

THE UPTICK RULE AND SHORT-SELLING STRATEGIES

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Abstract

The Security and Exchange Commission revoked the uptick rule in July 2007. The revocation of the uptick rule provides us with a unique setting to investigate the impact of short-sale constraints on various short-selling strategies in a controlled environment. Comparing short-selling behaviors for uptick-rule restricted and unrestricted stocks during the pre- and post-revocation periods, we find that contrarian short selling and voluntary-liquidity short selling are more profound in uptick-rule-restricted stocks than in unrestricted stock and that market trend chasing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks. Our results also show that the uptick rule has no impact on risk-bearing short-selling strategies.

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1. Introduction

Short sellers borrow shares from their brokers and sell them at the prevailing market prices, betting that share prices will fall so they can buy back the shares at lower prices to realize gains. Previous studies suggest that short sellers follow a variety of trading strategies. For example, Diether et al. (2009a) suggest that short sellers are contrarians who trade on short-term stock price overreaction; they short more (less) after a period in which stock prices have been increasing (declining) for several days. On the aggregate level, however, Lamont and Stein (2004) show that short sellers tend to chase the market trend; they short more (less) after a period in which the market has been declining (increasing). Furthermore, Dechow et al. (2001), Desai et al. (2006), Cohen et al. (2007), and Boehmer et al. (2008a) agree that short sellers are rational investors who target overvalued stocks and trade on firms' fundamentals. In addition, Christophe et al. (2004), Christophe et al. (2010) and Karpoff and Lou (2011) find evidence that short sellers trade on private information, such as firms' earnings announcements, financial analysts' recommendations, and financial misconduct. While most studies in the literature focus on a single type of short-selling strategy, Diether et al. (2009b) examine several different patterns in short selling and show that short sellers are not alike: they are informed traders who are able to predict future returns, contrarians who trade on short-term stock price overreaction, voluntary-liquidity providers when the market experiences order imbalance, and opportunistic risk bearers when stock-price uncertainties arise.

Although short sellers are legally allowed to implement the aforementioned trading strategies, short selling had been regulated by the so-called uptick rule, which allows short-sale orders to be

placed only on the uptick basis.¹ The uptick rule could shape short sellers' trading strategies in different ways. For example, Miller (1977) argues that short-sale constraints lead to stock overpricing. In this case, the uptick rule, along with other short-sale constraints, prevents pessimistic investors from registering their opinions on stock prices and leads to stock overvaluation, which provides short sellers with opportunities to trade on those overvalued stocks. Further, Boehmer et al. (2008b) suggest the uptick rule may mechanically induce contrarian short selling. When the uptick rule is binding, it is less likely that short sellers could initiate a short position. Once the market is moving up, those who were unable to build a short position can then initiate a short position. Moreover, the uptick rule that prohibits short sales on the downtick basis creates order imbalance and lowers liquidity (Alexander and Peterson, 2008). Diether et al. (2009a) show that low liquidity due to order imbalance motivates short sellers to step in and provide liquidity voluntarily. Existing literature provides rich evidence on what trading strategies short sellers followed in an environment in which the uptick rule was in place, but we know little about whether and how the uptick rule affect short sellers' trading behavior. In this paper, we fill this gap by examining the impact of the uptick rule on various short-selling strategies.

After a two-year market experiment (the Pilot program) that suspended the uptick rule on a pre-chosen set of pilot stocks, the Securities and Exchange Commission (SEC) of the U.S. voted to revoke the uptick rule for all exchange-traded securities in July 2007. The permanent removal of the uptick rule was followed by a 10% market decline in August 2008 and a mega market

¹ Rule 10a-1 (17 CFR 240.10a-1) under the Securities and Exchange Act was adopted in 1938 and was known as the "uptick rule". Under the rule, short sale orders could only be placed at a higher price than a previous trade. The uptick rule was adopted to prevent short sellers from manipulating stock prices downward in market declines such as occurred in 1929.

meltdown between 2007 and 2008. There was growing concern that unrestricted short-selling activity might have contributed to the recent stock market crash and that the revocation of the uptick rule might be a possible scapegoat for many firms' failures.² This controversy has been fueled further by debates over whether the SEC should bring back uptick-rule restrictions on short selling.³ Despite tremendous interest, an important question that remains unanswered is what short sellers were doing after the uptick rule was revoked. By examining a unique high-frequency short-selling dataset that covers a period from March to October 2007, we seek to provide answers to this question.

The revocation of the uptick rule in July 2007 provides us with a powerful empirical setting in which to examine the impact of the uptick rule on short sellers' trading behavior. Comparing matched pairs of (uptick-rule) restricted and unrestricted stocks during the pre- and post-revocation periods, we examine how the uptick rule affects several different short-selling strategies: contrarian, liquidity providing, opportunistic risk bearing, and market trend chasing. Our findings are fourfold. First, results show that contrarian short selling is more profound in (uptick-rule) restricted stocks than in unrestricted stocks. More specifically, a 10% five-day stock price run-up in (uptick-rule) unrestricted stocks during the pre-revocation period leads to an

² For example, Morgan Stanley fell as much as 44% on September 17, 2007, and Chief Executive Officer John Mack told employees in a memo that "short sellers are driving our stock down." In March 2009, U.S. Senator Ted Kaufman said, "Abusive short selling amounts to gasoline on the fire for distressed stocks and distressed markets." Bloomberg reported on March 19, 2009, that the trading pattern that emerges from 2008 SEC data shows that manipulative shorts contributed to the fall of both Lehman Brothers and Bear Stearns.

³ See "Exchanges Try to Limit Shorts Ban" by Jacob Bunge, *Wall Street Journal*, March 25, 2009; "There's a Better Way to Prevent 'Bear Raids'" by R. Pozen and Y. Bar-Yam, *Wall Street Journal*, November 18, 2008; "Anatomy of the Morgan Stanley Panic" by S. Pulliam et al., *Wall Street Journal*, November 24, 2008. Furthermore, Representative Gary Ackerman introduced on January 8, 2009, a bill in the U.S. House of Representatives to require the SEC to reinstate the uptick rule on short sales of securities. The SEC announced in August 2009 that it is seeking public comments on the proposals related to restoring the uptick rule.

increase in the short-selling ratio of 1.92 percentage points (or an 8.6% increase in short-selling activity). For restricted stock during the same period, a 10% five-day stock price run-up leads to an increase of 3.76 percentage points in the short selling ratio (or a 20.5% increase in short-selling activity). The difference between the restricted and unrestricted stocks is statistically and economically distinguishable. Our results are robust after performing a difference-in-difference analysis, accommodating serial correlation in both short-selling activity and stock returns, and conducting difference-in-difference regressions.

Second, using both the bid-ask spread and shares turnover as proxies for trading liquidity, we examine the relation between short-selling activity and measures for both contemporaneous and subsequent trade liquidity. Results support our hypothesis that voluntary liquidity-providing short selling is more profound in uptick-rule restricted stocks than in unrestricted stocks. This is consistent with the notion that removing the uptick rule improves trading liquidity, therefore decreasing liquidity providing short selling.

Third, we hypothesize that opportunistic risk-bearing short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks. However, our results show that the uptick rule has no material impact on opportunistic risk-bearing short selling.

Last, we examine the relation between short-selling activity and market returns in order to evaluate the impact of the uptick rule on market-trend-chasing short selling. We find that the effect of previous market returns on short selling activity is remarkable. A 10% five-day past-market downward movement is associated with a more than 10% increase in short-selling activity for uptick-rule-restricted stocks during the pre-revocation period. This effect is much more profound for unrestricted stocks: a 10% five-day past-market downward movement

increases short-selling activity by nearly 20%. Meanwhile, the effect of contemporaneous market returns on short-selling activity is tremendous. A 10% contemporaneous-market downward movement induces an increase in short-selling activity by 26.9% (39.5%) for uptick-rule-restricted (unrestricted) stocks. Results here indicate that the uptick rule plays an important role in discouraging short sellers from chasing the market trend when the market experiences downward movements, suggesting that the uptick rule may help stabilize stock markets at the aggregate level. If stabilizing stock markets is the top priority for policymakers during a market crisis, then bringing back the uptick rule might be a legitimate measure to consider.

