Journal of Financial Intermediation **8**, 90–116 (1999)
Article ID jfin.1998.0254, available online at http://www.idealibrary.com on IDEAL®

Short Selling on the New York Stock Exchange and the Effects of the Uptick Rule*

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Received November 21, 1997

We examine the impact of Rule 10a-1, the Uptick Rule, on short-sell orders sent to the NYSE. The principal finding is that the execution quality of short-sell orders is adversely affected by the Uptick Rule, even when stocks are trading in advancing markets. This is inconsistent with one of the three stated objectives of the rule, i.e., to allow relatively unrestricted short selling when a firm's stock is advancing so that the rule does not affect price discovery during such times. *Journal of Economic Literature* Classification Numbers: G18, K22 © 1999 Academic Press

Of the various restrictions on short selling, there is perhaps none more controversial than the Uptick Rule.[1] The Securities and Exchange Commission's ("SEC") Uptick Rule, which restricts market participants from short selling exchange-listed stocks on downticks or zero-minus ticks, has been in effect since 1938. The stated

* We are grateful for discussions with and comments from Franklin Allen, Blair Corkran, Maureen O'Hara, Erik Sirri, and the referee, and for computer assistance from Peter Martin. The U.S. Securities and Exchange Commission, as a matter of policy, disclaims any responsibility for any private publication or statements by any of its employees. The views expressed herein are those of the authors and do not necessarily reflect the views of the Commission or of the authors' colleagues on the staff of the Commission.

[1] Other restrictions on short selling include prohibiting shorting by certain institutional investors and corporate insiders, finding an insufficient pool of shares to borrow, forcing the covering of a short position, requiring margin, and limiting the reinvestment of short sales proceeds.

1042-9573/99 $30.00

objectives of the Uptick Rule are to: (1) allow relatively unrestricted short selling when the firm's stock is advancing; (2) prevent short selling of the firm's stock at successively lower prices; and (3) prevent short sellers from accelerating a declining market in a firm's stock by exhausting all remaining bids at one price level, thereby causing successively lower prices to be established by long sellers.[2]

To date the empirical evidence on the transaction level effects of the Uptick Rule is scant. With few exceptions, much of the data behind the analysis of short selling has been limited to monthly observations of short interest reported by the exchanges. Nevertheless, Ramsay (1993) contends regulators have ignored most of the evidence challenging the objectives underlying the Uptick Rule.

The purpose of this study is to empirically evaluate the effects of the Uptick Rule on short-sell orders sent to the New York Stock Exchange ("NYSE") through its automated SuperDOT system and thus to gain some insights into its effect on price discovery.[3] In particular, we focus on two questions. First, we address the effectiveness of the rule by asking if the Uptick Rule meets its intended objectives. Second we ask how the Uptick Rule affects the execution quality of short-sell orders. The importance of understanding the effects of the Uptick Rule is illustrated by noting that the London Stock Exchange and the Tokyo Stock Exchange do not have such a rule, but in addition to the organized exchanges in the U.S., the Toronto Stock Exchange does have such a rule. In addition, a short-sell rule similar (but not identical) to the NYSE's Uptick Rule was introduced in 1994 on a pilot basis by Nasdaq. Hence, there appears to be a difference of opinion around the world about whether such a rule should be part of the design of a financial market.

We assess the direct effects of the rule on investors by comparing short-sell orders to regular-sell orders across several execution quality measures. These measures include the probability of execution, the time to execution, and the frequency of price improvement. The primary observation is that the Uptick Rule impedes short selling, regardless of whether a stock is trading on an uptick or a downtick. Executed short-sell orders receive price improvements significantly more often than regular-sell orders, a finding that is directly attributable to the Uptick Rule. As specialist participation rates are relatively low (less than 10% of executed short-sell orders), the gains from price improvement would not appear to be coming from a decrease in dealer profits. Offsetting the gains to short sellers from price improvement, however, are the opportunity costs of foregone trades, as short-sell orders tend to be canceled or remain unfilled more often than regular-sell orders. With regard to the intended objectives, we find some evidence that the second and third objectives of the Uptick Rule have been met. However, it appears that the first objective has not been met.

We have organized the rest of this paper as follows. Section 1 reviews the rules and regulations on short selling. Section 2 provides a brief review of the literature

[2] Securities Act Release No. 16964, July 9, 1980.

[3] See Macey *et al.* (1989) for a discussion of the impact of the Uptick Rule on price discovery.

regarding short selling. Section 3 provides a summary of the sample and data. Section 4 is an examination of whether the Uptick Rule is meeting its stated objectives. Section 5 reports some additional results regarding the impact of the Uptick Rule on the quality of order execution. Section 6 is the conclusion.

1. SHORT SELLING REGULATION AND THE HANDLING OF SHORT ORDERS

Short selling rules are imposed by the SEC and the exchanges. Rule 10a-1 under the Securities Exchange Act of 1934 is the Uptick Rule.[4] This rule defines the lowest price at which a short-sell order can be executed. The lowest shortable price is determined by a stock's most recent price change. If a stock is trading on an uptick or a zero-uptick, a short-sell order can execute at the last trade price or higher. If a stock is trading on a downtick or a zero-downtick, a short-sell order must execute at a price higher than the last trade. For example, if a stock trades at \$20, \$20-1/8, and \$20-1/8, the lowest shortable price is \$20-1/8. However, if a stock trades at \$20, \$19-7/8, and \$19-7/8, the lowest shortable price is \$20.

Rule 10a-1 allows each exchange to elect whether short-sell orders are to be governed by the "tick test" in terms of either its own market or all markets in an effective transaction reporting plan as defined in Rule 11Aa3-1.[5] In other words, each exchange may utilize transaction prices on its particular exchange as the basis for determining tick status or the exchange may use transactions from the consolidated tape. Currently, the New York Stock Exchange and the American Stock Exchange use their own transactions as the reference and the regional exchanges use transactions reported on the consolidated tape as the reference. Other rules concerning short-selling include Rule 3b-3, which defines a short sale, and Rule 10a-2, which addresses the covering of short sales.

As shown below, it is frequently the case that market shorts cannot execute at the prevailing bid. In this case the short market order takes the form of a limit order. The limit price is set to the lowest price at which the short-sell order can legally be executed. The specialist maintains price and time priority upon receiving a short market order that cannot be executed immediately.

2. PREVIOUS STUDIES REGARDING SHORT SELLING

Angel (1997) has conducted the first academic study of short selling on the NYSE that uses intraday data. He utilized the TORQ database to provide summary

[4] Congress gave the SEC the authority to regulate short selling when it passed the Securities Exchange Act of 1934. As a result the SEC instituted the Uptick Rule in 1938. For a history and debate on the Uptick Rule, see Macey *et al*. (1989), Ramsay (1993), Worley (1990), and SEC (1963).

[5] See Rule 10a-1(a)(2) of the 1934 Act for exemptions to 10a-1.

statistics on short-sell order characteristics such as trade sizes, account types submitting orders, time-of-day order patterns, and the price impact of short sales. Angel documents that the Uptick Rule prohibits short selling at the bid over 90% of the time and prevents short selling altogether approximately 6% of the time, suggesting the Uptick Rule impedes short selling. Furthermore, the national best bid and offer ("NBBO") is typically lowered after the placement of a short-sell order, albeit by a small amount, relative to its position just before the order was placed. The prevalence of non-speculative short selling is also emphasized, which is of interest since there is no practical benefit of the Uptick Rule for orders of this type.

Aitken *et al*. (1997) investigate the intraday price behavior of short-sell orders on the Australian Stock Exchange ("ASX"). They observe that market bid and ask prices move systematically upward in the 15-minute interval prior to short trades initiated with market orders. They attribute this price behavior to the ASX's uptick rule.[6] Also, they find arbitrage and hedge-related short sales typically do not cause a price reaction, while short sales executed immediately prior to an information event tend to precede a significant price reaction.

Pollack (1986) surveys the studies on the regulation of short selling to address what, if any, additional short-selling regulation is desirable for the Nasdaq market. He concludes that the preponderance of short selling is done by market professionals engaged in the day-to-day provision of liquidity to the market. With regard to the Uptick Rule, he reasons that tick restrictions that broadly impact all short-selling activities may be of questionable utility.

Hatheway (1994) examines the role of the Uptick Rule in explaining the end-of-day price rise observed on the NYSE. The paper argues that rising prices best enable the specialist to extract information from the flow of trading and maximize available liquidity. One implication is that the Uptick Rule presents additional risk to the specialist of not being able to allow short sales at the opening. Consequently, the Uptick Rule causes the specialist to change his or her behavior to minimize this risk. Risk mitigation does not come without a cost, however. Since this cost is difficult to estimate and because it likely represents a small fraction of the total cost of the Uptick Rule, it is not pursued here.

