect. Similar to the results in Panel B, the hedge portfolio generates significant returns in at least four momentum groups. Moreover, the return predictability is the strongest in past winner and loser quintiles. These results suggest that the return predictability of the SST is not subsumed by the traditional well-known determinants of stock returns such as firm size, BM ratio, and momentum.

Last, we examine whether the return predictability of the SST is subsumed by the recent level of short interest. Panel D and E of Table 2 report the results. Panel D shows that the hedge portfolio based on the SST generates positive and significant raw returns at the 5% significance level in

TABLE 2—*Continued*

Panel E: Controlling for the Trend in Short Interest (SST)

	SIR					Raw	FF3	FF4
SST	1	2	3	4	5	1-5	1-5	1-5
1	1.44	1.38	1.35	1.29	1.37	0.07	0.53	0.46
						(0.28)	(2.61)	(2.24)
2	1.24	1.21	1.27	1.29	0.91	0.33	0.73	0.54
						(1.42)	(3.82)	(2.72)
3	1.32	1.30	1.19	1.13	0.89	0.43	0.82	0.65
						(1.97)	(4.65)	(3.64)
4	1.12	1.14	1.13	0.97	0.80	0.32	0.72	0.53
						(1.41)	(3.92)	(2.81)
5	0.89	0.94	0.91	0.74	0.49	0.40	0.80	0.59
						(1.59)	(3.95)	(2.88)

This table presents average monthly raw and risk-adjusted returns for portfolios of stocks double-sorted on the trend in short interest (SST) over past 1-year and other four well-known variables (size, book-to-market ratio, momentum, and the level of short interest). For the dependent sorting, each month, stocks are first sorted into quintiles based on one of four variables; then within each variable quintile, stocks are further sorted into quintiles based on the SST. The 25 double-sorted portfolios are held for 1-month. All portfolio returns are equally weighted. Fama-French 3-factor and 4-factor alphas are also presented for the long-short portfolios. We exclude stocks with prices less than $1 at the end of formation period. Average returns are presented in percentages. The Newey-West (1987) t-statistics are in parentheses. The sample period is from January 1988 to December 2014. Panel A controls for size (market capitalization); Panel B controls for book-to-market ratio (BM); Panel C controls for past 6-month cumulative returns (momentum); Panel D controls for current level of short interest. Panel E controls for the trend in short interest.

three SIR quintiles and the 10% significance level among lightly shorted stocks. The results are robust after controlling for the market, size, book-to-market ratio, and momentum. In contrast, Panel E shows that the raw returns of the long-short hedge portfolio based on the SIR is significant in only one out of five SST quintiles, though the alpha spreads are significant in all quintiles. Overall, these striking results indicate that the long-term change in short interest contains incremental predicative information on returns beyond that in the level of short interest.

3.2. Fama-MacBeth Regression Analysis

The portfolio analysis indicates that the long-term change in short interest contains incremental return predicative information beyond the level of short interest. However, the portfolio analysis cannot control for several significant variables simultaneously due to the insufficient number of

stocks after N-way independent or dependent sorts. Fama-MacBeth (1973) regressions allow us to examine the significance of the change in short interest after controlling for several important variables simultaneously. In this section, we run the following monthly firm-level cross-sectional Fama-MacBeth (1973) regression:

$$\begin{aligned} R_{i,t+1:t+k} \;=\; & a + b1 \times MOM_{i,t-1} + b2 \times \log(Size_{i,t-1}) \\ & + b3 \times \log(BM_{i,t-1}) + b4 \times SIR_{i,t-1} + b5 \times SST_{i,t-1} \\ & + b6 \times TO_{i,t-1} + b7 \times IO_{i,t-1} + b8 \times REV_{i,t} + \varepsilon_t \end{aligned} \tag{2}$$