Our study contributes to the literature in the following ways. First, previous literature examines the impact of the uptick rule on market quality and efficiency. Using Reg SHO short-sale data during a six-month period around the introduction of the Pilot program, Diether et al. (2009a) examine the effect of the uptick rule on a variety of market quality measures, such as trading volume, liquidity, and volatility. They find that the suspension of the uptick rule on the New York Stock Exchange (NYSE) is associated with a significant increase in short-selling activities, a large reduction in the asymmetries of depth and order flows, and a slight increase in short-term volatility. Their testing results are confirmed by Alexander and Peterson (2008), who use eight-month Reg SHO data around the introduction of the Pilot program in 2005. Both studies suggest that the uptick rule on the NYSE should be removed permanently. The Economic Analysis Office of the SEC (2007) compares pilot and control stocks along several dimensions and shows that the suspension of the uptick rule is associated with increased short-selling activity, more orders executed on downticks, a decrease in quote depth, higher intraday volatility for small stocks, and lower intraday volatility. While these studies use Reg SHO data in 2005 and focus on the effect of the uptick rule on various measures of market quality and market

efficiency, this paper includes the post-revocation short-sale data in 2007 and focuses on the effect of the uptick rule on a variety of short sellers' trading strategies. This is our first contribution to the literature.

Second, there is a large body of literature regarding short sellers' trading behavior. Previous studies show that short sellers are informed investors who are able to forecast future negative stocks returns (Dechow et al., 2001; Desai et al., 2006; Cohen et al., 2007; and Boehmer et al., 2008a). More recently, Diether et al. (2009a) show that short sellers short stocks for different reasons: short sellers can be characterized as contrarians, liquidity providers, risk arbitrageurs, and information driven traders. In addition, Lamont and Stein (2002) and Blau et al. (2009) suggest that short sellers are market-trend chasers (momentum traders). Empirical evidence regarding short sellers' trading strategies is abundant in an environment in which short sales are constrained by the uptick rule. However, little research has been done to characterize short-selling behaviors after the SEC permanently revoked the uptick rule in July 2007; our study adds to the current literature by showing who short sellers were and what they were doing at the time.

Third, the evidence showing the relation between short-selling activity and market returns is critical in determining whether the uptick rule plays the role of stabilizing stock markets. The literature has paid little attention to this issue. The exception is Lamont and Stein (2004), who use monthly short-interest data and show a negative correlation between market-aggregate short interests and market returns. In this paper, we address this issue by studying the impact of previous and current market returns on short-selling activity using daily short-sale data. Our results show that the tendency of market-trend-chasing short selling increased greatly when the uptick rule was removed. Given the destabilizing nature of market-trend-chasing trading, results

in our paper indicate that whether the uptick rule plays the role of stabilizing stock markets is a debatable issue. This is our third contribution.

One contemporaneous study is most closely related to this paper. Using NYSE short-sale data from January through August 2007, Boehmer et al. (2008b) examine the changes in stock prices, short-selling activity, liquidity measures, and informativeness of short sales due to the July 2007 revoking of the uptick rule. They find that revoking the uptick rule led to significantly more short-selling activity and slightly worse market quality. They also find weak evidence that short sellers tended to switch from contrarian traders to momentum traders after the repeal of the uptick rule. Our paper differs from theirs in the following ways. First, in Boehmer et al. (2008b), the sample period after the repeal of the uptick rule is very short. Their data covers post-revoke short-sale activity for only six weeks from July to August 2007. Their results may be fragile due to the short post-revocation sample period. Another concern is that short-sale activity during that period may have been heavily affected by a sharp market decline that occurred between July 20 and August 16, 2007, and slashed more than 10% of the total market value. This may have introduced biases when they studied the effect of revoking the uptick rule. In contrast, our post-revocation sample period covers a four-month period from July to October 2007, much longer than that in Boehmer et al. (2008b). These four-months are important because the market was relatively stable during this period after the SEC revoked the uptick rule. During our sample period, the S&P 500 return was -1.37%. The stock market began to crash afterward. The four-month S&P 500 return was -11.86% from November 2007 to February 2008; -5.1% from March 2008 to June 2008; -23.3% from July 2008 to October 2008; and 29.4% from November 2008 to February 2009. Therefore, our data provide us a great opportunity to filter out the impact of the worsening market fundamentals on short-selling activity, offering us an unbiased environment in

which to study the impact of the uptick rule on a variety of short-selling strategies. In addition, while Boehmer et al. (2008) examine the effect of revoking of the uptick rule on stock prices, short-sale activity, market quality, and informativeness of short sales, our paper focuses on the impact of the uptick rule on short sellers' trading strategies.

Nevertheless, our study is subject to the following limitations. Due to the data limitation, we investigate the effect of the uptick rule on short sellers' trading strategies for only NYSE-listed stocks. This limits our capability to generalize conclusions to other markets, such as NASDAQ and AMEX. Examining the effect of NASDAQ's bid-price test on short sellers' trading behavior would be an interesting extension to our study. In addition, in this paper we establish that market-trend chasing is more profound in uptick-rule unrestricted stocks than in restricted stocks and conjecture that there is a potential for the uptick rule to mitigate market volatility and stabilize stock prices. However, no direct link has been established between the uptick rule and stock-market volatility to support this conjecture. This opens a promising venue for future research.

The balance of the paper proceeds as follows. Section 2 develops testable hypotheses. Section 3 describes the data and the sample. Section 4 examines the impact of the uptick rule on short-selling trading strategies. Section 5 provides conclusions.

2. Hypotheses Development

In this section, we develop several testable hypotheses regarding the impact of the uptick rule on short sellers' trading strategies.

Hypothesis 1: Contrarian short selling is more profound in the uptick-rule-restricted stocks than in unrestricted stocks.

Lamont and Jones (2004) contend that cross-sectional short interests are contrarian in nature. Diether et al. (2009b) provide evidence showing that short sellers increase their shorting activity after a period in which stock prices increase for several days. Moreover, short-selling trades are often followed by significant price declines over the following weeks (Boehmer et al., 2008). Extant empirical evidence favors the notion that short sellers trade on short-term overreaction of stock prices.

The uptick rule shapes the contrarian short selling through two possible mechanisms. Miller (1977) argues that when short sales are constrained, stock prices tend to be overvalued. The first mechanism is that short sellers adopt the contrarian trading strategy by short selling overvalued stocks, so they can generate sizeable gains by covering their short position once stock prices subsequently fall. The second mechanism is that contrarian short selling may simply be an artifact of the uptick rule (Boehmer et al., 2008). When the market is trending down, it is less likely that short sellers could initiate a short position given that the uptick rule is in place. When the market is moving upward, it is easier for short sellers who were unable to build a short position on the downtick to initiate a position. This leads mechanically to a trading strategy that appears contrarian.

Both mechanisms favor the hypothesis that contrarian short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks. On one hand, if contrarian short selling is motivated by overvalued stock prices due to short-sale constraints, then when the uptick rule is revoked, we would expect that less-overvalued stock prices provide fewer incentives for short

sellers to follow the contrarian strategy. On the other hand, if contrarian short selling is an artifact of uptick rules, then it is much easier for short sellers to initiate short positions even when the market is declining once the uptick rule is removed, resulting in less mechanical contrarian short selling. Our first hypothesis, therefore, is that contrarian short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks.

Hypothesis 2: Voluntary liquidity-providing short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks.

Diether et al. (2009b) suggest that short sellers are voluntary liquidity providers. They step in and sell short during a period in which the stock experiences low liquidity due to significant and temporary buy-order imbalance. Once the temporary buying pressure is balanced by those short-sale orders, stock prices tend to move to a fundamental level, and short sellers can cover their short-sale positions for profits. When the uptick rule is binding, short-sale orders are presented above the mid-quote point more often, resulting in temporary buying pressure. When the uptick rule is removed, we would expect that more short-sale orders would be presented below the mid-quote point, improving the trading liquidity by mitigating the buy-order imbalance. Both Diether et al. (2009b) and Alexander and Peterson (2008) find evidence that the uptick rule produces significant biases in how short-sale orders are represented in quotes and how short sales are executed relative to the mid-quote; they agree that removing the uptick rule would help improve trading liquidity. For uptick-rule-restricted stocks, the existence of low liquidity due to the buy-order imbalance provides a strong incentive for short sellers to step in and provide liquidity voluntarily. For unrestricted stocks, the improvement in liquidity along with the lower level of buy-order imbalance would provide fewer incentives to short sellers to follow the liquidity-

providing strategy. Therefore, we hypothesize that voluntary liquidity-providing short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks

Hypothesis 3: Opportunistic risk-bearing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks.

Diether et al. (2009a) contend that short sellers are opportunistic risk bearers. After a period in which uncertainty has been increasing, short sellers step in to provide additional risk-bearing capacity. They tend to short more on days with high intraday volatility, and their trades are followed by days with lower volatility. The impact of the removal of the uptick rule on stock-price volatility has been studied by Alexander and Peterson (2008) and Diether et al. (2009a). While Alexander and Peterson (2008) find no evidence that the suspension of the uptick rule for pilot stocks on the NYSE during 2005 had an adverse effect on volatility, Diether et al. (2009a) find that intra-day volatility increased slightly for pilot stocks. If the uptick rule helps mitigate stock-price volatility, then we would expect that opportunistic risk-bearing short selling would be less profound in uptick-rule-restricted stocks than in unrestricted stocks. However, if the uptick rule does not have a significant impact on stock-price volatility, as Alexander and Peterson (2008) show, then we would expect similar patterns of risk-bearing short selling for uptick-rule-restricted stocks and unrestricted stocks.