3. SAMPLE AND DATA SOURCES

3.1. Sample Selection

The study is conducted using a representative sample of stocks listed on the NYSE during the month of May 1996. The final sample is composed of 300 NYSE-listed stocks. Since several studies have found differences in short selling behavior between stocks with traded options and stocks without traded options,

[6] Interestingly, they note that subsequent to their sample period, the ASX eliminated their uptick rule.

the sample was constrained to have one-half of the 300 stocks be ones that have traded options.[7]

The sample was generated as follows: all NYSE-listed stocks were ranked by market capitalization of equity as of December 31, 1995.[8] The stocks were then divided into three groups with equal numbers of members based on size, i.e., stocks of small firms, medium firms, and large firms. For each group the number of stocks with and without traded options were then counted. From the subgroup with the smaller number of stocks, 50 stocks were selected at random. From the complementary subgroup, stocks were matched first by SIC and then by market capitalization.

Table I summarizes the sample characteristics. The average 1995 year-end market capitalization (MKTCAP) for stocks with traded options is $1.7 billion and that for stocks without traded options is $1.4 billion.[9] The average trading volume (VOLUME) and the average short interest (SHORTINT) are both about twice as high for stocks with traded options.[10] The ratio of short interest to shares outstanding (PCTSHORT) is higher for large and medium firms that have traded options, but lower for small firms with traded options. Additionally, the average institutional ownership (PCTINST) is 34% for the options sample and 27% for the no-options sample.

The SuperDOT sample data indicate that 68%, 21%, and 11% of the sample short-sell order volume was accounted for by large, medium, and small firms, respectively. Additionally, 53% of the short-sell orders came from 25 stocks and 96% of the short-sell orders came from 150 stocks. Thus, the existence of SuperDOT short-sell orders was largely absent for approximately one-half of the sample.[11]

During May 1996 the NYSE Composite index increased 12 days and decreased 10 days, with similar results for the Dow Jones Industrial Average ("DJIA"). The average daily returns were 0.08%, 0.06%, and 0.10%, for the sample, DJIA, and NYSE Composite, respectively. In terms of trading activity, there did not appear to be any days with unusual trading volume. The volume of NYSE-listed stocks across all exchanges ranged from 329 million shares to 493 million shares, averaging about 400 million shares per day. As a percentage, the stocks in the

[7] Diamond and Verrecchia (1987) argue that the introduction of options trading will increase the speed of adjustment to private information, and as a consequence, reduce the informativeness of short sales. See also Jennings and Starks (1986), Conrad (1989), Senchack and Starks (1993), and Figlewski and Webb (1993). In general, other than a noticeable difference in the number of orders, there was no statistically significant difference between the options and no-options samples.

[8] Any issues that were shares of closed-end funds, REITs, or firms domiciled outside the United States were excluded. Also excluded were any issues that were not ordinary common shares.

[9] Differences in mean MKTCAP are due to matching first by SIC and then by size.

[10] Figlewski and Webb (1993) and Senchack and Starks (1993) find that stocks with traded options have larger short interest, all else equal.

[11] A logistic regression was run in order to see what characteristics separated those 150 stocks that had substantive amounts of short selling from those that did not. The results indicated that the stocks without much short selling tended to have small market capitalizations and low trading volume, were not members of the S&P 500, and did not have traded options.

TABLE I
Sample Summary

Size group	Average MKTCAP	Average SHORTINT	Average PCTSHORT	Average VOLUME	Average PCTINST
		Panel A: 150 stocks with traded options			
Large firms	4243.1	2.4	2.50%	100.8	34.6%
Medium firms	741.7	1.0	2.60%	32.8	38.1%
Small firms	197.4	0.5	2.70%	30.0	30.1%
All	1727.4	1.0	2.60%	54.5	34.3%
		Panel B: 150 stocks without traded options			
Large firms	3419.0	1.2	1.24%	40.1	24.0%
Medium firms	625.1	0.3	1.28%	11.4	25.9%
Small firms	197.1	0.4	3.54%	9.5	29.6%
All	1413.7	0.6	2.04%	20.3	26.5%
		Panel C: Full sample			
Large firms	3831.1	1.8*	1.86%*	70.5*	29.3%*
Medium firms	683.4	0.7*	1.93%	21.6*	32.0%*
Small firms	197.3	0.4	3.12%	19.8*	29.9%
All	1570.6	0.8*	2.32%	37.4*	30.4%*

Note. This table reports summary statistics for a sample of NYSE-listed stocks. The sample was derived as follows. All issues of ordinary common shares were ranked, except for closed-end funds, REITs, or shares of firms domiciled outside the U.S., by market capitalization as of December 31, 1995. The sample was divided into three groups with equal number of members. For each group the number of stocks that had traded options and those that did not have traded options were counted. From the sub-group with lower number of members 50 stocks were selected at random. From the complementary sub-group stocks were matched by SIC (first by 4-digit, then by 3-digit, 2-digit, and 1-digit), then by market capitalization. MKTCAP is the market capitalization of equity in millions of dollars measured on December 31, 1995. SHORTINT is the short interest for May 1996 in millions of shares (Source: *Daily Stock Price Record*). PCTSHORT is the percentage of shares outstanding that are held short in May 1996. VOLUME is the cumulative trading volume in 1995 in millions of shares (Source: *Center for Research in Security Prices*, University of Chicago). PCTINST is percentage of shares outstanding held by institutions, 2nd quarter, 1996 (Source: 13F filings).

* Mean difference in subsamples is significant at 1% level.

sample accounted for roughly 7% of the total NYSE volume, and the DJIA stocks accounted for roughly 9%. The mean trading volume was 28.2 million, 36.5 million, and 404.2 million shares per day for the sampled stocks, the DJIA stocks, and all NYSE-listed stocks, respectively.

The aggregate short interest on the NYSE during May 1996 was 2.3 billion shares, up slightly from 2.2 billion shares in April 1996.[12] The total short interest from the sample was 240 million shares, representing approximately 10% of the short interest on the NYSE during the sample period. The short interest ratio for all NYSE-listed securities in May 1996 was 5.47, which was typical for the months surrounding the observation period and similar to the sample's ratio of 5.39.

[12] Source: *Daily Stock Price Record*.

3.2. Data Sources

The data available for analysis consists of trade and quote data from the Securities Industry Automation Corporation ("SIAC") and order submission data from the NYSE's System Order Database ("SOD") file. The trade and quote data provide all quotes and executions for all Nasdaq and exchange-listed stocks. This file was used for two purposes. First, the national best bid and offer ("NBBO") was recreated for each of the 300 stocks in the sample at each moment during May 1996. Second, trades occurring on the NYSE were ordered in time sequence and the tick status was calculated for each point in time over the month. Recall that the NYSE uses the last trade on the NYSE as the reference price in determining the tick status. These data allowed for the calculation of what we refer to as the minimum shortable price ("MSP"), defined as the lowest price at which a stock can be sold short under the Uptick Rule.

While the SIAC data provide a comprehensive measure of trading activity, they do not include any order information (e.g., order submission time, order type, or order size) that is vital to the study. The SOD file, however, includes all relevant information for orders submitted through the NYSE's SuperDOT system. Note that even though the SOD data elements are fairly comprehensive, many orders are not channeled through SuperDOT.[13] Ross, Shapiro, and Smith (1996) have reported over 80% of the NYSE orders go through SuperDOT, but only 30–40% of the volume is accounted for by these orders. Hence, the results pertain only to orders submitted through SuperDOT since we cannot measure the effect of the rule on the execution quality of orders submitted through floor brokers.

To build the transaction-level database, we excluded all orders that arrived when a valid quote was unavailable, such as orders entered prior to the opening. Limit orders away from the market (i.e., above the ask) were also excluded, as well as any order that was not a regular market or limit order, so as to eliminate many of the potential confounding effects arising from unusual order characteristics.[14] Limit orders were categorized in three ways based on the location of the limit price relative to the NBBO. Marketable limit orders have a limit price at or below the bid. Quote-improving limit orders have a limit price between the bid and ask and hence do not exist in 1/8-point markets. At-the-quote limit orders have a limit price that is at the ask. Any limit or market order without a time limit was assumed to expire at the end of the day. Last, a record was kept of canceled orders and their quotes at the time of cancellation.

We examine regular-sell orders and short-sell orders that are not exempt from the Uptick Rule. Table II provides the distribution of orders by size, type of order,

[13] See Hasbrouck (1992) for a description of the SOD database.

[14] More specifically, stop, stop limit, market on close, market or better, market if touched, cabinet, market with or without a round-lot sale, limit or better, limit with or without a round-lot sale, limit basis price, crossing section I, and limit on close orders were excluded.