Table 3 reports the average estimated coefficients of these variables from the Fama-MacBeth regressions during the period of 1988 to 2014. We run two sets of regressions. In the first set, the dependent variable $R_{i,t+1:t+6}$ is the average monthly raw return from month $t+1$ to month $t+6$. MOM is the past cumulative returns from month $t-6$ to $t-1$. $\log(Size_{i,t-1})$ is the natural logarithm of market capitalization at the end of month $t-1$. $\log(BM_{i,t-1})$ is the natural logarithm of the book-to-market ratio at the end of the previous year. $SIR_{i,t-1}$ is the relative short interest ratio at month $t-1$. $TO_{i,t-1}$ is the turnover at month $t-1$. $IO_{i,t-1}$ is the institutional ownership during the previous quarter. Nagel (2005) finds that institutional ownership as a proxy for short-sale constraints helps explain some well-known anomalies. $SST_{i,t-1}$ is the cumulative percentage change in the short interest ratio over the past 12 months. There is a one-month gap between the dependent variable and the independent variables.

Table 3 reports the results for the first set of regressions. The results show that past medium-term returns and the book-to-market ratio are significant return predictors in all models. Model 7 and 9 show that smaller firms experience significantly higher future returns after excluding stocks with prices lower than \$5. Institutional ownership is also a significant predictor. These results are consistent with previous studies. Most importantly, the negative coefficients of the SIR and SST in all models indicate that both the level of short interest (SIR) and the short selling trend (SST) significantly and negatively predict future returns. Overall, consistent with the portfolio analysis, the regression results indicate that the long-term trend in short interest contains incremental return predictive information controlling for other significant return predictors. In the second set of regressions, the dependent variable $R_{i,t}$ is the raw return in month t. We also include the past one-month return ($REV_{i,t-1}$) as a control variable in the model

specification. An unreported table shows similar results for the second set of regressions.

TABLE 3.

Fama-MacBeth (1973) Regression Analysis

	1	2	3	4	5	6	7	8	9
MOM	0.0043	0.004	0.0044	0.004	0.0049	0.0047	0.0034	0.0056	0.0041
	(2.76)	(2.56)	(2.82)	(2.59)	(3.25)	(3.19)	(2.37)	(3.81)	(2.92)
ME	0.0001	0.0000	0.0000	0.0000	0.0000	−0.0002	−0.0003	−0.0001	−0.0003
	(0.30)	(0.04)	(0.25)	(0.05)	(−0.23)	(−1.26)	(−2.11)	(−0.36)	(−1.96)
BM	0.002	0.002	0.002	0.0019	0.0019	0.0014	0.001	0.0019	0.0008
	(5.87)	(5.84)	(5.71)	(5.75)	(5.86)	(4.30)	(3.38)	(5.79)	(2.97)
SIR		−0.046		−0.0426	−0.0423	−0.0421	−0.0233	−0.0507	−0.0334
		(−7.01)		(−6.18)	(−6.80)	(−6.86)	(−4.31)	(−8.31)	(−6.24)
SST			−0.0006	−0.0004	−0.0004	−0.0005	−0.0003	−0.0007	−0.0005
			(−6.44)	(−4.31)	(−4.49)	(−4.60)	(−3.03)	(−4.86)	(−3.45)
TO					0.0009	−0.001	0.0002	−0.0006	−0.0008
					(0.25)	(−0.29)	(0.07)	(−0.19)	(−0.25)
IO						0.0022			0.0017
						(2.82)			(2.40)
Adjusted R^2	0.033	0.038	0.034	0.039	0.045	0.045	0.046	0.043	0.046
Obs.	325814	325814	325814	325814	325814	275412	296960	353746	272196

This table presents the average coefficient estimates of Fama-MacBeth (1973) cross-sectional regressions. The regressions are estimated monthly from 1988 to 2014. The sample consists of common stocks listed in NYSE/AMEX. The dependent variable is the average monthly return in the 6-month holding period. The independent variables include the natural logarithm of firm size measured by the market capitalization at the end of month $t-1$ (ME), the natural logarithm of book-to-market ratio measured at the end of prior year (BM), the past 6-month cumulative return (MOM), the short interest ratio at month $t-1$ (SIR), the past J-month cumulative percentage changes in short interest (SST), the monthly trading volume scaled by outstanding shares at the end of month $t-1$ (TO), and institutional ownership in the most recent quarter (IO). There is 1-month gap between formation period and holding period. In model 1-6, the formation period $J = 12$, and stocks with prices less than \$1 are excluded. In Model 7, $J = 12$ and price screen is \$5. In model 8, $J = 6$ and price screen is \$1. In model 9, $J = 6$ and price screen is \$5. The Newey-West (1987) t-statistics are in parentheses.