Hypothesis 4: Market-trend-chasing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks.

Lamont and Stein (2004) show that market-aggregate short interests move in a countercyclical fashion, evident in the significant negative relation between the changes in the short-sale ratio

and the value-weighted NYSE stock index during a period from 1960 to 2002. On the aggregate level, short sellers act as market-trend chasers who short more (less) after a period in which the market has been declining (increasing). More recently, Blau et al. (2009) find evidence that during periods in which the market experiences extreme movements, contrarian short sellers tend to become momentum traders. Consider a scenario in which the uptick rule is binding: short sellers who are chasing the market trend may not be able to submit a short-sale order aggressively on the downtick basis when the market is experiencing a downward trend. Therefore, we hypothesize that the uptick rule mitigates the propensity of short sellers to chase the market trend, especially when the market is trending down. Our fourth hypothesis is that market-trend-chasing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks.

3. Data and Sample

Our analysis involves investigating the effect of the uptick rule on various short sellers' trading strategies. More specifically, we look at the differences between the stocks with the uptick-rule restriction and stocks with no such binding restriction during the periods either prior to or after the SEC's uptick-rule revocation in July 2007. Tick-by-tick short-sale data from four months before the start of the uptick-rule revocation (March-June 2007) to four months afterward (July-October 2007) are obtained from the NYSE.⁴ The data include date, time, the

⁴ While tick-by-tick short-sale data prior to July 2007 were publically available according to Regulation SHO, such data were no longer free to the public after July 2007, when the SEC permanently revoked the uptick rule on the NYSE. However, the NYSE has continued to collect short-sale data since then. We acquired tick-by-tick short-sale data from the NYSE Data Service for a four-month period from July to October 2007.

stock ticker, short-sale volume, and short prices for all short sales occurring on the NYSE and cover a 173-trading-day period from March 1 to Oct 31, 2007. High-frequency short-sale data are then aggregated on a daily basis for our subsequent analysis. The period prior to the uptick-rule revocation (March to June 2007) is denoted as the pre-revocation period, and the period after the uptick revocation (July to October 2007) is defined as the post-revocation period. To account for the trading adjustments that short sellers might make due to the revocation of the uptick rule, we also omit one week before and after the start of uptick-rule revocation (June 25-29 and July 2-6, 2007).

Our study's basic approach matches the uptick-rule-restricted stocks with a non-restricted group of stocks that are similar on firm characteristics. This study focuses on NYSE-listed stocks. We limit our sample to all NYSE stocks that appear in the Center for Research in Security Prices (CRSP) data with a share code of 10 or 11 (common stock). Prior to the revocation of the uptick rule in July 2007, the SEC conducted a two-year market experiment, the pilot program, according to Regulation SHO, in which the uptick rule was suspended for a small group of pre-chosen pilot stocks. These pilot stocks are in our non-restricted sample. Other non-pilot stocks that were subject to the uptick rule restriction prior to July 2007 are in our restricted sample.

To construct the non-restricted sample, we start with the pilot stock list from the NYSE. There were 446 pilot stocks listed on the NYSE at the beginning of 2005. To eliminate the potential effect of index inclusion or index exclusion on stock returns, we require that sample stocks were members of the Russell 3000 index after the June 2006 reconstitution and remained in the Russell 3000 member list after the June 2007 reconstitution. Further, we exclude stocks

that were added to the index due to IPOs during the period January 2005 through the end of 2007 as well as stocks that were eliminated during the same period due to mergers, bankruptcies, and ticker changes. To mitigate the impact of additional short-sale constraints due to low stock prices, we exclude stocks with prices lower than five dollars. The resulting sample yields 322 uptick-rule non-restricted stocks.

To establish the restricted sample, we conduct the following matching procedure. We match the non-restricted sample with the restricted sample by 2-digit SIC industry code, market capitalization, and book-to-market ratio. Two-digit SIC industry code, market capitalization, and book-to-market ratio are obtained from either CRSOP or COMPUSTAT databases. First, we require restricted stocks to have the same 2-digit SIC code as non-restricted stocks. Then we match each non-restricted stock with the stock that minimizes the following expression:

$$Deviation = \left| \frac{(firm.size^{restricted} - firm.size^{non-restricted})}{(firm.size^{restricted} + firm.size^{non-restricted})/2} + \frac{(BMK^{restricted} - BMK^{non-restricted})}{(BMK^{restricted} + BMK^{non-restricted})/2} \right|, \quad (1)$$

where firm size is market capitalization and BMK is book-to-market ratio during the sample period. To ensure that the match for each non-restricted stock is unique, matches are performed without replacement. Table 1 provides a descriptive summary for the restricted and non-restricted samples.

Panel A of Table 1 presents the characteristics of stocks in our study. There are 322 pairs of matched uptick-rule-restricted stocks and unrestricted stocks. Mean values of firm characteristics of the restricted stock sample during the pre- and post-revocation periods are presented in columns [1] and [2], and those for the unrestricted stock sample during the pre- and post-revocation periods are presented in columns [4] and [5]. Time-series differences are computed in

columns [3] and [6]. The time-series comparison for restricted and unrestricted stocks could be problematic due to the potential systemic changes that occur between two sample periods. To fix this issue, we analyze the sample values of restricted stock changes minus unrestricted stock changes, which we refer to as the “difference-in-difference.” If this difference-in-difference is statistically significant, then the sample value of the restricted stock is different from that of the unrestricted stock. The difference-in-differences are calculated and presented in column [7]. Standard errors are reported below the mean values in italics. Although the time-series differences are significant for spread and shares turnover, the difference-in-differences of all firm-characteristic variables between restricted and unrestricted stocks are not significant, suggesting that the restricted and unrestricted samples are well matched in terms of various firm characteristics. In other words, the firm-characteristic difference will not contribute to the different short-selling strategies that we may discover in the later analysis.

Panel B of Table 1 reports the short-sale activity for restricted and unrestricted stocks during the pre- and post-revocation periods. We use four different variables to describe daily short-selling activities. The first measure is the number of short-sale trades for each stock on a given trading day. The second measure is short-sale 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 the size of short-sale trades, the number of shares traded in a short-sale transaction. The fourth measure is the shorting ratio, the proportion of share volume associated with short selling for a stock on a given day. Results in Panel B of Table 1 show that short-sale volume is essentially the same for restricted and unrestricted stocks. However, the number of short-sale trades is significantly greater in restricted stocks than in unrestricted stocks, and the size of short-sale trades is larger in restricted stocks

than in unrestricted stocks. Consistent with Boehmer et al. (2008) and Alexander and Peterson (2008), the results here suggest that the removal of the uptick rule may induce short sellers to split their orders more frequently. Last, it also shows that the shorting ratio is significantly lower for restricted stocks than unrestricted stocks by an economically sizeable magnitude of 3.4 percentage points. On average, revoking the uptick rule boosts short-selling activity by more than 15%, suggesting that revoking the uptick rule relaxes short-sale constraints and stimulates short-selling activity.

4. The Impact of the Uptick Rule on Short-Selling Strategies

4.1 Contrarian short-selling strategy

Lamont and Stein (2004) find that cross-sectional short interests appear to be contrarian in nature. Similarly, Diether et al. (2009) argue that short sellers adopt a contrarian trading strategy whereby they go against the short-term stock-price trend. Short sellers tend to short more (less) when the stock price increases (declines) for several days. More specifically, they find that a five-day stock return of 10% results in an increase in short selling of 3.7% for NYSE-listed stocks. Boehmer and Wu (2008) show that the contrarian nature of short sellers helps to improve the informational efficiency of stock prices. In particular, they find that short selling at the daily level reduces pricing errors, suggesting that when stocks become temporarily overvalued, informed investors short these stocks, thus reducing any further overvaluation.

To test the relation between short selling and past stock returns, we regress the short-sale ratio (ssr) on five-day past return ($ret_{t-5,t-1}$) in a two-way fixed effect panel regression framework. The regression is formalized in equation (2)

$$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \varepsilon_{i,t} \cdot \quad (2)$$

In order to test our first hypothesis that contrarian short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks, we run the above regressions for restricted stocks as well as for unrestricted stocks during both the pre- and the post-revocation periods. During the pre-revocation period, restricted stocks are subject to the uptick rule while unrestricted stocks are not. A larger coefficient of $ret_{i,(t-5,t-1)}$ for restricted stocks than for unrestricted stocks during the pre-revocation period would indicate that contrarian short selling is more profound in restricted stocks than in unrestricted stocks, supporting our first hypothesis. During the post-revocation period, both restricted and unrestricted stocks are free of the uptick-rule restriction; therefore, we expect that there is no statistically significant difference between the coefficients of $ret_{i,(t-5,t-1)}$ for the two samples.