TABLE II
Number of Sell Orders

Order type, size	Spread = $1/8		Spread = $1/4	
	Regular-sell	Short-sell	Regular-sell	Short-sell
100–500 shares				
Market	43,598	3,663	16,449	1,563
Marketable limit	12,958	3,424	1,681	355
Quote-improving limit[a]	NA	NA	14,491	3,155
At-the-quote limit	26,902	12,150	8,855	5,543
Total	83,458	19,237	41,476	10,616
501–5000 shares				
Market	20,438	6,532	6,716	1,985
Marketable limit	21,063	3,940	2,217	431
Quote-improving limit[a]	NA	NA	12,999	3,319
At-the-quote limit	37,307	16,603	9,213	5,812
Total	78,808	27,075	31,145	11,547
>5000 shares				
Market	940	370	269	90
Marketable limit	2,465	419	226	44
Quote-improving limit[a]	NA	NA	934	229
At-the-quote limit	4,285	2,467	902	562
Total	7,690	3,256	2,331	925
Market	64,976	10,565	23,434	3,638
Marketable limit	36,486	7,783	4,124	830
Quote-improving limit[a]	NA	NA	28,374	6,703
At-the-quote limit	68,494	31,220	18,970	11,917
Total	169,956	49,568	74,902	23,088

Note. This table reports the number of NYSE SuperDOT regular-sell and short-sell orders for a sample of stocks in May 1996 which were included in the NYSE's System Order Database ("SOD") file. The sample is described in Table I. The reference quotes are derived from the national best bid and offer ("NBBO"). Marketable limit orders have limit prices equal to the bid at order submission. Quote-improving limit orders have limit prices greater than the bid and lower than the ask at order submission. At-the-quote limit orders have limit prices equal to the ask at order submission. Only regular market orders and regular limit orders are considered, e.g., stop orders are excluded. Short-sell figures do not include orders exempted from short sale rules.

[a] A very small number of quote-improving limit orders in 1/8-point markets were excluded.

and bid–ask spread at order submission.[15] There were nearly 170,000 regular-sell orders and 50,000 short-sell orders in 1/8-point markets, and nearly 75,000 regular-sell orders and slightly more than 23,000 short-sell orders in 1/4-point markets. Thus, short-sell orders account for roughly 23% of all sell orders. Most of these short-sell orders were limit orders, amounting to 77% in 1/8-point markets and

[15] A very small number of quote-improving limit orders in 1/8-point markets were excluded. These occurrences resulted when the stock price was less than $10 or the limit price was given in odd sixteenths.

84% in 1/4-point markets, with the remainder being market orders (23% and 16%, respectively). We do not analyze orders from stocks with spreads greater than \$1/4 as the number of observations is sparse.

4. DOES THE UPTICK RULE MEET ITS OBJECTIVES?

In this section the quality of execution for short-sell orders is analyzed in order to see if the Uptick Rule is meeting its objectives. Specifically, the probability of execution and the delay in execution for short-sell and regular-sell orders are calculated and compared. The analysis begins by examining the price relative to the NBBO that short-sell orders could have legally been executed at during the average trading day.

4.1. Conditional Frequencies of the Relative MSP and the Return from the Open

One of the objectives of the Uptick Rule is to allow for relatively unrestricted short selling in advancing markets, while restricting short selling in declining markets. To examine the restrictions on short selling, the aggregate time that the MSP is equal to the bid, at the midpoint, equal to the ask, or outside the quotes was calculated for each stock. In addition to examining the data from an overall perspective, the data were partitioned by the return from the opening. By doing so, the effects of the Uptick Rule can be observed while controlling for market movements.

Table III reports the aggregate conditional frequencies in stock-days of the MSP's relative position within the NBBO, based on the stock's return from the open. Overall, the MSP was at or below the bid 9.6% ($= 0.1\% + 9.5\%$) of the time, at the ask 78.7% of the time, and greater than the ask 11.8% of the time in 1/8-point markets. For 1/4-point markets, the MSP was at or below the bid 3.0% of the time, between the quotes 43.6% of the time, at the ask 50.2% of the time, and greater than the ask 3.2% of the time. Thus, short selling was prohibited at the bid 90.4% ($= 100\% - 9.6\%$) of the time in 1/8-point markets and 97% ($= 100\% - 3.0\%$) of the time in 1/4-point markets.

To examine the effects of the rule during periods of advancing and declining markets, consider the instance when a stock's price was at least 2% above or below its opening price. In declining 1/8-point markets, short-sell orders could have been executed at the bid 5.2% of the trading day. However, in advancing 1/8-point markets, short-sell orders could have executed at the bid only 13.1% of the trading day, for a difference of 7.9% ($= 13.1\% - 5.2\%$). In 1/4-point markets, the corresponding percentages are 1.9% and 3.4%, for a difference of 1.5% ($= 3.4\% - 1.9\%$). While these data suggest that the Uptick Rule is restricting short selling during declining markets (as intended), they also suggest that the rule has an adverse effect on short selling during advancing markets (which is inconsistent with the intent of the rule).

TABLE III
Percentage of Day That the Uptick Rule Permits Short Selling by Minimum Shortable Price vs Return from Open

	Location of minimum shortable price ("MSP") at order submission				
Return from open	MSP < Bid	MSP = Bid	MSP = Ask	MSP > Ask	Total
Panel A: Spread = \$1/8					
Ret. < −2%	0.12	11.02	176.59	29.25	216.98
	0.1%	5.1%	81.4%	13.5%	100.0%
−2% ≤ Ret. < −1%	0.46	22.71	362.67	65.57	451.41
	0.1%	5.0%	80.3%	14.5%	100.0%
−1% ≤ Ret. < 0%	0.33	43.76	845.24	155.11	1044.44
	0.0%	4.2%	80.9%	14.9%	100.0%
Ret. = 0%	0.39	76.53	426.03	87.07	590.02
	0.1%	13.0%	72.2%	14.8%	100.0%
0% < Ret. ≤ 1%	0.53	134.14	766.57	76.39	977.62
	0.1%	13.7%	78.4%	7.8%	100.0%
1% < Ret. ≤ 2%	0.12	49.46	299.93	26.15	375.67
	0.0%	13.2%	79.8%	7.0%	100.0%
Ret. > 2%	0.10	33.77	202.45	22.25	258.56
	0.0%	13.1%	78.3%	8.6%	100.0%
Total	2.06	371.39	3079.48	461.79	3914.72
	0.1%	9.5%	78.7%	11.8%	100.0%
	$\chi^2 = 123$, 18 d.f., reject independence at p = 0.01				
Panel B: Spread = \$1/4					
Ret. < −2%	0.02	1.78	32.86	56.09	3.94	94.68
	0.0%	1.9%	34.7%	59.2%	4.2%	100.0%
−2% ≤ Ret. < −1%	0.07	3.28	77.98	123.30	12.84	217.47
	0.0%	1.5%	35.9%	56.7%	5.9%	100.0%
−1% ≤ Ret. < 0%	0.11	16.33	222.90	319.29	24.13	582.75
	0.0%	2.8%	38.2%	54.8%	4.1%	100.0%
Ret. = 0%	0.00	8.06	181.68	218.82	7.30	415.86
	0.0%	1.9%	43.7%	52.6%	1.8%	100.0%
0% < Ret. ≤ 1%	0.11	23.48	293.40	257.91	16.49	591.38
	0.0%	4.0%	49.6%	43.6%	2.8%	100.0%
1% < Ret. ≤ 2%	0.01	8.93	98.79	83.85	3.43	195.02
	0.0%	4.6%	50.7%	43.0%	1.8%	100.0%
Ret. > 2%	0.02	4.57	65.33	60.99	2.63	133.54
	0.0%	3.4%	48.9%	45.7%	2.0%	100.0%
Total	0.35	66.43	972.93	1120.24	70.75	2230.70
	0.0%	3.0%	43.6%	50.2%	3.2%	100.0%
	$\chi^2 = 50$, 24 d.f., reject independence at p = 0.01					

Note. This table reports the cumulative time of day (measured in stock-days) whereby a short-sell order may be executed after controlling for the minimum shortable price "MSP," the bid-ask spread, and the return from the opening. Trade and quote data is from the Securities Industry Automation Corporation ("SIAC") trade and quote files. The bid–ask spread is derived from the national best bid and offer ("NBBO"). MSP is the lowest possible price where a nonexempt short-sell order can be executed at any given time. The chi-squared statistic tests the null hypothesis of independence across cells. The stocks used in this table are from the sample described in Table I.