3.3. Event-Time and Long-Term Performance

In this section, we examine the return predictability of the trend in short interest in event time. We track the average raw and risk-adjusted returns for the long portfolio, the short portfolio, and the long-short portfolio in each of the 36-month holding periods. The path of event-time returns provides a clear picture of the riskiness and persistence of the strategy based on the trend in short interest.

TABLE 4.

Return Predictability of the Trend in Short Selling in Event Time

	Raw Return			FF4 Alpha		
Month	G1	G10	G1-G10	G1	G10	G1-G10
1	1.40	0.74	0.66	0.52^{***}	-0.32^{***}	0.84^{***}
2	1.30	0.77	0.53	0.42^{**}	-0.28^{**}	0.70^{***}
3	1.31	0.72	0.59	0.42^{**}	-0.34^{***}	0.76^{***}
4	1.23	0.67	0.55	0.35^{**}	-0.36^{***}	0.71^{***}
5	1.24	0.71	0.53	0.36^{**}	-0.33^{***}	0.68^{***}
6	1.24	0.80	0.44	0.34^{**}	-0.24^{**}	0.58^{***}
7	1.32	0.78	0.54	0.42^{**}	-0.25^{**}	0.67^{***}
8	1.24	0.82	0.41	0.33^{*}	-0.17	0.51^{***}
9	1.22	0.89	0.33	0.34^{**}	-0.12	0.45^{***}
10	1.27	0.85	0.42	0.36^{**}	-0.18	0.54^{***}
11	1.31	0.99	0.32	0.41^{**}	-0.03	0.44^{***}
12	1.30	0.95	0.35	0.40^{**}	-0.08	0.48^{***}
13	1.34	0.97	0.37	0.43^{***}	-0.06	0.49^{***}
14	1.31	0.99	0.32	0.40^{**}	-0.05	0.45^{***}
15	1.38	1.08	0.29	0.47^{***}	0.06	0.41^{***}
16	1.32	1.14	0.18	0.38^{**}	0.09	0.30^{**}
17	1.31	1.21	0.11	0.38^{**}	0.20	0.18
18	1.37	1.25	0.12	0.45^{***}	0.20	0.25^{*}
19	1.33	1.29	0.04	0.42^{**}	0.25	0.16
20	1.41	1.22	0.19	0.47^{***}	0.10	0.37^{**}
21	1.44	1.22	0.22	0.47^{***}	0.05	0.43^{***}
22	1.37	1.27	0.09	0.36^{**}	0.08	0.28^{*}
23	1.28	1.25	0.03	0.27	0.08	0.20
24	1.35	1.27	0.08	0.36^{*}	0.09	0.27^{*}
25	1.32	1.15	0.16	0.35^{**}	0.02	0.33^{**}
26	1.28	1.14	0.14	0.34^{*}	0.02	0.32^{**}
27	1.33	1.17	0.16	0.41^{**}	0.08	0.33^{**}
28	1.26	1.16	0.10	0.33^{*}	0.05	0.28^{*}

Table 4 reports the results. The empirical results show that stocks with large decreasing trends in short interest experience significant and persistent positive abnormal returns over a holding period of three years. However, stocks with large increasing trends in short interest experience significant negative abnormal returns only in the first seven months after the formation period and this reverses after the fifteenth month, though the magnitude of the reversal is very small. Specifically, the long-short strategy generates significant and persistent profits over a 36-month holding period