Regression results are presented in Panel A of Table 2. In Table 2, coefficients on $ret_{i,(t-5,t-1)}$ are positive and statistically significant for both restricted and non-restricted stocks during both pre- and post-revocation periods, supporting the notion that short sellers are contrarians who short more after a period in which stock prices increase for several days.

More important, results show that the magnitude of the coefficients for restricted and unrestricted stocks are quite different during the pre-revocation period but similar during the post-revocation period, providing supporting evidence for our first hypothesis. In column 2 of Panel A of Table 2, the coefficient of 0.192 for unrestricted stocks during the pre-revocation period suggests that a 10% five-day stock price run-up leads to an increase of 1.92 percentage points in the short-selling ratio. This increase in short-selling activity is sizeable, representing a nearly 8.6% increase in short-selling activity, given that the average short-selling ratio for

unrestricted stocks during the pre-revocation period is 22.4%. In column 1, the coefficient on $ret_{i,(t-5,t-1)}$ is 0.376, suggesting that for the uptick-rule-restricted stocks, a 10% five-day stock price run-up leads to an increase of 3.76 percentage points in the short-selling ratio, or a 20.5% increase in short-selling activity. The difference between the restricted and unrestricted stocks during the pre-revocation period is statistically and economically distinguishable, supporting the notion that the relation between short-selling activity and past stock returns is stronger when the uptick rule is binding during the pre-revocation period. In columns 4 and 5, results show that during the post-revocation period, for restricted (unrestricted) stocks, a 10% five-day stock price run-up leads to an increase of 1.26 (1.43) percentage points in the short-selling ratio. Although the effect is less profound than that during the pre-revocation period, the magnitude of the effect is still economically significant: short-selling activity increases by 5.78% (6.56%) following a 10% five-day stock price run-up for restricted (unrestricted) stocks. During the post-revocation period, restricted and unrestricted stocks are both free of the uptick-rule restriction; therefore the relation between short-selling activity and past stock returns for both should be similar. Results in column 6 in Panel A of Table 1 show that the difference between the coefficients on $ret_{i,(t-5,t-1)}$ for restricted and unrestricted stocks during the post-revocation period is not statistically significant, providing supporting evidence to this notion.

Thus far, cross-sectional difference between the restricted and unrestricted stocks on the contrarian short-selling strategy is examined, and the results are favorable to our hypothesis, yet the cross-sectional difference could be caused by time-series factors other than status of the uptick-rule restriction. Therefore, it is necessary to examine the difference-in-differences, which reflect the net effect of the uptick rule on the relation between short-selling activity and past

stock returns. Difference-in-differences are computed as the difference between columns [3] and [6]. Statistical significance of difference-in-differences is tested by using Wilcoxon rank sum tests. Column 7 in Panel A of Table 1 shows that the difference-in-difference for the coefficients of $ret_{i,(t-5,t-1)}$ is positive and significant at the 1% level, suggesting that past stock-price run-up leads to more short-selling activity in the uptick-rule-restricted stocks than in unrestricted stocks. The magnitude of the difference-in-differences (0.201) is sizable. Specifically, for a 10% five-day stock price run-up, the short-sale ratio increases more in restricted stocks than in unrestricted stocks by two percentage points, representing about 10% of normal short-sale activity. This provides strong evidence supporting our first hypothesis that contrarian short selling is more profound in the uptick-rule-restricted stocks than in unrestricted stocks.

Furthermore, to formally test the net effect of the uptick rule on the relation between short-selling activity and past stock return, we adopt a difference-in-difference regression model, which is specified in equation (3).

$$ssr_{i,t} = \alpha + \gamma_1 ret_{i,(t-5,t-1)} + \gamma_2 D_1 ret_{i,(t-5,t-1)} + \gamma_3 D_2 ret_{i,(t-5,t-1)} + \gamma_4 D_1 D_2 ret_{i,(t-5,t-1)} + \varepsilon_{i,t} , \quad (3)$$

where D_1 is the dummy variable that indicates whether an observation is in the pre- or post-revocation period. D_1 equals one if it is in the pre-revocation period and zero otherwise. D_2 is the dummy variable that indicates whether a stock is an uptick-rule-restricted stock or unrestricted stock. D_2 equals one if a stock is in the restricted sample and zero otherwise. In equation (3), the cross-sectional difference between restricted and unrestricted stocks during the pre-revocation period is expressed as γ_2 , and the time-series difference between the pre- and post-revocation period for restricted stocks is expressed as γ_3 . The net difference due to the uptick-rule restriction is expressed as γ_4 . The results presented in Table 3 are consistent with

those in Table 2 and provide robust evidence that contrarian short selling is more profound due to the uptick-rule constraints.

It is well known that stock returns are positively correlated. To avoid falsely associating past returns with today's short selling, we include contemporaneous return, $ret_{i,t}$, in our regressions. In addition, to account for the positive serial correlation in short selling, we include past five-day short selling, $ssr_{i,(t-5,t-1)}$, as an independent variable. The specification of the panel regression model is expanded in equation (4).

$$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \varepsilon_{i,t} \quad (4)$$

Results presented in Panel B of Table 2 show that after controlling for serial correlation for both stock returns and short-selling activity, the coefficient of $ret_{i,(t-5,t-1)}$ is greater for restricted stocks than for unrestricted stocks during the pre-revocation period and is similar for restricted stocks and unrestricted stocks during the post-revocation period. The test of difference-in-difference in Panel B of Table 2 confirms that the net effect due to the uptick rule is significant. In addition, we notice that the coefficient of $ssr_{i,(t-5,t-1)}$ is different between restricted and unrestricted stocks, suggesting that the uptick rule may have an impact on the nature of the serially correlated short-sale activity.

We also include $ret_{i,t}$ and $ssr_{i,(t-5,t-1)}$ in the difference-in-differences regression model specified in equation (5):

$$ssr_{i,t} = \alpha + \gamma_1 ret_{i,(t-5,t-1)} + \gamma_2 D_1 ret_{i,(t-5,t-1)} + \gamma_3 D_2 ret_{i,(t-5,t-1)} + \gamma_4 D_1 D_2 ret_{i,(t-5,t-1)} + \gamma_5 ret_{i,t} + \gamma_6 D_1 ret_{i,t} + \gamma_7 D_2 ret_{i,t} + \gamma_8 D_1 D_2 ret_{i,t} + \gamma_9 ssr_{i,(t-5,t-1)} + \gamma_{10} D_1 ssr_{i,(t-5,t-1)} + \gamma_{11} D_2 ssr_{i,(t-5,t-1)} + \gamma_{12} D_1 D_2 ssr_{i,(t-5,t-1)} + \varepsilon_{i,t} \quad (5)$$

The results presented in column 2 of Table 3 show that the net effect of the uptick rule on the relation between short-selling activity and past stock return is positive and significant after controlling for the autocorrelation in stock returns and the autocorrelation in short-selling activity.

In addition, we find that the net effect of the uptick rule on the serial correlation of short-selling activity and stock returns is both positive and significant. The results here suggest that short-selling activity is less clustered in the uptick-rule-restricted stocks than in unrestricted stocks. Extant literature has established that information arrivals contribute to the clustering of trading volume (He and Wang, 1995; Cao et al., 2002; and Covrig and Ng, 2004). Short-sale constraints prevent short sellers from trading on arriving negative information when the stock price has already trended downward (Miller, 1977; Figlewski, 1981; and Diamond and Verrecchia, 1987). Therefore, the existence of short-sale constraints may undermine the relationship between information arrivals and autocorrelation in short sales. Our results provide supporting evidence to this notion.

In sum, we investigate the impact of the uptick rule on contrarian short-selling strategy by examining the cross-sectional difference in the relation between short-selling activity and past stocks returns, by calculating the difference-in-difference by considering time-series factors, by controlling for serially correlated stock returns and short-selling activity, and by running formal difference-in-differences regressions. We find consistent and strong evidence supporting our first hypothesis: contrarian short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks.

4.2. The impact of the uptick rule on voluntary liquidity-providing short-selling strategy

To test our second hypothesis that voluntary liquidity-providing short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks, we include measures of liquidity in our regression model. Stoll (2000) finds that trading costs are negatively correlated with trading volume. Jones et al. (1994) show that the number of trades contains the information content of informed traders. Following Boulton and Bragga-Alves (2010), we use share turnover, trading volume as the percentage of total shares outstanding on a given day, as the measure of trading liquidity.