TABLE IV
Distribution of the Number of Short-Sell Orders and Tick Status at Order Submission Time

	Location of minimum shortable price ("MSP") at order submission					
Tick status	MSP < Bid	MSP = Bid	MSP = Midpoint	MSP = Ask	MSP > Ask	All
			Panel A: Spread = \$1/8			
Downtick or	14	144		20984	5284	26426
0− tick	0.0%	0.5%	NA	79.4%	20.0%	100.0%
Uptick or	13	5096		17903	70	23082
0+ tick	0.0%	22.1%	NA	77.6%	0.3%	100.0%
All	27	5240		38887	5354	49508
	0.1%	10.6%	NA	78.6%	10.8%	100.0%
			$\chi^2 = 9821$, 3 d.f., reject independence at p = 0.01			
			Panel B: Spread = \$1/4			
Downtick or	3	18	1415	10282	492	12210
0− tick	0.0%	0.1%	11.6%	84.2%	4.0%	100.0%
Uptick or	6	495	7955	2350	9	10815
0+ tick	0.0%	4.6%	73.6%	21.7%	0.0%	100.0%
All	9	513	9370	12632	501	23025
	0.0%	2.2%	40.7%	54.9%	2.2%	100.0%
			$\chi^2 = 10448$, 4 d.f., reject independence at p = 0.01			

Note. This table reports the distribution of NYSE SuperDOT short-sell orders by tick status for a sample of NYSE-listed stocks in May 1996. The sample of stocks is described in Table I. Order information is taken from NYSE's System Order Database ("SOD") file. "MSP" is the minimum shortable price where a short-sell order can be executed and is measured at order submission time. Tick status is based on all NYSE transactions reported in the Securities Industry Automation Corporation ("SIAC") trade file. The national best bid and offer ("NBBO") is constructed from the SIAC quote file. The chi-squared statistic tests the null hypothesis of independence across categories.

A chi-squared statistic was computed in order to test independence between return and the MSP's location in Table III. The statistic rejected independence in both 1/8- and 1/4-point markets. Hence, the location of the MSP at any moment is related to the stock's return from the opening to that moment.

4.2. Tick Status at Order Submission

It is possible that even though short selling is impeded most of the time, short sellers might tend to submit their orders during those times when there is a window of opportunity for receiving quick execution. To see if this is the case, we examine how the location of a stock's MSP is related to both the NBBO and its tick status. Table IV provides the distribution of short-sell orders by spread, tick status, and the location of the MSP within the NBBO.[16] Interestingly, in both 1/8 and 1/4-point markets, slightly more than half of the orders were entered on downticks or

[16] In Table IV the MSP is calculated without regard to the limit price for limit orders.

zero-minus ticks (hereafter these will be simply referred to as "downticks"). In 1/8-point markets, 10.7% of the short-sell orders were entered when the MSP was less than or equal to the bid. In this situation, the tick status was generally an uptick or a zero-plus tick (hereafter these will be simply referred to as "upticks"). Nearly 79% of the orders were entered when the MSP equaled the ask, thereby requiring price improvement for execution. Approximately 11% of the orders were entered when the Uptick Rule prohibited short selling altogether (i.e., when the MSP was greater than the ask), which generally occurred on a downtick. While the MSP was typically equal to the ask regardless of tick status in 1/8-point markets, a chi-squared test statistic rejects independence across categories, indicating that a significant relationship exists between tick status and the location of the MSP within the NBBO.

In 1/4-point markets there is an opportunity for the MSP to be at the midpoint of the NBBO. Of the orders entered on downticks, approximately 12% occurred when the MSP was at the midpoint, 84% occurred when the MSP was at the ask, and 4% occurred when the Uptick Rule prohibited short selling (i.e., when the MSP was greater than the ask), in contrast to 20% of the time for 1/8-point markets. On upticks, about 74% of short-sell orders were entered when the MSP was at the midpoint, and slightly less than 5% of the short-sell orders were entered when the MSP was at the bid. Thus, the MSP was typically at the midpoint of the spread on upticks, and at the ask on downticks. Regardless of tick, the MSP tended to be at a price that required price improvement for execution. Similarly to 1/8-point markets, the chi-squared test rejects independence, indicating a significant relationship exists between tick status and the MSP's location.

The major result of Table IV is that the Uptick Rule prevents execution at the bid for most short-sell orders. More than 89% of short-sell orders in 1/8-point markets and nearly 98% of short-sell orders in 1/4-point markets could not be filled immediately because the MSP was greater than the bid. In such cases short-sell market orders are similar to limit orders with a limit price equal to the MSP. When these numbers are compared to the results in Table III, it can be seen that short sellers submitted their orders about as often when the Uptick Rule allowed them to short at the bid (e.g., 9.6% probable vs 10.7% actual in 1/8-point markets), and about as often when the Uptick Rule only allowed short selling above the ask (e.g., 11.8% probable vs 10.8% actual in 1/8-point markets). Apparently, short sellers did not submit orders based on the current tick status. Next, we measure the extent of the Uptick Rule's impediment to short selling by measuring the likelihood of execution and the time to execution for both short-sell and regular-sell orders.

4.3. Likelihood of Execution

Results from the trade and quote data show that market shorts are guaranteed executions less than 10% of the trading day and prohibited about 12% of the trading day in 1/8-point markets, with smaller percentages for 1/4-point

markets.[17] Therefore, the Uptick Rule delayed or prohibited the execution of more than 90% of the short-sell orders. As mentioned earlier, when such an order is entered with the MSP greater than the bid, it is handled in a manner that is similar to a limit order with a limit price equal to the MSP.

To evaluate the impact of the Uptick Rule on executing a short-sell order, the proportion of orders in the sample that were executed was calculated after controlling for the spread, order type, and the tick status at the time the order was submitted. Panel A of Table V reports the proportion of orders that were executed in 1/8-point markets. Almost 74% of the short-sell market orders submitted on an uptick were executed. In contrast, regular-sell market orders entered on an uptick were executed 99.4% of the time. The 25.5% difference in these two proportions is significant at the 1% level. When short-sell market orders were submitted on downticks, the proportion of orders that were executed decreased to 51%, which is 48.5% lower than the proportion of regular-sell market orders that were executed ($= 99.5\% - 51\%$) and 22.9% ($= 73.9\% - 51\%$) lower than short-sell market orders entered on upticks. In both cases, these differences in proportions are statistically significant.

The fill rates of short-sell limit orders follow the same patterns as short-sell market orders. That is, short-sell limit orders were executed less often when entered on downticks than upticks and less often than regular-sell limit orders. Specifically, in 1/8-point markets short-sell limit orders executed from 19.3% to 39.8% less often when entered on downticks than upticks, depending on order type, and from 6.3% to 65.0% less often than regular-sell limit orders depending on order type and tick status. In all cases these differences are statistically significant. The results in 1/4-point markets are qualitatively similar to those just described for 1/8-point markets.

Table V illustrates that upticks do not guarantee executions of short-sell orders.[18] Recall from Table IV that the MSP was typically greater than the bid on upticks. This suggests that the relative location of the MSP within the NBBO is a factor in executing a short-sell order. We also calculated the fill rates for short-sell orders, controlling for the location of the MSP within the NBBO. When the MSP was at the bid the fill rate of short-sell market orders was around 95%, very close to the proportion for regular-sell market orders. However, when the MSP was at the ask, the fill rate dropped substantially to 58% in 1/8-point markets and 57% in 1/4-point markets. It is also interesting to note that the proportion of short-sell marketable limit orders that were executed is 14–18% less than the proportion for short-sell market orders (43% vs 61% in 1/8-point markets, 55% vs 69% in 1/4-point markets). A partial explanation for this result may be that marketable limit orders are canceled more frequently than market orders (see Section 5.2).

[17] See Table III; this assertion assumes that the order size is less than or equal to the posted depth.

[18] May 1996 was a period of general market advance. To check the robustness of our results we replicated our tables using data from March 11, 1997 to March 24, 1997, a period of general market decline. Comparing the results across sample periods we found nearly identical results.

TABLE V
Proportion of Orders That Execute by Order Type

Order type	Upticks	Downticks	Difference	All
		Panel A: Spread = \$1/8		
Short market	73.9%	51.0%	22.9%*	61.4%
Short marketable limit	68.9%	29.1%	39.8%*	43.2%
Short at-the-quote limit	48.9%	29.6%	19.3%*	39.2%
All short-sell orders	56.5%	34.2%	22.3%*	44.6%
Regular market	99.4%	99.5%	−0.1%	99.5%
Regular marketable limit	96.8%	94.1%	2.7%*	94.9%
Regular at-the-quote limit	55.2%	43.9%	11.3%*	49.2%
All regular-sell orders	78.8%	77.8%	1.0%*	78.2%
Difference: Market	−25.5%*	−48.5%*	NA	−38.1%*
Difference: Mkt. limit	−27.9%*	−65.0%*	NA	−51.7%*
Difference: ATQ limit	−6.3%*	−14.3%*	NA	−10.0%*
Difference: All	−22.3%*	−43.6%*	NA	−33.6%*
		Panel B: Spread = \$1/4		
Short market	83.9%	57.2%	26.7%*	68.9%
Short marketable limit	77.4%	39.6%	37.8%*	55.4%
Short quote-imp. limit	77.4%	31.1%	46.3%*	53.6%
Short at-the-quote limit	29.4%	21.5%	7.9%*	25.3%
All short-sell orders	53.4%	30.9%	22.5%*	41.4%
Regular market	99.5%	99.5%	0.0%	99.5%
Regular marketable limit	96.1%	91.5%	4.6%*	93.3%
Regular quote-imp. limit	82.6%	76.0%	6.6%*	78.8%
Regular at-the-quote limit	36.8%	28.9%	7.9%*	32.6%
All regular-sell orders	75.6%	73.4%	2.2%*	74.4%
Difference: Market	−15.6%*	−42.3%*	NA	−30.6%*
Difference: Mkt limit	−18.7%*	−51.9%*	NA	−37.9%*
Difference: Qt-imp. limit	−5.2%*	−44.9%*	NA	−25.2%*
Difference: ATQ limit	−7.4%*	−7.4%*	NA	−7.3%*
Difference: All	−22.2%*	−42.5%*	NA	−33.0%*