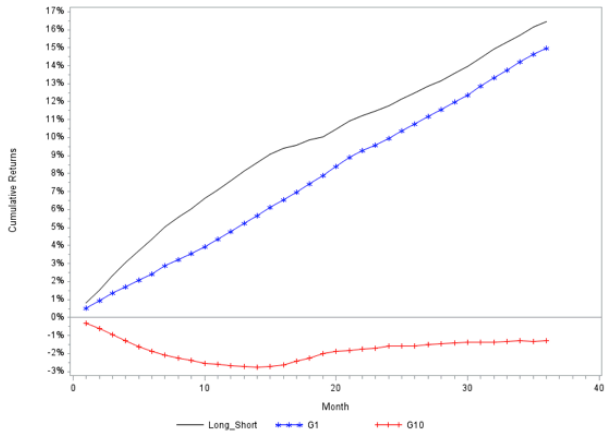
TABLE 4—*Continued*

	Raw Return			FF4 Alpha		
Month	G1	G10	G1-G10	G1	G10	G1-G10
29	1.33	1.12	0.22	0.39**	0.04	0.35**
30	1.29	1.11	0.18	0.34**	0.01	0.33**
31	1.35	1.11	0.25	0.43**	0.02	0.41***
32	1.35	1.05	0.29	0.43**	−0.02	0.45***
33	1.28	1.13	0.15	0.37**	0.06	0.31**
34	1.29	1.12	0.17	0.39**	0.04	0.34**
35	1.30	1.07	0.22	0.36*	−0.04	0.40**
36	1.22	1.14	0.08	0.31*	0.05	0.26*

This table presents monthly raw returns and Fama-French-Carhart 4-factor alphas for portfolios formed based on past 12-month cumulative percentage changes in short interest (SST) in event time. G1 represents the long portfolio, G10 represents the short portfolio, and G1-G10 represents the long-short portfolio. *, **, and *** represent statistically significance at the 10%, 5%, and 1% levels, respectively. The sample consists of commons stocks with short interest data listed in NYSE/AMEX. The sample period is from January 1988 to December 2014.

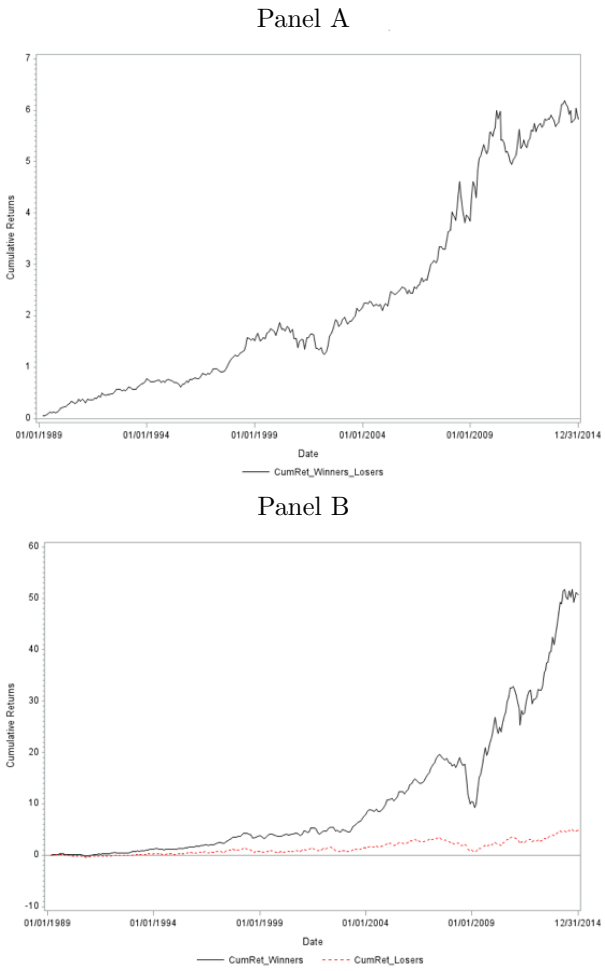
due to the good performance of the long leg and a very weak reversal of the short leg.

FIG. 1. Long-Term Performance of Portfolios Based on the Trend in Short Selling



This figure presents the 36-month cumulative Fama-French-Carhart alphas of the long leg, the short leg, and the long-short hedge portfolio based on the trend in short selling over past 1-year. See Table 1 for the description of portfolio construction. G1 is the long portfolio and G10 is the short portfolio.

FIG. 2. Performance of Long-Short Strategy Based on SST: 1988-2014



This figure presents performance of the long leg, the short leg, and the long-short strategy based on the change in short interest. See Table 1 for the description of portfolio construction.

