5-2021

Short Selling Around Reverse Stock Splits

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By

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Abstract:

I examine whether short selling increases around reverse stock splits using 2019 daily short selling data instead of bimonthly short interest data required by FINRA. In my difference-in-difference analysis, I find that average short selling increases significantly for firms that reverse split their stock, relative to matched control firms that do not, around the split dates. I also find that firms that reverse split their stock experience negative cumulative abnormal returns in the 20-day period after the reverse stock splits, particularly for those firms that are heavily shorted. These results are in agreeance with existent literature and suggest that short sellers are informed and correctly predict future negative abnormal returns. The results also suggest that short sellers put downward pressure on stock prices after reverse splits.

Keywords: Short Selling; Cumulative Abnormal Returns; Reverse Stock Splits

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1. Introduction

Under the assumption of efficient markets (Malkiel and Fama 1970; Fama, 1991), stock splits and reverse stock splits should have no fundamental effect on shareholder wealth. However, Fama, Fisher, Jensen, and Roll (1969) show that the prices for stocks that engage in splits change significantly both before and after the splits occur. Prior research suggests that reverse splits convey negative information to investors which results in negative post-split cumulative abnormal returns (Woolridge and Chambers, 1983; Desai and Jain, 1997). Given this information, investors might be inclined to take short positions on firms that perform a reverse stock split. Consistent with this notion, Diether, Lee, and Werner (2009) show that short sellers correctly predict future negative abnormal returns. Thus, it can be inferred that short sellers will be attracted to reverse stock splits.

In this study, I seek to find the relation between a reverse split and the number of shares sold short. To the extent that stock prices drop on average around reverse stock splits, I expect to find an increase in abnormal short selling prior to the split. I also expect to find that short selling puts additional downward pressure on the prices of stocks that reverse split their shares. A common empirical measure of how many shares a particular stock is short is known as short interest, but the Financial Industry Regulatory Authority (FINRA) only requires firms to report short interest positions bi-monthly. This makes it difficult to know exactly when short sellers are taking their positions. It also makes it difficult to observe the magnitude of short positions taken on a particular stock day. To circumvent these concerns, I obtain daily short sale volumes by stock from 12 different equity exchanges and from FINRA's Trade Reporting Facility (TRF).[1] This allows me to

[1] We are unable to obtain daily short sale volumes from the NASDAQ and IEX exchanges.

estimate daily short ratios, or the number of shares sold short to total shares outstanding, by stock day.

The empirical results show that for firms that perform a reverse split, relative to a sample of matched control firms that do not, the average daily short ratio increases by 2.9 percentage points in the restricted model, and by 4.1 percentage points – other factors held constant. Furthermore, I find that for firms that perform a reverse split, relative to the sample of matched control firms that do not, the average cumulative abnormal return in the 20 trading days after the reverse split is negative 19.1%. When controlling for additional factors, this average cumulative abnormal return is negative 38.6%. Last, I find that short sellers put downward pressure on the prices of stocks that engage in reverse stock splits. In particular, the average 20-day cumulative abnormal return decreases significantly (between 0.84 and 1.012 percent depending on the model specification) with each unit increase in the daily short ratio.

Combined my results of negative cumulative abnormal returns are consistent with previous research (see e.g., Lamoureax and Poon, 1987; Woolridge and Chambers, 1983). Perhaps more importantly, I find that the short ratio for firms that perform a reverse stock split increases significantly after the reverse split and that the worst performing stocks see the largest increase in short selling. These results seem to suggest that short sellers are not only informed and correctly predict future negative abnormal returns (Diether, Lee, and Werner, 2009), but they also place downward pressure on stocks that engage in reverse splits ex-post.

2. Data Description

2.1. Data Collection

I gather daily short sale data from 12 different equity exchanges and the FINRA TRF. I gather additional daily pricing data from the Center for Research in Security Prices (CRSP) database. From the CRSP database I collect exchange listing, daily prices, daily volume, daily shares outstanding, daily returns, daily ask high price, and daily bid low price for all stocks listed on an exchange in 2018 and 2019.