Note. This table reports the proportion of regular-sell and short-sell orders that executed for a sample of NYSE-listed stocks in May 1996. The sample of stocks is described in Table I. The order data, described in Table II, is partitioned by bid–ask spread ("NBBO") at order submission, order type, and the current tick status derived from the Securities Industry Automation Corporation ("SIAC") trade and quote files. Column with "Upticks" heading is for orders entered on upticks or zero-plus ticks. Column with "Downticks" heading is for orders entered on downticks or zero-minus ticks. Percent differences across tick status and order type were tested for statistical significance using a binomial z-test. Orders fully canceled are considered not executed.

* Significant at the 1% level.

This analysis was repeated, but instead of tick status being used to divide the sample, the rate of return from the opening price was used. Orders entered on an uptick were replaced with orders that were entered when the stock's price was up at least 2% above the opening price. Similarly, orders entered on a downtick

were replaced with orders that were entered when the stock's price was at least 2% below the opening price. The results were qualitatively similar to those when orders were conditioned on tick status. Again, short-sell orders were executed less frequently in declining markets than in advancing markets, and less frequently than regular-sell orders, regardless of the type of order.

4.4. Time to Execution

Table VI reports the time to execution of short-sell and regular-sell orders, conditioned on tick status at order submission, order type, and bid–ask spread at time of submission.[19] Only those orders that executed are considered in the four left-hand columns. Short-sell orders entered on upticks were found to receive faster execution than short-sell orders entered on downticks for all order types. For example, short-sell market orders in 1/8-point markets had a median time to execution of 2.7 minutes when entered on upticks and 21.4 minutes when entered on downticks. The lengthy delay for short-sell market orders is consistent with these orders being treated as limit orders and moved to the back of the limit order queue. Similar results are reported for all types of short-sell limit orders. Furthermore, for all order types except at-the-quote limit orders on upticks, short-sell orders took longer to execute than regular-sell orders. The overall difference in time to execution for short-sell orders relative to regular-sell orders was 3.3 minutes during upticks and 16.7 minutes during downticks. The results are qualitatively similar for 1/4-point markets. All differences are significant at the 1% level using Wilcoxon rank-sum tests.

One surprising result is the observation that short-sell market orders took longer to execute than short-sell marketable limit orders. When regular-sell orders are examined, market and marketable limit orders are executed in about the same time. Again, a possible explanation may be that investors submitting marketable limit orders cancel their orders more often if they do not receive quick execution.

Similar results are obtained when orders entered on an uptick were replaced with orders entered when the stock's price was at least 2% above the opening, and when orders entered on a downtick were replaced with orders entered when the stock's price was at least 2% below the opening price. Short-sell orders took longer to execute in declining markets than in advancing markets, and longer to execute than regular-sell orders under both advancing and declining markets.

As shown earlier, a significant fraction of short-sell orders do not execute. Ignoring these "censored" orders most certainly biases the time to execution. We employed a "survival analysis" model to more accurately measure the time to execution that accounts for all orders, not only executed orders.[20] The results are

[19] Time to execution as used here means time to first fill, defined as the time from order submission to the first time that at least part of the order was executed. The results are qualitatively similar when time to last fill, defined to be the time from order submission to when the entire order was executed, was used as the time to execution.

[20] Our approach is similar to that of Lo *et al*. (1997).

TABLE VI
Distribution of Time to Execution (in Minutes)

Order type	Conditional on execution				Censored regression model			
	All	Upticks	Downticks	Difference	All	Upticks	Downticks	Difference
Panel A: Spread = $1/8								
Short market	9.9	2.7	21.4	−18.7*	7.2	1.0	8.5	−7.5*
Short marketable limit	3.4	0.6	12.0	−11.4*	8.6	1.0	9.3	−8.3*
Short at-the-quote limit	8.8	5.6	16.1	−10.5*	54.0	29.4	249.6	−220.2*
All short-sell orders	8.1	3.8	17.1	−13.3*	28.3	26.1	219.4	−193.4*
Regular market	0.3	0.3	0.3	0.0*	0.5	0.5	0.5	−0.1*
Regular marketable limit	0.3	0.3	0.3	0.0*	0.7	0.6	0.7	−0.2*
Regular at-the-quote limit	8.2	6.2	10.7	−4.5*	16.6	14.5	18.5	−4.0*
All regular-sell orders	0.4	0.5	0.4	0.1*	0.8	3.7	0.8	−3.0*
Difference: Market	9.6*	2.4*	21.1*		6.7*	0.5*	8.0*	
Difference: Mkt. limit	3.1*	0.3*	11.7*		7.9*	0.4*	8.6*	
Difference: ATQ limit	0.6*	−0.6*	5.4*		37.4*	14.9*	231.1*	
Difference: All	7.7*	3.3*	16.7*		27.5*	22.4*	218.6*	
Panel B: Spread = $1/4								
Short market	6.3	1.4	18.4	−17.0*	5.8	1.2	6.6	−5.4*
Short marketable limit	3.6	0.9	14.7	−13.8*	6.6	1.4	7.5	−6.1*
Short quote-imp. limit	2.3	1.1	11.0	−9.9*	13.0	3.2	16.3	−13.2*
Short at-the-quote limit	11.8	10.2	14.8	−4.6*	271.4	61.8	318.6	−256.8*
All short-sell orders	5.5	2.2	14.4	−12.2*	51.5	48.2	212.3	−164.1*
Regular market	0.4	0.5	0.4	0.0*	0.9	0.8	0.9	−0.1*
Regular marketable limit	0.4	0.4	0.3	0.0*	1.0	0.9	1.0	−0.1*
Regular quote-imp. limit	0.7	0.8	0.6	0.2*	2.1	2.1	2.3	−0.2*
Regular at-the-quote limit	14.7	12.6	17.1	−4.5*	41.6	39.8	43.1	−3.3*
All regular-sell orders	0.6	0.7	0.6	0.1*	2.2	2.1	2.2	−0.1*
Difference: Market	5.9*	0.9*	18.0*		4.9*	0.4*	5.7*	
Difference: Mkt limit	3.2*	0.5*	14.4*		5.6*	0.5*	6.5*	
Difference: Qt-imp. limit	1.6*	0.3*	10.4*		10.9*	1.1*	14.0*	
Difference: ATQ limit	−2.9*	−2.4*	−2.3*		229.8*	22.0*	275.5*	
Difference: All	4.9*	1.5*	13.8*		49.3*	46.1*	210.1*	

Note. This table presents the median time to execution of regular-sell and short-sell orders for a sample of NYSE-listed stocks in May 1996. Time to execution is estimated using two methods. The estimates under the heading 'Conditional on Execution' are simple medians of time to execution for executed orders only. The estimates under the heading 'Censored Regression Model' are derived from a model that includes all orders, i.e., executions, cancellations, and unexecuted orders. Following Lo *et al*. (1997), the model uses survival analysis and the gamma distribution to estimate the 50th percentile point in the probability distribution (see also Table XI). The dependent variable in the censored regression model is the time until the first fill. The sample of stocks is described in Table I. The order data, described in Table II, is partitioned by bid-ask spread at order submission, and the current tick status, derived from the Securities Industry Automation Corporation ("SIAC") trade and quote files. Median differences across tick status and order type are tested for statistical significance using a Wilcoxon rank-sum test.

* Significant at the 1% level.

reported in the four right-hand columns of Table VI. In 1/8-point markets the model predicted that the median short-sell market order took 7.2 minutes to execute, compared to the median regular-sell market order of 0.5 minutes. Longer execution times were predicted for limit orders (particularly for at-the-quote limit orders submitted on downticks), but again the predicted time for short-sell orders

was significantly longer than for regular-sell orders. Also of interest is the observation that now market orders are predicted to execute more quickly than marketable limit orders.