Figure 1 shows the graphical representations of the cumulative risk-adjusted returns of the long portfolio, the short portfolio, and the long-short portfolio in the 36-month holding period. The cumulative abnormal returns of the long leg is represented as a beautiful upward straight line, thus indicating that investors consistently underreact to the positive infor-

mation contained in the large decreases in short interest. The short leg experiences a very weak reversal after one and a half years, thus suggesting that there is no significant overreaction in the data. The long-short portfolio generates stable and upward cumulative abnormal returns in the long run. This evidence suggests that underreaction to positive information seems to explain the return predictability due to the change in short interest.

Figure 2 reports the cumulative raw returns of the long portfolio, the short portfolio, and the long-short portfolio in the sample period of 1988 to 2014. For the long-only position, an initial investment of one dollar at the beginning of 1989 reaches fifty dollars at the end of 2014. The return of the long-short strategy reaches 6000

3.4. Subperiods

Chordia, Subrahmanyam, and Tong (2014) show that many anomalies have become less profitable in the recent decade due to increasing trading and arbitrage activities. In this subsection, we report the results in two subperiods. Table 5 shows that the long-short portfolio generates significant positive abnormal returns in both subperiods. The main profits of the hedge portfolio, however, are from different legs. The short leg generates significant negative abnormal returns, and the long leg generates insignificant positive abnormal returns during 1988-2001. In contrast, the long leg generates significant positive abnormal returns and the short leg generates insignificant negative abnormal returns during 2002-2014. The strategy based on the trend in short interest is obviously superior to other anomaly-based strategies in the recent decade.

3.5. Seasonality

Many anomalies show striking seasonal patterns. For example, momentum profits are negative in January, whereas short-term reversal and long-term reversal are the strongest in January (DeBondt and Thaler, 1985; Jegadeesh, 1990; Jegadeesh and Titman, 1993). In this subsection, we examine whether the return predictability of the trend strategy is robust in different calendar months.

Table 6 reports the results. Panel A reports the raw returns, and Panel B reports the risk-adjusted returns. Panel A shows that the long-short hedge portfolio experiences positive returns in ten out of twelve months of the year. The raw return of the hedge portfolio is significantly higher in January (1.8%) than in other months (0.56%). Panel B shows that the hedge portfolio's alpha is economically and statistically significant in nine

TABLE 5.

Subperiods

	Raw	CAPM	FF3	FF4
		1988-2001		
G1	1.23	0.29	−0.02	0.18
	(3.06)	(1.01)	(−0.10)	(0.87)
G10	0.65	−0.43	−0.77	−0.48
	(1.47)	(−1.40)	(−4.36)	(−3.03)
G1-G10	0.58	0.72	0.75	0.65
	(3.00)	(3.52)	(3.53)	(2.59)
		2002-2014		
G1	1.57	0.84	0.71	0.78
	(3.16)	(3.23)	(3.18)	(3.37)
G10	0.84	−0.08	−0.24	−0.18
	(1.48)	(−0.36)	(−1.66)	(−1.31)
G1-G10	0.72	0.92	0.95	0.96
	(3.08)	(4.06)	(4.28)	(4.25)

This table presents the performance of strategies based on the trending in short selling in two subperiods.

out of twelve months. The hedge portfolio's alpha is significantly higher in January (1.83%) than in other months (0.69%). However, in the other eight non-January calendar months, the hedge portfolio also generates comparable alphas. More specifically, in January, the alpha of the portfolio of stocks with the largest decreases in short interest is significant and positive, and the alpha of the portfolio of stocks with the largest increases in short interest is negative but insignificant. Overall, these results indicate that the return predictability of the trend in short interest is quite robust in different calendar months, thus confirming the usefulness of the predictive information contained in the trend in short interest.

3.6. The Trend in Short Selling and Investor Sentiment

Investor sentiment is significantly related to the cross-section of stock returns (Baker and Wurgler, 2006). More specifically, Stambaugh, Yu, and Yuan (2012) document that most market anomalies are more profitable following high sentiment periods in which most profits are from short legs. In this subsection, we examine the effect of investor sentiment on the return predictability of the trend in short selling.

We conduct both the portfolio analysis and predictive regression analysis to examine the effect of investor sentiment on the return predictability

TABLE 6.