[Insert Table 1 Here]

I remove all observation that have missing daily share volume. I also ensure that all prices are positive. Next, I identify the date of the reverse stock split as the event date for each firm that performed a reverse stock split in 2019. At this point I have 196 firms that perform a reverse stock split in 2019 according to the CRSP database. I remove six firms from the sample that perform multiple reverse stock splits in 2019. I also exclude all 27 stocks with an event date in January or December to ensure there is sufficient data both before and after the split to yield accurate results. Next, I remove two firms that do not have positive short sale volume in the month prior to the reverse split. To create a benchmark for the treatment firms and to control for endogeneity, I match each firm that had a reverse stock split in 2019 to a control firm one-to-one without replacement. In the month prior to the reverse (pseudo-reverse) stock splits, I match firms on average market capitalization, price, and short ratio. The final sample consists of 161 unique firms that reverse split their stock during the sample period and 161 unique control firms that do not reverse split their stock during the same time period. This totals 322 firms in the final sample.

2.2. Variable Descriptions

In this subsection I describe the variables used in the empirical analysis. In Table 2, I report distributional characteristics, before the event dates (pseudo-event dates), for treatment stocks in *Panel A*, control stocks in *Panel B*, and the difference in means between the two in *Panel C*. The two outcome variables used in the empirical analysis are short ratio (*SR*) and cumulative abnormal returns (*CAR*). The short ratio is defined as the number of shares sold short divided by the total shares outstanding on a particular day for a given stock.

$$SR_{i,t} = \frac{Short\ Volume_{i,t}}{Shrout_{i,t}}$$

Price is the daily per share closing price of a stock. *Volume* is the total number of shares transacted daily for a given stock. Market capitalization (*MCAP*) is defined as price multiplied by shares outstanding. Return volatility (*Rvolt*) is the difference of the log of the daily high ask price and the log of the daily low bid price. *% Spread* is calculated as the difference between the daily closing ask and bid prices divided by the midpoint of the daily ask and bid prices. Illiquidity (*Illiq*) is Amihud's (2002) illiquidity measure calculated as the absolute value of the daily return divided by daily dollar volume, scaled by 10^6.

[Insert Table 2 Here]

Panels *A*, *B*, and *C* from Table 2 show that the average *SR* for treatment stocks, control stocks and the difference between the two are 37.71%, 37.99%, and -0.29%, respectively. This shows that the *SR* difference between treatment stocks and control stocks is minimal prior to the event date. The average *Price* for treatment stocks is $2.4152 while control stocks have an average *Price* of $2.6380 with a difference between the two being -$0.2229. The average *volume* is 2,676,314 and 596,615 for treatment stocks and control stocks, respectively, with a difference of 2,079,699. The average *MCAP* for treatment stocks and control stocks is 673,207,788 and 615,930,681, respectively, with a difference of 57,277,107. The average *Rvolt* is 9.68% and 7.77% for treatment stocks and control stocks, respectively, with a difference of 1.91%. The average *% Spread* is 1.64% and 1.85% for treatment stocks and control stocks, respectively, with a difference of -0.21%. The average *Illiq* is 0.6076 and 0.9945 for treatment stocks and control stocks, respectively, with a difference of -0.3869. *Panel C*'s t-stat shows that only *Volume, Rvolt,* and *Illiq* are statistically different than zero at the 5% level.

[Insert Table 3 Here]

Table 3 shows the estimates of from a series of Pearson Correlation coefficients for all variables used in the analysis. The correlations of interest are between *SR* and all the independent variables (*Price, Volume*, *MCAP*, *Rvolt*, *% Spread*, and *Illiq*). The only variables that have a correlation coefficient statistically different than zero at the 1% level, when compared to *SR*, are *Price*, *MCAP*, and *Rvolt*. *Price* has a strong negative correlation of -0.2207 with *SR*. *MCAP* has a strong negative correlation of -0.1712 with *SR*. *Rvolt* has a strong positive correlation of 0.2592 with *SR*. The correlation of *Price* and *SR* seems to suggest that stocks with a smaller per share price have a larger short ratio. Given that *Price* has a strong correlation with *SR*, I expect *MCAP* and *Rvolt* to have a similar correlation as *MCAP* and *Rvolt* are variables derived from *Price*. This is also shown in Table 3. *Price* has strong correlation with *MCAP*, *Rvolt*, and *% Spread,* all significant at the 1% level.