4.5. Summary

In summary, the Uptick Rule prohibited short selling at the bid in advancing markets 87% of the trading day in 1/8-point markets and 97% of the trading day in 1/4-point markets. When the market is in decline, short selling was prohibited at the bid 95% of the day in 1/8-point markets and 98% of the day in 1/4-point markets. Furthermore, short-sell orders entered on downticks had lower rates of execution and took longer to execute than short-sell orders entered on upticks. In addition, short-sell orders had lower rates of execution and took longer to execute than regular-sell orders, regardless of tick status or type of order. These results provide some evidence that the Uptick Rule is meeting the second and third objectives. After all, if short sellers cannot execute at the bid, then they can neither sell at successively lower prices, nor wipe out all of the orders at the bid. Thus, the observation that short-sell orders take longer to execute but are less likely to be executed is not unexpected. However, the evidence is inconsistent with the Uptick Rule meeting the first stated objective, as short-sell orders entered on upticks face notable execution impediments that are not encountered by regular-sell orders.

5. IMPACT OF THE UPTICK RULE ON THE QUALITY OF ORDER EXECUTION

There are other aspects to the quality of order execution that are important in studying the effects of the Uptick Rule. We begin by examining the role of the specialist in executing short-sell orders, and the amount of price improvement received by short-sell orders.

5.1. The Specialist's Role and Price Improvement Rates

Analysis of participation rates by specialists found that specialists were involved in executing short-sell orders significantly less frequently than regular-sell orders. In 1/8-point markets specialists participated in 5.2% of the executed short-sell orders compared to 12.7% of executed regular-sell orders. In 1/4-point markets, specialists participated in 7.4% of executed short-sell orders and 31.3% of executed regular-sell orders. These results are expected as the MSP is typically the ask or midpoint while specialists usually buy at the bid. The decrease in participation rates coupled with the increased delay in execution for short-sell orders is consistent with short-sell orders being treated much like a "stopped" order (which, in turn, is much like a limit order), as specialists delay execution to comply with the rule. If short-sell market orders trade as limit orders, then we should observe a high rate of price improvement for short-sell orders, as short sellers will tend to trade at a price higher than the bid because of the Uptick Rule. Note that previous studies have

identified a link between price improvement and the stopping of orders (see Harris and Hasbrouck (1996), Lightfoot *et al*. (1997), and Ready (1996)). However, for our sample only 0.02% of all short-sell market orders were stopped. Thus, any observed price improvement of short-sell orders is not attributable to stopping, but rather to the specialist's obligation to comply with the Uptick Rule.

Table VII presents the results from the calculation of price improvement rates, controlling for location of the MSP and order type. The rate of price improvement is defined as the percentage of trades executing at a price greater than the prevailing

TABLE VII
Average Rate of Price Improvement by Order Type

	Location of minimum shortable price ("MSP") at order submission					
Order type	MSP < Bid	MSP = Bid	MSP = Midpoint	MSP = Ask	MSP > Ask	All
			Panel A: Market orders			
			Spread = \$1/8			
Executed short-sell orders	47.2%	6.6%	NA	72.3%	67.4%	60.4%
Executed regular-sell orders	8.1%	5.1%	NA	8.3%	41.8%	12.1%
Difference	39.1%*	1.5%	NA	64.0%*	50.8%*	48.3%*
			Spread = \$1/4			
Executed short-sell orders	76.5%	19.3%	91.8%	73.4%	74.2%	80.2%
Executed regular-sell orders	42.5%	15.0%	43.5%	68.0%	61.7%	56.7%
Difference	NA	4.3%	48.3%*	5.4%*	12.5%	23.5%*
			Panel B: Marketable limit orders			
			Spread = \$1/8			
Executed short-sell orders	40.0%	4.9%	NA	75.1%	71.6%	48.7%
Executed regular-sell orders	5.0%	2.9%	NA	2.9%	16.6%	3.9%
Difference	NA	2.0%*	NA	72.2%*	55.0%*	44.8%*
			Spread = \$1/4			
Executed short-sell orders	100.0%	14.0%	95.1%	80.1%	100.0%	80.6%
Executed regular-sell orders	11.1%	7.1%	24.9%	38.7%	30.0%	30.7%
Difference	NA	6.9%	70.2%*	41.4%*	NA	69.8%*

Note. This table reports the average rate of price improvement of regular-sell and short-sell orders for a sample of NYSE-listed stocks in May 1996. The sample of stocks is described in Table I. The order data and order types are described in Table II. The sample is partitioned by the location of the minimum shortable price ("MSP") relative to the bid-ask spread (from NBBO) at order submission. An order is considered price improved if the execution price exceeds the bid at order submission.

* Significant at the 1% level.

bid at order submission. The analysis is restricted to market and marketable limit orders since quote-improving and at-the-quote limit orders must, by definition, receive price improvement.

Market and marketable limit short-sell orders have similar results. In 1/8-point markets price improvement occurred significantly more often for short-sell orders than regular-sell orders except when the MSP equaled the bid. In 1/4-point markets the results are even more striking. The most notable difference in price improvement occurred when the MSP was greater than the bid. When the MSP was equal to the ask, over 72% and 75% of short-sell market and marketable limit orders, respectively, received price improvement in 1/8-point markets compared to 8% and 3% for regular-sell orders. In 1/4-point markets the corresponding figures for short-sell orders are 73% and 80%, which compares to 68% and 39% for regular sell orders. Note that price improvement rates in 1/4-point markets were higher for both short-sell and regular-sell orders than in 1/8-point markets. Nearly 92% of short-sell market orders and 95% of short-sell marketable limit orders received price improvement when the MSP equaled the midpoint of the NBBO in 1/4-point markets, over double the percentage for regular-sell orders of 44% and 25%, respectively. These price improvement figures indicate that short sellers electing to use market orders can be viewed as *net liquidity providers*, as a majority of market orders are treated in a manner similar to limit orders.

5.2. Canceled and Unfilled Orders

Table V shows that between 61% and 69% of all short-sell market orders received at least partial execution, which is in sharp contrast to 99.5% of the regular-sell orders. We next focus on the final outcome of unexecuted short-sell orders. Table VIII summarizes cancellations of short-sell and regular-sell orders for the

TABLE VIII
Percent Volume Cancellation

	Spread = \$1/8			Spread = \$1/4		
Order type	Regular-sell orders	Short-sell orders	Difference	Regular-sell orders	Short-sell orders	Difference
Market	0.4%	28.2%	−27.8%*	0.4%	23.1%	−22.7%*
Marketable limit	5.5%	50.6%	−45.1%*	7.5%	40.5%	−33.0%*
Quote-improving limit[a]	NA	NA	NA	20.2%	43.4%	−23.2%*
At-the-quote limit	39.8%	50.3%	−10.5%*	54.5%	64.2%	−9.7%*
Total	17.3%	45.6%	−28.3%*	22.0%	50.8%	−28.8%*

Note. This table reports the percentage of order volume that is canceled for regular-sell and short-sell orders in a sample of stocks in May 1996 included in the NYSE's System Order Database ("SOD") file. The sample is described in Table I and order types are described in Table II. The percentage of order volume canceled is measured for each order, then averaged over all orders.

[a] A very small number of quote improving limit orders in 1/8-point markets were excluded.

* Difference in means is significant at the 1% level.

sample. The percentage of volume canceled was measured by calculating the fraction of each order that was canceled (normally 0% or 100%) and averaging. For every type of order, short-sell orders were canceled significantly more frequently than regular-sell orders.[21] In particular, a notably larger proportion of market, marketable limit, and quote-improving short-sell orders were canceled relative to regular-sell orders. This is consistent with some traders being impatient and electing not to wait for the Uptick Rule to allow execution. In 1/8-point markets, more than 28% of all short-sell market order volume was canceled, which is significantly greater than the 0.4% of regular-sell market order volume that was canceled. The corresponding figures for 1/4-point markets are, at 23.1% and 0.4%, nearly the same and also significantly different. Marketable limit orders were canceled at a significantly greater percentage (5.5% for regular-sell orders and 50.6% for short-sell orders in 1/8-point markets, 7.5% and 40.5% in 1/4-point markets) than market orders. Lastly, quote-improving short sell limit orders were canceled 43.4% of the time, which is 23.2% greater than regular-sell orders, an amount that is significant.

In order to determine the characteristics of canceled orders, a logistic regression was run for each type of order where each order was assigned a value of 1 if it was canceled and 0 otherwise. Table IX shows that these regressions correctly classified between 79.5% and 95.0% of the orders. The following characteristics indicated a greater likelihood of cancellation: (1) orders entered earlier in the day (TOD coefficient < 0), (2) orders outstanding for a longer period of time (TDIFF coefficient > 0), (3) orders in stocks that were members of the S&P 500 (S&P coefficient > 0), (4) orders involving low volume stocks (VOL95 coefficient < 0), (5) market orders submitted when the MSP was greater than the bid (MSP coefficient > 0), (6) limit orders submitted when the MSP was less than or equal to the bid (MSP coefficient < 0), (7) orders submitted on downticks (TICK coefficient < 0), and (8) orders from nonindividual accounts (INDIV coefficient < 0). In general, the existence or absence of traded options had no bearing on order cancellation, nor did the rate of return on the stock from the opening to the time the order was submitted (except for at-the-quote limit orders). Interestingly, quote-improving and at-the-quote limit orders had a greater likelihood of being canceled when the order involved large capitalization stocks, but market and marketable limit order cancellation were unrelated to firm size.