To examine voluntary liquidity-providing short-selling strategy, we extend equation (3) by including both contemporaneous shares turnover, $trn_{i,t}$, and subsequent five-day average shares turnover, $trn_{i,(t+5,t+1)}$, as independent variables. The regression model is expressed in equation (6):

$$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+5,t+1)} + \varepsilon_{i,t} \cdot \quad (6)$$

Diether et al. (2009b) provide evidence showing that short sellers are voluntary liquidity providers who step in and sell short during a period in which the stock experiences low liquidity. Once the temporary order imbalance is mitigated by those short-sale orders, subsequent liquidity would be improved following those short-sale orders. Therefore, we expect a negative relation between short-selling activity and contemporaneous liquidity and a positive relation between short-selling activity and the liquidity during a short subsequent period. Regression results are presented in Table 4, showing that coefficients on $trn_{i,t}$ are significantly negative for both restricted stocks and unrestricted stocks during both the pre- and post-revocation periods. This confirms the assertion by Diether et al. (2009b) that short sellers are voluntary liquidity providers.

Our goal in this section is to examine the impact of the uptick rule on the voluntary liquidity-providing short-selling strategy. Diether et al. (2009b) find that when the uptick rule is in place short-sale orders tend to be presented above the mid-quote point more often, producing temporary order imbalance and lowering trading liquidity. Alexander and Peterson (2008) suggest that removing the uptick rule would help improve trading liquidity by bringing more short-sale orders above the mid-quote point. We expect to observe more voluntary liquidity-providing short selling activity in the uptick-rule-restricted stocks than unrestricted stocks. A greater magnitude of the coefficient on $trn_{i,t}$ in restricted stocks than in unrestricted stocks during the pre-revocation period would provide evidence to our second hypothesis. During the post-revocation period, since both restricted and unrestricted stocks are not subject to any uptick-rule constraints, we do not expect to find a significant difference in coefficients on $trn_{i,t}$ for restricted and unrestricted stocks. Moreover, we expect to find a significant and positive value for the difference-in-differences, which takes into account other time-series factors in addition to the uptick-rule status. Similarly, a smaller coefficient on $trn_{i,(t+5,t+1)}$ in restricted stocks than in unrestricted stocks during the pre-revocation period would provide additional evidence to our second hypothesis. Cross-sectional differences during the pre- and post-revocation periods and difference-in-differences are reported in columns [3], [6], and [7] of Table 4, showing that the cross-sectional difference between the coefficients on $trn_{i,t}$ during the pre-revocation period is negative and statistically significant but for the post-revocation period is not significantly distinguishable. This supports our hypothesis that voluntary liquidity-providing short-selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks. This conclusion is confirmed by a negative and significant value of difference-in-differences. In addition, we find a

significantly smaller coefficient on $trn_{i,(t+5,t+1)}$ for restricted stocks than for unrestricted stocks during the pre-revocation period, suggesting that short-selling activity helps to improve subsequent trading liquidity more efficiently without the uptick rule restriction.

As a robustness test, we use another measure of trading liquidity, the bid-ask spread, in our regression. Results not presented here are quantitatively similar to those in Table 4. The bid-ask spread is the difference between the ask price and the bid price, scaled by the average of ask and bid prices.

Taken together, we find evidence supporting our second hypothesis that voluntary liquidity-providing short selling is more profound in uptick-rule-restricted stocks than in unrestricted stocks.

4.3. Impact of the uptick rule on opportunistic risk-bearing short-selling strategy

In this section, we set out to examine if the uptick rule affects short sellers' opportunistic risk-bearing strategy. Diether et al. (2009a) suggest that short sellers may undertake opportunistic risk-bearing short-selling strategy, whereby they step in after a period in which uncertainty has been increasing. They tend to short more on days with high intraday volatility, and their trades are followed by days with lower volatility. We include measures of risk in our regression model while controlling for previously identified factors that determine the level of short-selling activity. The equation (7) is expressed as follows:

$$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+1,t+5)} + \beta_6 \cdot std_{i,t} + \beta_7 \cdot std_{i,(t+1,t+5)} + \varepsilon_{i,t}, \quad (7)$$

where $std_{i,t}$ is the proxy of intraday volatility, measured as the difference between day high and day low, scaled by the average of day high and day low. $std_{i,(t+1,t+5)}$ is the proxy of subsequent volatility, measured as the average of five-day intraday volatility during a period from day $t+1$ to $t+5$. If short sellers are opportunistic risk bearers, then we would expect a positive relation between short-selling activity and intraday volatility and a negative relation between short-selling activity and subsequent five-day stock volatility.

Empirical evidence on the impact of the uptick rule on stock price volatility is mixed. Alexander and Peterson (2008) find no evidence that the suspension of the uptick rule for pilot stocks on the NYSE during 2005 had an adverse effect on volatility, and Diether et al. (2009a) find that intra-day volatility increased slightly for pilot stocks. If the uptick rule helps mitigate stock price volatility, then we would expect less opportunistic risk-bearing short selling in uptick-rule-restricted stocks than in unrestricted stocks. A smaller coefficient on $std_{i,t}$ in restricted stocks than in unrestricted stocks would support our third hypothesis that opportunistic risk-bearing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks.

Results are presented in Table 5. It shows that coefficients on $std_{i,t}$ ($std_{i,(t+1,t+5)}$) are significantly positive (negative) for restricted and unrestricted stocks during pre- and post-revocation periods, confirming that short sellers follow the opportunistic risk-bearing strategies during both the pre- and post-revocation periods. However, the cross-sectional difference between restricted and unrestricted stocks during the pre-revocation period is not statistically distinguishable. In addition, the difference-in-differences for the coefficients of $std_{i,t}$ and

$std_{i,(t+1,t+5)}$ are not significantly different from zero. The hypothesis that opportunistic risk-bearing short selling is less profound in uptick-rule-restricted stocks than in unrestricted stocks is not supported by the results in Table 5.

4.4. Impact of the uptick rule on market-trend-chasing short-selling strategy

Examining short interest data for a period from 1960 to 2002, Lamont and Jones (2004) find that, on the aggregate level, short sellers follow the market trend; they short more (less) after a period in which the market has been declining (increasing). When the uptick rule is binding, short sellers who want to chase the market trend may not be able to submit short-sale orders aggressively on the downtick basis when the market is experiencing a downward trend. Therefore, we hypothesize that the uptick rule prevents short sellers from chasing market trends aggressively. To examine the relation between short-selling activity and market returns, we include contemporaneous market returns and past five-day market returns in our regression model while controlling for previously identified factors that determine the level of short-selling activity. We use the S&P 500 index return as the proxy for market return. The regression model is specified in equation (8).

$$\begin{aligned}
 ssr_{i,t} = & \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+1,t+5)} \\
 & + \beta_6 \cdot std_{i,t} + \beta_7 \cdot std_{i,(t+1,t+5)} + \beta_8 \cdot sptrn_{i,t} + \beta_9 \cdot sptrn_{i,(t-5,t-1)} + \varepsilon_{i,t}
 \end{aligned} \tag{8}$$

We expect to find a negative relation between short-selling activity and market returns if short sellers are market-trend chasers (or positive feedback traders or momentum traders).

Specifically, we expect the coefficients on $sptrn_{i,t}$ and on $sptrn_{i,(t-5,t-1)}$ to be significantly negative. Results reported in Table 6 show that coefficients on $sptrn_{i,t}$ and $sptrn_{i,(t-5,t-1)}$ are

significantly negative for both restricted and unrestricted stocks during both the pre- and post-revocation periods. This suggests that short sellers are following the market trend; they tend to short more (less) when the market declines (increases).

To test the hypothesis that market-trend-chasing short selling is less profound in restricted stocks than in unrestricted stocks, we calculate the cross-sectional differences between restricted and unrestricted stocks during the pre- and post-revocation periods. Results in Table 6 show that the magnitude of coefficients on $sptrn_{i,t}$ and $sptrn_{i,(t-5,t-1)}$ for restricted stocks is significantly smaller than for unrestricted stocks during the pre-revocation period. Specifically, during the pre-revocation period, a 1% market downward movement induces an increase in the short-selling ratio of 0.495 percentage point (a 2.69% increase in short-selling activity) for uptick-rule-restricted stocks. Meanwhile, a 1% market downward movement induces an increase in the short-selling ratio of 0.887 percentage point (a 3.95% increase in short-selling activity) for unrestricted stocks.

Results in Table 6 also show that a 10% five-day past market downward movement induces an increase in the short-selling ratio of nearly two percentage points (a 10.86% increase in short-selling activity) for uptick-rule-restricted stocks during the pre-revocation period. For unrestricted stocks in the same sample period, a 10% five-day past market downward movement induces an increase in the short-selling ratio of 4.26 percentage points (a 19% increase in short-selling activity). The cross-sectional difference between restricted and unrestricted is distinguishable from zero. Further, the difference-in-differences presented in column 7 shows that the net effect of the uptick rule on market-trend-chasing short selling is both statistically and economically significant.