3. Empirical Results

3.1. Daily Short Ratio Analysis

I begin my empirical analysis by running two univariate tests on the number of shares sold short, or the short ratio (*SR)*. In these tests I look at the difference in means and the difference in medians for the pre and post periods for treatment and control stocks.

[Insert Table 4 Here]

Table 4*, Panel A* shows that treatment stocks, on average, have a 37.71% *SR* in the pre-period; but in the post period, the *SR* of treatment stocks increases to 42.15%. This is a significant increase of 4.45 percentage points from the pre to post period. Additionally, the t-statistic for this difference in means is 4.59, suggesting that the post to pre-period change is statistically significant at a 1% level. The control stocks, on average, have a 38.00% *SR* in the pre-period and in the post-period they have an average *SR* of 39.57%. This is an increase of 1.57 percentage points. While there is an increase in the *SR* for control stocks, the increase is not as drastic. The t-statistic for this pre to post period difference is 1.57, which is not statistically significant at the 10% level. Thus, it cannot be said that the difference in *SR* for control stocks from the pre to the post period is statistically different than zero. When looking at the difference between treatment and control stocks in the pre-period, *Panel A* shows there is a minimal difference in means. The difference between the two is -0.29% with a t-stat of -0.30. This t-stat suggests that the difference, in the pre-period, is not different than zero. However, in the post period, the difference in means for treatment and control stocks is 2.58 percentage points. This results in a t-stat of 2.55 which is statistically significant at the 5% level. Looking at the difference-in-difference of treatment and control stocks from the pre to the post period, there is an increase in the mean *SR* of 2.87 percentage points. The t-statistic is 2.06 which is statistically significant at the 5% level. Therefore, it can be said that the difference-in-difference is different than zero.

Table 4 *Panel B* shows the difference in medians, which shows similar results as *Panel A*. *Panel B* shows that the median of treatment stocks is 37.14% *SR* in the pre-period; but in the post period, the median *SR* for treatment stocks increases to 43.99%. This is a significant increase of 6.85 percentage points from the pre to post period. Additionally, the P-value statistic for this difference in medians is 0.0001, suggesting that the post to pre-period change is statistically significant. The control stocks have a median of 38.69% *SR* in the pre-period and in the post period they have a median *SR* of 40.46%. This is an increase of 1.77 percentage points. The P-value for this pre to post period difference is 0.1208, which is not statistically significant. Thus, it cannot be said that the difference in *SR* for the median control stocks from the pre to the post period is statistically different than zero. When looking at the difference between treatment and control stocks in the pre-period, *Panel B* shows there is a minimal difference in medians. The difference between the two is -1.55% with a p-value of 0.7739. This p-value suggests that the median difference, in the pre-period, is not different than zero. However, in the post period, the difference in medians for treatment and control stocks is 3.53 percentage points. This results in a p-value of 0.0064 which is statistically significant. Looking at the difference-in-difference of treatment and control stocks from the pre to the post period, there is an increase in the median *SR* of 5.08 percentage points. The p-value is 0.0090 which is statistically significant. Therefore, it can be said that the difference-in-difference is different than zero. These results are in support of my alternative hypothesis that treatment stocks that perform a reverse stock split see an increase in short selling after the reverse stock split.