Seasonality

Panel A: Raw Return														
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Feb-Dec
G1	1.40	2.55	2.08	1.56	1.50	2.91	0.58	1.06	0.10	−0.33	−0.60	1.43	3.14	1.30
	(4.38)	(2.97)	(2.82)	(2.68)	(1.82)	(2.89)	(1.14)	(1.33)	(0.10)	(−0.29)	(−0.49)	(1.47)	(6.35)	(3.88)
G10	0.74	0.75	0.97	1.94	0.30	1.39	−0.93	0.13	−0.39	−1.12	−0.14	1.04	2.87	0.74
	(2.07)	(0.62)	(0.91)	(3.03)	(0.26)	(1.62)	(−1.00)	(0.12)	(−0.33)	(−0.87)	(−0.09)	(0.89)	(3.98)	(2.00)
G1-G10	0.66	1.80	1.11	−0.38	1.20	1.53	1.51	0.93	0.48	0.79	−0.47	0.39	0.26	0.56
	(4.32)	(2.81)	(1.88)	(−0.86)	(2.82)	(2.36)	(2.65)	(2.21)	(0.99)	(1.54)	(−0.68)	(1.07)	(0.52)	(3.61)
Panel B: Fama-French-Carhart Alpha														
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Feb-Dec
G1	0.52	1.29	1.40	−0.67	0.45	1.07	0.19	0.39	−0.05	−0.06	−0.83	0.18	1.50	0.38
	(3.15)	(2.62)	(3.59)	(−1.30)	(1.21)	(2.01)	(0.70)	(0.89)	(−0.13)	(−0.11)	(−1.65)	(0.55)	(4.25)	(2.24)
G10	−0.32	−0.54	0.11	−0.22	−0.77	−0.30	−0.42	−0.49	−0.32	−1.16	−0.17	−0.41	−1.03	−0.31
	(−2.86)	(−1.32)	(0.31)	(−0.78)	(−1.78)	(−1.02)	(−1.45)	(−1.92)	(−0.96)	(−3.41)	(−0.41)	(−1.55)	(−1.48)	(−2.66)
G1-G10	0.84	1.83	1.29	−0.45	1.22	1.37	0.61	0.88	0.27	1.10	−0.65	0.59	2.53	0.69
	(5.11)	(6.19)	(2.81)	(−0.95)	(5.43)	(2.66)	(2.13)	(1.92)	(0.79)	(1.68)	(−0.89)	(1.71)	(3.61)	(3.94)

This table presents the average monthly raw returns and Fama-French 4-factor alphas of the long portfolio, the short portfolio, and the long-short portfolio based on past 12-month cumulative changes in short interest in each calendar month. G1 is the long portfolio, G10 is the short portfolio, and G1-G10 is the long-short portfolio. These portfolios are held for 1-month. The sample consists of common stocks listed in NYSE/AMEX. Stocks with prices less than $1 are excluded. Average returns are presented in percentages. The Newey-West (1987) t-statistics are in parentheses. The sample period is from January 1988 to December 2014.

of the trend strategy. We use the monthly sentiment index constructed in Baker and Wurgler (2006) to measure investor sentiment. In the portfolio analysis, a high-sentiment (low-sentiment) month refers to a month in which the BW sentiment index is above (below) the median value of the index in the sample period. Then, we calculate the average monthly returns following high-sentiment and low-sentiment periods, respectively.

Table 7 reports the results of the portfolio analysis. Panel A reports the results based on the BW (2006) sentiment index that is orthogonalized with macroeconomic variables. The empirical results show that stocks in the bottom SST decile experience significant positive abnormal returns following both high and low sentiments, but stocks in the top SST decile experience significant negative abnormal returns only following low sentiment; however, the alpha is insignificantly negative following high sentiment. The long-short hedge portfolio experiences significant alphas following both high and low sentiments. The returns for the long leg, the short leg, and the long-short portfolio are insignificant between high and low sentiment. Panel B reports the results based on the sentiment index that

is not orthogonalized with macroeconomic variables. The results in Panel B are consistent with those in Panel A. The only difference is that stocks with large increases in short interest experience marginally significant negative abnormal returns following high sentiment. The evidence suggests that investor sentiment seems to have little effect on short sellers. It seems consistent with that short sellers are sophisticated rational investors and noise traders cannot significantly affect rational traders' trading behaviors.