Regression results in Table 6 support our hypothesis that the uptick rule plays an important role in preventing some short sellers from chasing market trends. DeLong et al. (1990) argue that market-trend-chasing trading (or momentum trading) destabilizes stock prices and threatens the efficiency of financial markets. An important implication of our results is that the uptick rule may help stabilize aggregate market returns and potentially improve market efficiency on the aggregate level. We conjecture that revoking the uptick rule may encourage aggressive market-trend chasing on the aggregate level and consequently has the potential to help generate a downward spiral when the market experiences a downward movement.

Extant literature agrees that the uptick rule prevents short sellers from registering their pessimistic opinions on stock prices in a timely manner, hampering the informational efficiency of the market (Boehmer et al., 2008; Diether et al., 2008; and Boehmer and Wu, 2009). These studies examine the issue on the individual stock level and do not rule out the possibility that the uptick rule may have a positive effect on market efficiency at the aggregate level. Therefore, our results are not necessary in conflict with previous studies.

4.5. Difference-in-differences regression model

To formally test the impact of the uptick rule on various short-selling strategies simultaneously, we adopt the following difference-in-differences regression model, expressed in equation (9).

$$\begin{aligned}
ssr_{i,t} = & \alpha + \gamma_1 ret_{i,(t-5,t-1)} + \gamma_2 D_1 ret_{i,(t-5,t-1)} + \gamma_3 D_2 ret_{i,(t-5,t-1)} + \gamma_4 D_1 D_2 ret_{i,(t-5,t-1)} + \gamma_5 ret_{i,t} + \gamma_6 D_1 ret_{i,t} \\
& + \gamma_7 D_2 ret_{i,t} + \gamma_8 D_1 D_2 ret_{i,t} + \gamma_9 D_1 ssr_{i,(t-5,t-1)} + \gamma_{10} ssr_{i,(t-5,t-1)} + \gamma_{11} D_2 ssr_{i,(t-5,t-1)} + \gamma_{12} D_1 D_2 ssr_{i,(t-5,t-1)} \\
& + \gamma_{13} tm_{i,t} + \gamma_{14} D_1 tm_{i,t} + \gamma_{15} D_2 tm_{i,t} + \gamma_{16} D_1 D_2 tm_{i,t} + \gamma_{17} tm_{i,(t+1,t+5)} + \gamma_{18} D_1 tm_{i,(t+1,t+5)} + \gamma_{19} D_2 tm_{i,(t+1,t+5)} \\
& + \gamma_{20} D_1 D_2 tm_{i,(t+1,t+5)} + \gamma_{21} std_{i,t} + \gamma_{22} D_1 std_{i,t} + \gamma_{23} D_2 std_{i,t} + \gamma_{24} D_1 D_2 std_{i,t} + \gamma_{25} std_{i,(t+1,t+5)} + \gamma_{26} D_1 std_{i,(t+1,t+5)} \\
& + \gamma_{27} D_2 std_{i,(t+1,t+5)} + \gamma_{28} D_1 D_2 std_{i,(t+1,t+5)} + \gamma_{29} sptm_t + \gamma_{30} D_1 sptm_t + \gamma_{31} D_2 sptm_t + \gamma_{32} D_1 D_2 sptm_t + \gamma_{33} sptm_{(t-5,t-1)} \\
& + \gamma_{34} D_1 sptm_{(t-5,t-1)} + \gamma_{35} D_2 sptm_{(t-5,t-1)} + \gamma_{36} D_1 D_2 sptm_{(t-5,t-1)} + \varepsilon_{i,t}
\end{aligned} \tag{9}$$

where D1 equals one if it is in the pre-revocation period and zero otherwise. D2 equals one if a stock is in the restricted sample and zero otherwise. In equation (9), the net effect of the uptick rule on contrarian short selling, liquidity-providing short selling, opportunistic risk-bearing short selling, and market-trend-chasing short selling, are expressed in γ_4 , γ_{16} , γ_{24} , and γ_{32} , respectively.

Results presented in Table 7 show that coefficients γ_4 , γ_{16} , and γ_{32} are distinguishable from zero, confirming our previous results and providing robust evidence supporting our first, second, and fourth hypotheses: when the uptick rule is in place, contrarian short selling is more profound, liquidity short selling is more profound, and market-trend-chasing short selling is less profound. It also shows that the coefficient on γ_{24} is not different from zero. The hypothesis that opportunistic risk-bearing short selling is more profound in restricted than unrestricted stocks is not supported by our results.

5. Conclusions

Extant literature suggests that short sellers are not alike; they are contrarians, liquidity providers, opportunistic risk bearers, and market-trend chasers. Although short selling is legally allowed in the U.S., short sales are constrained by a number of restrictions. One of these short-

sale constraints, the uptick rule prohibiting short sales from being executed on the downtick basis, has the potential of shaping short sellers' behavior in different ways. The effect of the uptick rule on market quality and efficiency has been studied in recent years. However, the literature remains silent on whether the uptick rule affects short sellers' trading strategies. In this paper, we fill this gap by examining the impact of the uptick rule on four previously documented short-selling trading strategies: contrarian, liquidity providing, opportunistic risk bearing, and market trend chasing. Using a unique short-sale dataset that covers an eight-month period surrounding the SEC's July 2007 revocation of the uptick rule, we are able to compare short-selling activities for restricted and unrestricted stocks during both the pre-and post-revoking periods.

Consistent with Diether et al. (2009b), our results confirm that short sellers are contrarians who tend to short more (less) following a positive (negative) stock price run-up. More important, we find that contrarian short selling is different between restricted and unrestricted stocks during the pre-revocation period but similar during the post-revocation period. While a 10% five-day stock price run-up in restricted stock during the pre-revocation period leads to an increase of more than 20% in short-selling activity, the same amount of price run-up during the same period in unrestricted stocks leads only to less than a 10% increase in short-selling activity, suggesting that contrarian short selling is more profound in restricted than in unrestricted stocks. We also find evidence supporting the second hypothesis that liquidity-providing short selling is more profound in restricted stocks than in unrestricted stocks. The results are robust after accommodating other factors that determine short-selling activity. The conclusions are also supported by results of difference-in-difference analysis and difference-in-difference regressions. Furthermore, we hypothesize that the uptick rule has the potential to curb stock-price volatility,

therefore discouraging opportunistic risk-bearing short selling. However, this hypothesis is not supported by our results.

Last, we test whether the uptick rule has any impact on market-trend-chasing short selling. Our results show that short sellers follow market trends; they short more (less) after a period in which the market has been declining (increasing) for several days. We also find evidence that uptick-rule-restricted stocks exhibit less market-trend chasing than unrestricted stocks. Market-trend-chasing trading has the potential to lift up market volatility and destabilize stock markets. Our finding here indicates that the uptick rule may play an important role in stabilizing stock markets at the aggregate level. We conjecture that revoking the uptick rule may encourage aggressive market-trend chasing at the aggregate level and consequently has the potential to help generate a downward spiral when the market experiences a downward movement. Future research on this issue would generate fruitful results that would provide valuable information to stock market regulators and practitioners.

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Table 1. Descriptive summary of restricted and unrestricted samples during pre- and post-revocation periods

The table presents a descriptive summary of restricted and unrestricted samples during both pre-and post-revocation periods. There are 322 matched pairs of uptick-rule restricted and unrestricted stocks in our samples. The pre-revocation period is from March to June 2007, and the post-revocation period is from July to October 2007. Panel A reports stock characteristics, and panel B reports stock-selling activity. Standard errors are in parentheses. Statistical significance of difference-in-differences is evaluated using Wilcoxon rank sum tests. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A Stock Characteristics	Pre-revocation			Post-revocation			Difference-in- -difference
	Restricted	Unrestricted	Difference	Restricted	Unrestricted	Difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
Equity market value (\$ million)	10350 (1211)	11173 (1355)	-823 (1817.3)	10237 (1211)	11050 (1330)	-813 (1798.73)	-10
Market-to-book ratio	0.538 (0.018)	0.558 (0.02)	-0.02 (0.030)	0.559 (0.021)	0.537 (0.019)	0.022 (0.030)	-0.042
Stock price (\$)	43.46 (1.89)	49.08 (3.13)	-5.62 (3.7)	41.92 (2.03)	47.94 (3.24)	-6.02 (3.82)	0.4
Trading volume (thousand shares)	1836 (160)	2050 (226)	-214 (276.9)	2197 (181)	2438 (181)	-241 (255.97)	27
Shares outstanding (million shares)	229 (24)	251 (33)	-22 (40.8)	230 (24)	252 (33)	-22 (40.80)	0
Spread	0.0011 (0.00003)	0.0012 (0.00003)	-0.0001** (0.00004)	0.00184 (0.00004)	0.00182 (0.00005)	0.00001 (0.00006)	-0.0001
Shares turnover	0.0100 (0.0004)	0.0104 (0.0004)	-0.0004 (0.0005)	0.0123 (0.0005)	0.0120 (0.0005)	0.0003 (0.0007)	-0.0007

Table 1 Continued

Panel B. Short Sale Activity	<u>Pre-revocation</u>			<u>Post-revocation</u>			Difference-in -difference
	Restricted	Unrestricted	Difference	Restricted	Unrestricted	Difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
# of short sale trades	803.8 (39.82)	1176.6 (62.64)	-372.8*** (74.2)	1503 (74.41)	1573.7 (88.47)	-70.7 (115.60)	-302.1***
Short sale volume (1,000 shares)	278 (20)	360 (33)	-82** (38.6)	366 (25)	394 (35)	-28 (43.01)	-54
size of short sale trades (shares)	270.1 (6.59)	236.6 (6.25)	33.5*** (9.1)	201.28 (3.53)	198.38 (3.99)	2.9 (5.32)	30.6***
short sale ratio	0.184 (0.003)	0.224 (0.003)	-0.040*** (0.0)	0.211 (0.003)	0.218 (0.003)	-0.007 (0.004)	-0.034***

Table 2. Impact of the uptick rule on contrarian short-selling strategies

Panel A reports the results of estimating a two-way fixed-effect panel regression for our samples of restricted and unrestricted stocks.