After the univariate test, I ran a regression to further examine whether treatment stocks see an increase in short selling after the event date. To do this I estimate specifications of the following regression model:

$$SR_{i,t} = \beta_1 Treat_i + \beta_2 Post_{i,t} + \beta_3 Treat_i \times Post_{i,t} + \beta_4 Price_{i,t} + \beta_5 MCAP_{i,t} + \beta_6 Rvolt_{i,t} + \beta_7 \%\, Spread_{i,t} + \beta_8 Illiq_{i,t} + \alpha + \varepsilon_{i,t} \quad (1)$$

where the dependent variable is $SR_{i,t}$, or the ratio of daily short selling volume to total volume for stock *i* on day *t*. The independent variables have been previously defined except for the interaction term $Treat_i \times Post_{i,t}$. $Treat_i \times Post_{i,t}$ indicates whether the stock is a treatment firm and whether the time window is before or after the event date. This interaction term allows me to specifically test if treatment firms see an increase in short selling after the event date. I report *t*-

statistics in parentheses, obtained from robust standard errors clustering, below the reported beta coefficients for each of the independent variables and the interaction term.

[Insert Table 5 Here]

In Table 5, column [1] is the restricted model, using only the independent variables *Treat*, and *Post* with the interaction term $Treat_i \times Post_{i,t}$. When looking at the variable of interest, $Treat_i \times Post_{i,t}$, the results show that the average daily amount of short selling increases by 2.9 percentage points for treatment firms relative to control firms after the reverse split. Column [2] shows the full regression model specification, controlling for another factor such as *Price*, *MCAP*, *Rvolt*, *% Spread*, and *Illiq*. The results of column [2] show that the variable of interest, $Treat_i \times Post_{i,t}$, results in an increase in daily short selling of 4.1 percentage points on average.

[Insert Figure 1 Here]

As a final verification, I plotted the average *SR* in the 20 days before and the 20 days after the event dates for 161 treatment firms and pseudo reverse stock splits for 161 matched control firms. The resulting graph suggests that, on average, there is an increase in the *SR* for treatment firms immediately after the event date and this increase in the *SR* is maintained throughout the 20-day post period. Additionally, the average *SR* for control firms remains relatively constant throughout the entire sample period. The combined results of Table 4, Table 5, and Figure 1 suggest that short selling increases immediately after a firm performs a reverse split.

3.2. Cumulative Abnormal Returns Analysis

Table 6 reports the market reactions to the reverse stock splits for the 161 treatment firms and to the pseudo reverse stock splits for the 161 control firms. I estimate different models to capture the expected return of a stock after a reverse stock split. The first model is simple raw returns. The second model is market adjusted returns. The market adjusted returns are calculated using the following abnormal return equation:

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{2}$$

where $R_{i,t}$ is defined as the return of stock *i* at time period t and $R_{m,t}$ is the market return value-weighted across CRSP securities on day *t*. The third model is the market model. These returns are calculated using the following equation:

$$E[R_{i,t}] = \beta_0 + \beta_1 R_{m,t} \tag{3}$$

where the parameter estimates, β_0 and β_1, are estimated in the period ending 46 days before the event date with a maximum of 255 days and a minimum of 3 days. I then estimate the abnormal returns for each stock day during the event window using the following equation:

$$AR_{i,t} = R_{i,t} - E[R_{i,t}] \tag{4}$$

The fourth, and final model I use is the Fama-French-Carhart 4-Factor model. I obtain the parameter estimates from the following four-factor model that is estimated in the period ending 46 days before the event date (maximum of 255 days and minimum of 3 days):

$$E\left[R_{i,t}\right] = \beta_0 + \beta_1 EXMKT_t + \beta_2 HML_t + \beta_3 SMB_t + \beta_4 UMD_t \tag{5}$$

where $EXMKT_t$ is the market risk premium, the return on the market value weighted across CRSP securities on day *t* minus the risk-free return. HML_t is the high minus low book-to-market risk factor. SMB is the small minus large market capitalization risk factor. UMD is the up-minus-down momentum risk factor. The first two risk factors are discussed in Fama and French (1993), while the last is outlined in Carhart (1997). I then estimate the abnormal returns for each stock day during the event window using equation (4).