TABLE 7.

The Trend in Short Selling and Investor Sentiment: Portfolio Analysis

Panel A

	Raw Return			FF4 Alpha		
	G1	G10	G1-G10	G1	G10	G1-G10
High	1.35	0.75	0.60	0.52	−0.23	0.75
	(3.44)	(1.61)	(2.27)	(2.88)	(−1.51)	(3.72)
Low	1.44	0.73	0.71	0.52	−0.40	0.93
	(3.65)	(1.57)	(3.26)	(2.93)	(−2.70)	(4.65)
High-Low	−0.09	0.02	−0.10	0.00	0.17	−0.17
	(−0.16)	(0.03)	(−0.34)	(0.00)	(0.83)	(−0.62)

Panel B

	Raw Return			FF4 Alpha		
	G1	G10	G1-G10	G1	G10	G1-G10
High	1.36	0.76	0.60	0.50	−0.26	0.76
	(3.46)	(1.63)	(2.77)	(2.73)	(−1.71)	(3.73)
Low	1.43	0.72	0.71	0.55	−0.37	0.91
	(3.63)	(3.63)	(3.27)	(3.06)	(−2.49)	(4.61)
High-Low	−0.07	0.04	−0.11	−0.04	0.11	−0.15
	(−0.13)	(0.06)	(−0.36)	(−0.17)	(0.50)	(−0.53)

This table presents the average raw and risk-adjusted returns following low and high levels of investor sentiment. The specification is as follow:

$$R_{i,t} = a_H \times D_{H,t} + a_L \times D_{L,t} + b \times MKT_t + c \times SMB_t + d \times HML_t + e \times MOM_t + u_t$$

where $R_{i,t}$ is the excess return in month t of the long portfolio, the short portfolio, or the long-short portfolio. DH and DL are dummy variables that indicate following high or low investor sentiment. G1 is the long portfolio, G10 is the short portfolio, and G1-G10 is the long-short portfolio. Panel A reports the results based on BW(2006) index that is orthogonalized with macroeconomic variables. Panel B reports the results based on BW(2006) index that is not orthogonalized with macroeconomic variables. Average returns are presented in percentages. The Newey-West (1987) t-statistics are in parentheses. The sample period is from January 1988 to December 2014.

The high or low sentiment classification in the portfolio analysis is a simple binary classification, and so we conduct an alternative predictive

regression analysis. Following Stambugh et al. (2012), we examine the effect of investor sentiment by regressing the monthly excess returns on the lagged sentiment index. We run the predictive regressions with and without controlling for other well-known risk factors.

The predictive regression model is as follows:

$$R_t = a+b\times SENT_{t-1}+c\times MKT_t+d\times SMB_t+e\times HML_t+f\times MOM_t+u_t \tag{3}$$

where R_t is the excess returns in month t of the long-leg, short-leg, or long-short portfolio; $SENT_{t-1}$ is the investor sentiment index in Baker and Wurgler (2006) in month $t-1$; and MKT_t, SMB_t, HML_t, and MOM_t are the Fama-French-Carhart risk-factor exposures.

An unreported table shows that the results from the predictive regressions are consistent with the portfolio analysis, though the coefficients of the lagged sentiment index for both the long, short, and hedge portfolios are significantly negative. Overall, these results suggest that the long-short strategy seems more profitable following low sentiment, hedging and improving other anomaly-based strategies because these anomalies are more profitable following high sentiment.

4. CONCLUSION

This paper examines the cross-sectional relation between the trend in short selling and stock returns. We find that NYSE/AMEX stocks with large increasing (decreasing) trends in short interest experience significant and negative (positive) abnormal returns. Specifically, stocks in the bottom (top) trend decile over the previous 1 year generate a significant average monthly return of 0.52% (−0.32%) after controlling for the market, size, book-to-market ratio, and momentum effect. The long-short strategy generates an average monthly risk-adjusted return of 0.84% ($t = 5.11$), but the return predictability is asymmetric.