The percentage of share volume that remained unfilled at the end of the trading day was also calculated. Table X reports that approximately 10% to 12% of the short-sell market order volume was unfilled, an amount that is significantly greater than the 0.2% of regular-sell market order volume that was unfilled.[22] Considering

[21] This observation was also true when three order-size groups (see Table II) were individually analyzed with one exception, quote improving limit orders for greater than 5,000 shares in 1/4-point markets, where short-sell orders were canceled 3.8% less often than regular sales.

[22] This observation was also true when the two smaller order-size groups (see Table II) were individually analyzed, but for the largest size group (5,000 or more shares), about 18–19% of short sale market orders were unfilled relative to about 2% of regular sell market orders.

TABLE IX
Cross-Sectional Regressions of Probability of Short Order Cancellation

Independent variable	Market orders	Marketable limit orders	Quote-improving limit orders	At-the-quote limit orders
Intercept	−2.6626*	−1.3575*	−0.2731	−1.3613*
TOD	−0.00002*	−0.00003*	−0.00001*	−0.00003*
TDIFF	0.00447*	0.0003*	0.00133*	0.000058**
TOD*TDIFF	1.233E-7*	2.378E-7*	2.008E-7*	1.564E-7*
RET	−0.6342	−0.3528	−1.1890	−1.4226*
S&P	0.3384*	0.2648*	0.2204**	0.3038*
ln(MKTCAP)	−0.0387	0.00454	0.1161*	0.2235*
OPTION	0.0387	0.0312	−0.0170	0.0380
VOL95	−0.00019	−0.00082*	−0.00092*	−0.00057*
MSP	1.2064*	1.6965*	−0.4637**	−0.0861**
TICK	−0.3244*	−0.6943*	−1.5128*	−0.4397*
OSIZE	0.00006*	−0.00013*	−0.0001*	−0.00004*
IND	−0.4820**	−1.1101*	−0.4774	−1.3321*
N	14156	9133	6690	43075
% Concordant	95.0%	86.0%	87.6%	79.5%

Note. This table reports the results from logistic regressions with the probability of cancellation of a short-sell order as the dependent variable that is modeled as a 1 for a cancellation and a 0 otherwise. The model predicts whether an order was canceled based on the set of independent variables. The sample of stocks is described in Table I. Order types are described in Table II. The independent variables are defined as follows. TOD is the time of order submission in seconds after the opening. TDIFF is the time between order submission and execution or cancellation, in seconds. RET is the return from the opening to order submission. S&P is a dummy variable equal to 1 if the stock is a member of the S&P 500, 0 otherwise. ln(MKTCAP) is the natural log of the market capitalization in $millions as of December 31, 1995. OPTION is a dummy variable equal to 1 if the stock has traded options, 0 otherwise. VOL95 is the aggregate trading volume for the stock over 1995. MSP is a dummy variable equal to 1 if the MSP is greater than the bid, 0 otherwise. TICK is a dummy variable equal to 1 if the order is entered on an uptick, 0 otherwise. OSIZE is the order size. IND is a dummy variable equal to 1 if the order is entered from an individual's account, 0 otherwise. A pair of input observations with different responses is said to be concordant if the larger response has a higher predicted event probability than the smaller response.

* Significant at the 1% level.

** Significant at the 5% level.

these results along with those from Table VIII suggests that about 40% of the short-sell market orders in 1/8-point markets were canceled or left unfilled by the end of the trading day in comparison to 0.6% for regular-sell market orders, with similar results in 1/4-point markets. For all orders, the average percentage of unfilled and canceled short-sell orders increases to approximately 57–60%, which is in sharp contrast to 23–27% for all regular-sell orders.

5.3. Cross-Sectional Results

As there may be many factors that jointly determine the execution quality of each order, three cross-sectional regressions were run using the following dependent

TABLE X
Percent Unfilled Volume

Order type	Spread = $1/8			Spread = $1/4		
	Regular-sell orders	Short-sell orders	Difference	Regular-sell orders	Short-sell orders	Difference
Market	0.2%	11.8%	−11.6%*	0.2%	9.8%	−9.6%*
Marketable limit	1.1%	7.6%	−6.5%*	1.3%	7.0%	−5.7%*
Quote-improving limit[a]	NA	NA	NA	4.1%	5.6%	−1.5%*
At-the-quote limit	13.0%	12.6%	0.4%	14.5%	11.8%	2.7%*
Total	5.6%	11.7%	−6.1%*	5.3%	9.5%	−4.2%*

Note. This table reports the percentage of order volume that is unfilled and not canceled for regular-sell and short-sell orders in a sample of stocks in May 1996 included in the NYSE's System Order Database ("SOD") file. The sample is described in Table I and order types are described in Table II. The percentage of order volume unfilled is calculated for each order, then averaged over all orders.

[a] A very small number of quote-improving limit orders in 1/8-point markets were excluded.

* Difference in means is significant at the 1% level.

variables that are associated with each order: (1) probability of execution, (2) time to execution based on first fill, and (3) probability of price improvement.

Four independent variables that relate to the firm whose stock is associated with the order were included in the regressions: (1) whether the firm had options being traded on its stock (OPTION), (2) whether the firm was a member of the S&P 500 (S&P), (3) market capitalization of the firm (ln(MKTCAP)), and (4) the 1995 trading volume in the stock (VOL95). Also included as independent variables are the following characteristics of each order: (1) order type (dummy variables for ATQ, QIMP, MLIM), (2) whether it was a short-sell order (SHORT), (3) whether the order was entered on an uptick (TICK), (4) whether the order was from an individual account (INDIV), (5) whether the order was stopped (STOP), (6) order size (OSIZE), (7) whether the MSP was greater than the bid (MSP), (8) interactive term involving MSP and SHORT, and (9) interactive term involving TICK and SHORT. A logistic model was used for both the probability-of-execution and the probability-of-price-improvement regressions. In the logistic regressions, the dependent variables equaled one for execution or price improvement, and zero otherwise. Survival analysis patterned after Lo *et al*. (1997) was used to estimate the model of the time to execution. The results are displayed in Table XI, with regressions run separately for 1/8 and 1/4-point markets. The following discussion focuses on those variables of most interest that were found to be statistically significant in both 1/8 and 1/4-point markets.[23]

[23] Other forms of the regressions shown in Table XI were run that allowed for interactive terms for the dummy variables but did not produce results that improved the fit of the models.

TABLE XI
Cross-Sectional Regressions of Probability of Execution, Time to Execution, and Probability of Price Improvement

Independent variable	Pr{Exec.}	Time to execution	Pr{PI}
	Panel A: Spread = \$1/8		
Intercept	2.5267*	3.8616*	−4.6709*
OPTION	−0.1171*	0.0465*	0.0951*
S&P	−0.3340*	0.1752*	−0.1616*
ln(MKTCAP)	−0.0025	−0.0713*	0.0376*
VOL95	0.0007*	−0.0008*	0.0007*
ATQ	−2.7030*	3.3807*	NA
MLIM	−0.6574*	0.0978*	0.0265
SHORT	−1.2433*	2.0456*	0.8135*
TICK	0.3595*	−0.2744*	0.8235*
INDIV	0.9172*	−0.2403*	0.2538*
STOP	1.5806*	2.3674*	2.6845*
OSIZE	0.00001*	0.00002*	−0.00003*
MSP	0.2923*	−0.2293*	0.9724*
MSP*SHORT	−0.5004*	0.5448*	3.2454*
TICK*SHORT	1.0340*	−1.8432*	−0.0069*
N	221527	221527	110262
Scale (std. err.)	NA	2.000 (0.004)	NA
Shape (std. err.)	NA	−0.681 (0.010)	NA
% Concordant	84.7%	NA	86.0%

Turning to the probability-of-execution logistic regression first, the significantly negative coefficient on SHORT indicates that a short-sell order has a reduced chance of being filled relative to a regular-sell order. Furthermore, the significantly negative coefficient associated with the interactive term MSP*SHORT indicates that a short-sell order entered when MSP is greater than the bid has an even lower probability of being executed. The significantly positive coefficient associated with the interactive term TICK*SHORT indicates that a short-sell order entered on an uptick has a higher probability of being executed. The significantly negative coefficients associated with the types of orders reveal that market orders have the highest probability of being executed, followed by marketable limit orders (MLIM), quote-improving limit orders (QI), and at-the-quote limit orders (ATQ), respectively. This is expected since it shows the higher the limit price relative to the bid the less likely the order would have been executed. Oddly, note that the coefficient associated with OSIZE is significantly positive, indicating that relatively larger orders had a higher probability of execution.