$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \varepsilon_{i,t}$. The dependent variable is the short-sale ratio on day t, and the independent variable is the cumulative stock return from days t-5 to t-1. Panel B reports the results of estimating a two-way fixed-effect panel regression specified as

$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \varepsilon_{i,t}$, where $ret_{i,t}$ is contemporaneous stock return, and $ssr_{i,(t-5,t-1)}$ is the short-sale ratio during a five-day period from days t-5 to t-1. Differences of coefficients between the restricted and unrestricted samples during the pre- and post-revocation periods are presented in columns [3] and [6], and difference-in-difference is presented in column [7] in both panels. Standard errors are in parentheses. Statistical significance of difference-in-differences is evaluated using Wilcoxon rank sum tests. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Panel A.

Variables	Pre-revocation			Post-revocation			Difference-in-differences
	Restricted	Unrestricted	Difference	Restricted	Unrestricted	Difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
intercept	0.165*** (0.009)	0.26*** (0.011)	-0.095*** (0.014)	0.246*** (0.008)	0.239*** (0.008)	0.007 (0.012)	-0.102***
ret(-5,-1)	0.376*** (0.024)	0.192*** (0.011)	0.184*** (0.027)	0.126*** (0.009)	0.143*** (0.010)	-0.017 (0.013)	0.201***
r^2	36.92%	30.36%		44.26%	45.34%		
Stock fixed effect	yes	yes		yes	yes		
Day fixed effect	no	no		no	no		

Table 2 Continued

Panel B

	<u>Pre- revocation</u>			<u>Post- revocation</u>			Difference-in -differences
	Restricted [1]	Unrestricted [2]	Difference [3]=[1]-[2]	Restricted [4]	Unrestricted [5]	Difference [6]=[4]-[5]	
intercept	0.097*** (0.008)	0.172*** (0.011)	-0.075*** (0.013)	0.132*** (0.008)	0.125*** (0.008)	0.007 (0.011)	-0.082***
ret(-5,-1)	0.147*** (0.014)	0.1007*** (0.018)	0.046** (0.022)	0.091*** (0.008)	0.11*** (0.009)	-0.019 (0.013)	0.065***
ret	0.775*** (0.028)	0.743*** (0.037)	0.032 (0.047)	0.190*** (0.017)	0.23*** (0.019)	-0.040 (0.026)	0.072
ssr(-5,-1)	0.385*** (0.011)	0.485*** (0.009)	-0.105*** (0.014)	0.491*** (0.009)	0.478*** (0.009)	0.013 (0.013)	-0.118***
r^2	44.25%	34.68%		49.65%	51.01%		
Stock fixed effect	yes	yes		yes	yes		
Day fixed effect	no	no		no	no		

Table 3. Difference-in-differences regression: The uptick rule and contrarian short-selling strategy

Columns [1] and [2] of the table present OLS regression results for difference-in-difference models specified in equations (3) and (5). $D1 = 1$ if the observation is in the pre-revocation period and zero otherwise. $D2 = 1$ if the stock is in the restricted sample and zero otherwise. Standard errors are in parentheses. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	[1]	[2]
intercept	-0.026*** (0.001)	-0.003*** (0.001)
ret(t-5,t-1)	0.220*** (0.059)	0.209*** (0.059)
D1*ret(t-5,t-1)	0.257** (0.104)	0.322*** (0.104)
D2*ret(t-5,t-1)	-0.042 (0.067)	-0.032 (0.067)
D1*D2*ret(t-5,t-1)	0.245** (0.120)	0.237** (0.118)
ret		0.369*** (0.123)
D1*ret		2.472 (2.230)
D2*ret		-0.034 (0.141)
D1*D2*ret		1.005 (0.954)
ssr(t-5,t-1)		0.324*** (0.128)
D1*ssr(t-5,t-1)		-0.149** (0.063)
D2*ssr(t-5,t-1)		0.075 (0.093)
D1*D2*ssr(t-5,t-1)		-0.383** (0.158)
r^2	0.076	0.128

Table 4. Impact of the uptick rule on voluntary-liquidity-providing short-selling strategies

The table reports the results of estimating the following equation:

$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+5,t+1)} + \varepsilon_{i,t}$. The dependent variable is the short-sale ratio on day t, $ret_{i,(t-5,t-1)}$ is the past five-day cumulative stock return from days t-5 to t-1, $ret_{i,t}$ is contemporaneous stock returns, $ssr_{i,(t-5,t-1)}$ is the average short-sale ratio during a five-day period from days t-5 to t-1, $trn_{i,t}$ is contemporaneous shares turnover, and $trn_{i,(t+5,t+1)}$ is the subsequent five-day average shares turnover. Differences of coefficients between the restricted and unrestricted samples during the pre- and post-revocation periods are presented in columns [3] and [6], and difference-in-difference is presented in column [7]. Standard errors are in parentheses. Statistical significance of difference-in-difference is evaluated using means and Wilcoxon rank sum tests. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	<u>Pre-revoking</u>			<u>Post-revoking</u>			Difference-in-difference
	restricted	unrestricted	difference	restricted	unrestricted	difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
intercept	0.101*** (0.008)	0.185*** (0.011)	-0.083*** (0.014)	0.135*** (0.008)	0.135*** (0.008)	0.000 (0.012)	-0.083***
ret(t-5,t-1)	0.149*** (0.010)	0.105*** (0.009)	0.044*** (0.013)	0.078*** (0.008)	0.089*** (0.009)	-0.011 (0.012)	0.055***
ret	0.821*** (0.028)	0.802*** (0.037)	0.019 (0.047)	0.175*** (0.017)	0.216*** (0.019)	-0.041 (0.026)	0.059
ssr(t-5,t-1)	0.382*** (0.009)	0.487*** (0.011)	-0.105*** (0.014)	0.483*** (0.009)	0.492*** (0.009)	-0.009 (0.013)	-0.096***
trn	-1.188*** (0.067)	-0.857*** (0.051)	-0.331*** (0.084)	-0.840*** (0.048)	-0.784*** (0.039)	-0.056 (0.062)	-0.275***
trn (t+5,t+1)	0.289*** (0.082)	0.638*** (0.109)	-0.348*** (0.136)	0.555*** (0.061)	0.572*** (0.069)	-0.017 (0.092)	-0.331**
r^2	44.85%	35.47%		50.39%	52.09%		
Stock fixed effect	yes	yes		yes	yes		
Day fixed effect	no	no		no	no		

Table 5. Impact of the uptick rule on opportunistic risk-bearing short-selling strategies

The table reports the results of estimating the following equation:

$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+1,t+5)} + \beta_6 \cdot std_{i,t} + \beta_7 \cdot std_{i,(t+1,t+5)} + \varepsilon_{i,t}$. The dependent variable is the short-sale ratio on day t, $ret_{i,(t-5,t-1)}$ is the past five-day cumulative stock return from days t-5 to t-1, $ret_{i,t}$ is contemporaneous stock returns, $ssr_{i,(t-5,t-1)}$ is the short-sale ratio during a five-day period from days t-5 to t-1, $trn_{i,t}$ is contemporaneous shares turnover, and $trn_{i,(t+5,t+1)}$ is the subsequent five-day average shares turnover. $std_{i,t}$ is the proxy of intraday volatility, measured as the difference between day high and day low, scaled by the average of day high and day low; $std_{i,(t+1,t+5)}$ is the proxy of subsequent volatility, measured as the average of five-day intraday volatility during a period from days t+1 to t+5. Differences of coefficients between the restricted and unrestricted samples during the pre- and post-revocation periods are presented in columns [3] and [6], and difference-in-difference is presented in column [7]. Standard errors are in parentheses. Statistical significance of difference-in-difference is evaluated using means and Wilcoxon rank sum tests. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	Pre-revocation			Post-revocation			Difference-in-difference
	Restricted	Unrestricted	Difference	Restricted	Unrestricted	Difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
intercept	0.089*** (0.008)	0.175*** (0.011)	-0.087*** (0.014)	0.132*** (0.008)	0.135*** (0.008)	-0.003 (0.012)	-0.083***
ret(t-5,t-1)	0.150*** (0.014)	0.108*** (0.016)	0.042** (0.021)	0.081*** (0.008)	0.091*** (0.009)	-0.010 (0.012)	0.052**
ret	0.801*** (0.028)	0.748*** (0.037)	0.053 (0.047)	0.212*** (0.017)	0.189*** (0.019)	0.023 (0.026)	0.030
ssr(t-5,t-1)	0.383*** (0.009)	0.485*** (0.011)	-0.102*** (0.014)	0.484*** (0.009)	0.493*** (0.009)	-0.010 (0.013)	-0.093***
trn	-1.170*** (0.076)	-0.816*** (0.056)	-0.354*** (0.094)	-1.032*** (0.053)	-0.938*** (0.043)	-0.094 (0.068)	0.260**

trn (t+5,t+1)	0.475*** (0.092)	0.781*** (0.123)	-0.306** (0.154)	0.760*** (0.069)	0.697*** (0.078)	0.062 (0.104)	-0.369**
std	0.784*** (0.044)	0.665*** (0.060)	0.118 (0.074)	0.226*** (0.027)	0.246*** (0.029)	-0.020 (0.040)	0.139
std(t+5,t+1)	-0.203*** (0.085)	-0.296** (0.116)	0.093 (0.144)	-0.239*** (0.048)	-0.281*** (0.055)	0.042 (0.073)	0.051
r^2	45.59%	35.79%		50.53%	52.24%		
Stock fixed effect	yes	yes		yes	yes		
Day fixed effect	no	no		no	no		

Table 6. The impact of the uptick rule on market-trend-chasing short-selling strategies

The table reports the results of estimating the following equation:

$$ssr_{i,t} = \alpha + \beta_1 \cdot ret_{i,(t-5,t-1)} + \beta_2 \cdot ret_{i,t} + \beta_3 \cdot ssr_{i,(t-5,t-1)} + \beta_4 \cdot trn_{i,t} + \beta_5 \cdot trn_{i,(t+1,t+5)} + \beta_6 \cdot std_{i,t} + \beta_7 \cdot std_{i,(t+1,t+5)} + \beta_8 \cdot sptrn_t + \beta_9 \cdot sptrn_{(t-5,t-1)} + \varepsilon_{i,t}$$

. The dependent variable is the short-sale ratio on day t ; $ret_{i,(t-5,t-1)}$ is the past five-day cumulative stock return from days $t-5$ to $t-1$; $ret_{i,t}$ is contemporaneous stock returns; $ssr_{i,(t-5,t-1)}$ is the short-sale ratio during a five-day period from days $t-5$ to $t-1$; $trn_{i,t}$ is contemporaneous shares turnover; $trn_{i,(t+5,t+1)}$ is subsequent five-day average shares turnover; $std_{i,t}$ is the proxy of intraday volatility, measured as the difference between day high and day low, scaled by the average of day high and day low; $std_{i,(t+1,t+5)}$ is the proxy of subsequent volatility, measured as the average of five-day intraday volatility during a period from days $t+1$ to $t+5$; $sptrn_t$ is the S&P 500 index return on day t ; and $sptrn_{i,(t-5,t-1)}$ is past five-day S&P 500 index cumulative return from days $t-5$ to $t-1$. Differences of coefficients between the restricted and unrestricted samples during the pre- and post-revocation periods are presented in columns [3] and [6], and difference-in-difference is presented in column [7]. Standard errors are in parentheses. Statistical significance of difference-in-difference is evaluated using means and Wilcoxon rank sum tests. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables	Pre-revocation			Post-revocation			Difference-in-difference
	Restricted	Unrestricted	Difference	Restricted	Unrestricted	Difference	
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]=[4]-[5]	[7]=[3]-[6]
intercept	0.072*** (0.008)	0.153*** (0.010)	-0.081*** (0.013)	0.137*** (0.008)	0.135*** (0.008)	0.002 (0.011)	-0.083***
ret(t-5,t-1)	0.151*** (0.014)	0.110*** (0.013)	0.041** (0.019)	0.095*** (0.009)	0.102*** (0.010)	-0.007 (0.013)	0.048**
ret	0.776*** (0.028)	0.709*** (0.037)	0.067 (0.046)	0.174*** (0.020)	0.147*** (0.019)	0.027 (0.027)	0.040
ssr(t-5,t-1)	0.380*** (0.009)	0.486*** (0.011)	-0.106*** (0.014)	0.482*** (0.009)	0.501*** (0.009)	-0.019 (0.013)	-0.087***

trn	-1.602*** (0.076)	-1.350*** (0.056)	-0.252*** (0.094)	-1.322*** (0.045)	-1.230*** (0.054)	-0.092 (0.070)	-0.16**
trn (t+5,t+1)	0.535*** (0.093)	0.853*** (0.124)	-0.318** (0.155)	0.592*** (0.071)	0.497*** (0.081)	0.095 (0.108)	-0.413**
std	0.852*** (0.043)	0.721*** (0.058)	0.131* (0.072)	0.167*** (0.026)	0.127*** (0.028)	0.040 (0.038)	0.091
std(t+5,t+1)	-0.231*** (0.082)	-0.333*** (0.112)	0.102 (0.139)	-0.268*** (0.039)	-0.308*** (0.044)	0.040 (0.059)	0.062
sptrn	-0.495*** (0.067)	-0.887*** (0.087)	0.392*** (0.110)	-0.868*** (0.040)	-0.960*** (0.041)	0.092* (0.057)	0.300**
sptrn(-5,-1)	-0.199*** (0.033)	-0.426*** (0.042)	0.228*** (0.053)	-0.272*** (0.022)	-0.268*** (0.023)	-0.004 (0.032)	0.232***
r^2	44.18%	34.32%		45.45%	47.10%		
Stock fixed effect	yes	yes		yes	yes		
Day fixed effect	no	no		no	no		

Table 7. Difference-in-difference regression

The table reports results of estimating a difference-in-difference regression model specified in equation (9). D1 is the pre- and post-indicator dummy variable. D1 = 1 if the observation is in the pre-revocation period and zero otherwise. D2 is the uptick-rule-restriction indicator (dummy) variable. D2 = 1 if the stock is uptick-rule restricted and zero otherwise. Standard errors are in parentheses. ***, **, and * are significant at the 1%, 5%, and 10% level, respectively.

Variables		Variables		Variables		Variables	
intercept	0.033*** (0.003)	ssr(t-5,t-1)	0.343*** (0.126)	D1*trn(t+1,t+5)	-1.089** (0.530)	D2*std(t+1,t+5)	-0.079 (0.254)
ret(t-5,t-1)	0.331*** (0.067)	D1*ssr(-5,-1)	-0.141*** (0.062)	D2*trn(t+1,t+5)	0.249 (0.677)	D1*D2*std(t+1,t+5)	0.067 (0.480)
D1*ret(-5,-1)	0.508*** (0.115)	D2*ssr(-5,-1)	-0.072 (0.098)	D1*D2*trn(t+1,t+5)	-0.632*** (0.266)	sptrn	-4.384*** (0.303)
D2*ret(-5,-1)	0.033 (0.074)	D1*D2*ssr(-5,-1)	-0.403*** (0.164)	std	-0.717*** (0.262)	D1*sptrn	-1.030** (0.501)
D1*D2*ret(-5,-1)	0.423*** (0.183)	trn	-6.603*** (0.393)	D1*std	0.717 (0.656)	D2*sptrn	0.057 (0.351)
ret	0.517*** (0.140)	D1*trn	-1.535*** (0.435)	D2*std	0.265 (0.217)	D1*D2*sptrn	0.454*** (0.181)
D1*ret	-0.158 (0.159)	D2*trn	1.007** (0.547)	D1*D2*std	0.325 (0.402)	sptrn(t-5,t-1)	-1.566*** (0.159)
D2*ret	2.487 (2.490)	D1*D2*trn	-0.491*** (0.113)	std(t+1,t+5)	-1.306*** (0.427)	D1*sptrn(t-5,t-1)	0.487** (0.232)
D1*D2*ret	1.003 (0.983)	trn(t+1,t+5)	5.241*** (0.470)	D1*std(t+1,t+5)	-0.094 (0.132)	D2*sptrn(t-5,t-1)	-0.044 (0.184)
r^2	0.253					D1*D2*sptrn(t-5,t-1)	0.560** (0.238)