The return predictability of the long-term change in short interest is not subsumed by the level of short interest and other well-known return determinants such as the size, book-to-market ratio and momentum effect. The return spread of the hedge portfolio is particularly large among small stocks, value and growth stocks, and past winners and past losers. It is robust to different formation and holding periods, price screen, microstructural concerns, and various measures of the change in short inter-

est.[2] Moreover, short sellers do not appear to be significantly affected by investor sentiment.

These empirical results provide new evidence that short sellers are informed and sophisticated investors. The market seems to underreact slowly to the public information contained in the trend in short interest. Specifically, stock prices adjust very slowly to reflect the positive information contained in the decrease in short interest. The asymmetric speed of incorporation of good news versus bad news into stock prices is contrary to the implication of short-sale constraints and limits to arbitrage. Lastly, an important practical implication of these results is that the information contained in the change in short interest may offer a great hedge or complement to anomaly-based trading strategies.

REFERENCES

Asquith, P. and L. Meulbroek, 1995. An empirical investigation of short interest. Unpublished Working Paper, MIT.

Asquith, P., P. Pathak, and J. Ritter, 2005. Short Interest, Institutional Ownership, and Stock Returns. *Journal of Financial Economics* **78**, 243-76.

Baker, M. and J. Wurgler, 2006. Investor Sentiment and the Cross-Section of Stock Returns. *Journal of Finance* **61**, 1645-1680.

Boehmer, E., Z. R. Huszar, and B. D. Jordan, 2010. The good news in short interest. *Journal of Financial Economics* **96**, 80-97.

Chordia, T., A. Subrahmanyam, and Q. Tong, 2014. Have Capital Market Anomalies Attenuated in the Recent Era of High Liquidity and Trading Activity? *Journal of Accounting and Economics* **58**, 41-58.

Christophe, S. E., M. G. Ferri, and J.J. Angel, 2004. Short-Selling Prior to Earnings Announcements. *Journal of Finance* **59**, 1845-1875.

DeBondt, W. F. M. and R. Thaler, 1985. Does the stock market overreact? *Journal of Finance* **40**, 793-808.

Desai, H., K. Ramesh, S. Thiagarajan, and B. Balachandran, 2002. An Investigation of the Information Role of Short Interest in the Nasdaq Market. *Journal of Finance* **52**, 2263-87.

Deshmukh, S., K. J. Gamble, and K. M. Howe, 2015. Short Selling and Firm Operating Performance. *Financial Management* **44**, 217-236.

Diamond, D. and R. Verrecchia, 1987. Constraints on Short-Selling and Asset Price Adjustment to Private Information. *Journal of Financial Economics* **18**, 277-311.

Fama, E. F. and K. R. French, 1993 Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* **33**, 3-56.

Fama, E. F. and J. MacBeth, 1973. Risk, Return and Equilibrium: Empirical Tests. *Journal of Political Economy* **81**, 607-636.

[2]Results for the robustness tests on different formation and holding periods, the NASDAQ and an alternative measure of the trend in short selling are available upon request.

Jegadeesh, N., 1990. Evidence of Predictable Behavior of Security Returns. *Journal of Finance* **45**, 881-898.

Jegadeesh, N., and S. Titman, 1993. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance* **48**, 65-91.

Karpoff, J. M. and X. Lou, 2010. Short Sellers and Financial Misconduct. *Journal of Finance* **65**, 1879-1913.

Miller, E., 1977. Risk, Uncertainty, and Divergence of Opinion. *Journal of Finance* **32**, 1151-68.

Nagel, S., 2005. Short Sales, Institutional Investors, and the Cross-section of Stock Returns. *Journal of Financial Economics* **78**, 277-309.

Senchack, A. J. and L. Starks, 1993. Short-Sale Restrictions and Market Reaction to Short Interest Announcement. *Journal of Financial and Quantitative Analysis* **28**, 177-194.

Shleifer, A. and R. Vishny, 1997. The limits of arbitrage. *Journal of Finance* **52**, 35-55.

Stambaugh, R. F., J. Yu, and Y. Yuan, 2012. The short of it: Investor sentiment and anomalies. *Journal of Financial Economics* **104**, 288-302.