In the time-to-execution regression there is a significantly positive coefficient for the variable SHORT, revealing that a short-sell order takes longer to execute than a regular-sell order.[24] This is especially so when the order is entered at a time

[24] The time-to-execution regression was also run using time to last fill, with results that were similar to those reported here using time to last fill; see footnote 20.

TABLE XI—*Continued*

Independent variable	Pr{Exec.}	Time to execution	Pr{PI}
	Panel B: Spread = \$1/4		
Intercept	1.9378*	4.0988*	−2.8293*
OPTION	0.1248*	−0.1371*	0.1615*
S&P	−0.3278*	0.0927*	−0.0124
ln(MKTCAP)	0.0670*	−0.0894*	0.0920*
VOL95	0.0007*	−0.0008*	0.0019*
ATQ	−3.4947*	3.8862*	NA
QIMP	−1.6485*	0.9123*	NA
MLIM	−0.8027*	0.1246*	−0.5762*
SHORT	−0.9938*	1.7803*	−0.2516
TICK	0.3273*	−0.1056*	0.1660*
INDIV	0.9962*	−0.2485*	0.2202*
STOP	2.1826*	1.9435*	0.7915*
OSIZE	0.00002*	0.00002*	−0.0001*
MSP	0.2505*	−0.1516*	1.9292*
MSP*SHORT	−0.4911*	0.2351	1.5323*
TICK*SHORT	1.0394*	−1.5588*	1.0021*
N	98230	98230	30365
Scale (std. err.)	NA	2.109 (0.007)	NA
Shape (std. err.)	NA	−1.017 (0.011)	NA
% Concordant	86.0%	NA	70.8%

Note. This table reports the results from regressions with the probability of execution, the time to execution, and the probability of price improvement (PI) as dependent variables. The probability of execution is modeled as a 1 for an execution and a 0 for non-execution using logistic regression. The time to execution is estimated in seconds for all orders including canceled and unexecuted orders, which are censored (see Lo *et al.* (1997)). This model is estimated using the time until the first fill. The probability of price improvement is modeled as a 1 for an order that executed at a price greater than the bid at order submission and a 0 for orders that executed at the bid or lower using logistic regression. The independent variables are defined as follows. OPTION is a dummy variable equal to 1 if the stock has traded options, 0 otherwise. S&P is a dummy variable equal to 1 if the stock is included in the S&P 500, 0 otherwise. ln(MKTCAP) is the natural log of the market capitalization in \$millions as of December 31, 1995. VOL95 is the total trading volume for 1995. ATQ is a dummy variable equal to 1 if the order is an at-the-quote limit order, 0 otherwise. QI is a dummy variable equal to 1 if the order is a quote improving limit order, 0 otherwise. MLIM is a dummy variable equal to 1 if the order is a marketable limit order, 0 otherwise. SHORT is a dummy variable equal to 1 if the order is a short order, 0 otherwise. TICK is a dummy variable equal to 1 if the order is entered on an uptick, 0 otherwise. INDIV is a dummy variable equal to 1 if the order is submitted from an individual's account, 0 otherwise. STOP is a dummy variable equal to 1 if the order was stopped, 0 otherwise. OSIZE is the order size. MSP is a dummy variable equal to 1 if the order was entered when the MSP was greater than the bid, 0 otherwise. The sample of stocks is described in Table I. Order types are described in Table II. A pair of input observations with different responses is said to be concordant if the larger response has a higher predicted event probability than the smaller response.

* Significant at the 1% level.

that MSP is greater than the bid, as shown by the significantly positive coefficient for the interactive term MSP*SHORT. In addition, the significantly negative coefficient for the interactive term TICK*SHORT shows that a short-sell order entered on an uptick is executed more quickly than if it were entered on a downtick. The coefficients reveal that market orders are executed quickest, followed by marketable limit orders (MLIM), quote-improving limit orders (QI), and at-the-quote limit orders (ATQ), respectively. Like the probability-of-execution results, this is expected, since it shows the higher the limit price relative to the bid, the longer it took the order to execute. Last, note that the coefficient associated with OSIZE is significantly positive, indicating that relatively larger orders took longer to execute than smaller ones.

The last regression estimates the likelihood of price improvement. The significantly positive coefficient on SHORT in 1/8-point markets indicates that a short-sell order is more likely to receive price improvement than regular-sell orders. Surprisingly, this coefficient is negative (but not significant) in 1/4-point markets. In both markets, the significantly positive coefficient on MSP*SHORT indicates that a short-sell order entered when MSP was greater than the bid is more likely to receive price improvement. This is as expected, given the results in Table VII. The coefficient to the interactive term TICK*SHORT is significantly negative in 1/8-point markets and significantly positive in 1/4-point markets, indicating in the first case a lower likelihood of price improvement and in the second a greater likelihood. Since these regressions were only run with market and marketable limit orders, it is surprising to see that marketable limit orders had a significantly lower probability of receiving price improvement than market orders in 1/4-point markets.[25] One possible explanation consistent with the conditional execution times in Table VI is that marketable limit orders were canceled if they did not get executed quickly, meaning that those that were executed were more likely to be executed at the bid and thus were less likely to receive price improvement. Last, the negative coefficients associated with OSIZE indicates that large orders in both types of markets were less likely to receive price improvements.

6. CONCLUSIONS

In this paper the effect of the Uptick Rule on the execution quality of short-sell orders was examined. The primary result is that short selling was found to be adversely affected by Rule 10a-1 regardless of the stock's tick or return status at the time the order was submitted. Indeed, short selling was rarely allowed at the current bid price regardless of whether a stock was trading on an uptick or a downtick, or if the return from opening to order submission was above 2% or below −2%. Accordingly, the Uptick Rule hinders price discovery in both advancing and declining markets.

[25] This apparent anomaly has been recognized previously by Harris and Hasbrouck (1996), Angel (1994), and Lightfoot *et al*. (1997).

In general, short-sell orders were found to have a lower rate of execution and a longer delay until execution relative to regular-sell orders, findings that can be attributed to the Uptick Rule. These results can be explained by thinking of short-sell market orders as limit orders with a limit price equal to the MSP. In this context, short-sell orders executed less often, took longer to execute, but frequently executed at prices greater than the current bid. Since these results occurred regardless of tick or return status, it appears that Rule 10a-1 is not meeting one of its three intended objectives—to allow relatively unrestricted short selling in advancing markets. Whether this unintended cost is of sufficient magnitude to cause the rule to not, on balance, be beneficial remains an unanswered question.

In terms of regulatory policy, it would seem that there are a variety of ways to advance the objectives of the Uptick Rule by making simple alterations to it. For example, since the objectives can be viewed as focusing on executions at the bid or lower, it would seem straightforward to make the Uptick Rule apply only when the current inside bid is lower than the previous different inside bid that day. For the opening, the Uptick Rule would be in effect as it currently exists. Such a modification would mean that in advancing markets, short-sell orders would be readily executed, but in declining markets, the Uptick Rule would remain in effect. Furthermore, this would put the Uptick Rule on more equal footing with Nasdaq's Short Sale Rule.[26] In summary, such a rule change would seem to enhance price discovery while still meeting the original objectives of the Uptick Rule.

On a broader level, the question can be asked whether an Uptick Rule in any form is beneficial. If the underlying rationale for the Uptick Rule is to avoid price manipulation on the downside, then what makes short selling unique in that limits need to be in place that regulate only short selling transactions? Since price manipulation can occur with purchases as well as with sales, arguments that the Uptick Rule is an appropriate method of minimizing downward price manipulation would seem to be just as applicable for some kind of comparable "Downtick Rule" to regulating purchases.[27] With the electronic audit trail data that are currently available, perhaps the best answer is to rely on general federal anti-price-manipulation statutes and let all types of trade take place without interference, thereby allowing price discovery to proceed unimpeded.

[26] There are many other alternative reformulations of the Uptick Rule, such as prohibiting short selling in a given stock on a given trading day after it has fallen in price by a stated percentage that day. Regardless of the form of the rule, the costs of possible price manipulation (see Cherian and Jarrow (1995) for a review article) must be balanced against the benefits of price discovery.

[27] Allen and Gorton (1992) argue than an asymmetric response to order flows can result in market manipulation. This notion is predicated on the assumption that sells are more likely to be liquidity motivated, and thus have a smaller price reaction than buys. In their example one could run a stock price up with a series of buys, then follow with a series of sells and make profits without the benefit of any private information. However, the converse is not true. That is, one could not profitably execute a series of sells followed by a series of buys, since the average price of the sells will likely be less than the average price of the buys.

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