The cumulative abnormal returns for each model are estimated as the sum of the abnormal (or raw) returns for a given stock over an event window as follows:

$$CAR_{t,T}^{i} = \sum_{t=1}^{T} AR_t \qquad (6)$$

[Insert Table 6 Here]

Table 6 *Panel A* shows the raw returns for treatment stocks, control stocks, and the difference between the two. On average, treatment stocks have returns of -4.15%, -5.46%, -7.81% and -11.66% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. Control stocks, on average, have returns of 1.63%, 2.66%, 3.35% and 10.07% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. On average, the difference in returns between treatment and control stocks is -5.78%, -8.12%, -11.16% and -21.73% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split.

Panel B reports the market adjusted returns for treatment stocks, control stocks, and the difference between the two. On average, treatment stocks have market adjusted returns of -4.42%, -5.80%, -8.25% and -13.19% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. Control stocks, on average, have market adjusted returns of 1.36%, 2.31%, 2.91% and 8.53% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. On average, the difference in market adjusted returns between treatment and control stocks is -5.78%, -8.11%, -11.16% and -21.72% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split.

Panel C reports the market model returns for treatment stocks, control stocks, and the difference between the two. On average, treatment stocks have a market model return of -3.81%, -4.60%, -6.77% and -6.92% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. Control stocks, on average, have a market model return of 1.71%, 2.83%, 3.77% and 12.17% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. On average, the difference in the market model returns between treatment and control stocks is -5.52%, -7.43%, -10.54% and -19.09% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split.

Panel D reports the returns using the Fama-French 4-Factor alphas model for treatment stocks, control stocks, and the difference between the two. On average, treatment stocks have returns of -3.66%, -4.36%, -6.58% and -6.08% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. Control stocks, on average, have returns of 1.84%, 3.06%, 3.66% and 12.01% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split. On average, the difference in returns between treatment and control stocks is -5.50%, -7.42%, -10.24% and -18.09% for 1 day, 3 days, 5 days, and 20 days, respectively, following the reverse stock split.

Together, the results from Table 6 are consistent with previous research Woolridge and Chambers, 1983; Desai and Jain, 1997) and suggest that firms that perform a reverse stock split have negative returns in the 20 days following the reverse stock split. Additionally, these results validate the findings from Tables 4 and 5, and from Figure 1.

3.3. Cross-Sectional Regressions Analysis

In this final subsection, I estimate four different cross-sectional regressions on the dataset to see the effect of treatment stocks and short selling on returns. Table 7 shows the results of these regressions. More specifically, I estimate specifications of the following regression model:

$$CAR_i = \beta_1 Treat_i + \beta_2 SR_i + \beta_3 Treat_i \times SR_i + \beta_4 Price_i + \beta_5 MCAP_i + \beta_6 Rvolt_i + \beta_7 \%\,Spread_i + \beta_8 Illiq_i + \alpha + \varepsilon_i \tag{8}$$

where the dependent variable is the value-weighted market model cumulative abnormal returns in the 20 days following the reverse stock splits for 161 treatment firms and the pseudo reverse stock splits for the 161 matched control firms. The variable $Treat_i$ is the variable of interest in regressions [1] and [2]. While the interaction term $Treat_i \times SR_i$ is the variable of interest in regressions [3] and [4]. All the independent variables have been previously defined.

[Insert Table 7 Here]

Table 7, column [1] is the most restrictive model using only the independent variable $Treat$. The coefficient of $Treat$ is -0.191 and significant suggesting that stocks that have a reverse split, on average, see negative abnormal returns of -19.1% in the 20 trading days following the reverse stock split. Column [2] controls for more factors, such as $Price$, $MCAP$, $Rvolt$, $\%\,Spread$, and $Illiq$. The regression estimates the coefficient of $Treat$ as -0.386 and significant. This suggests that stocks that have a reverse stock split, on average, see negative abnormal returns of -38.6% in the 20 trading days following the reverse stock split. Column [3] is another restrictive model using the independent variables $Treat$, SR, and $Treat\ x\ SR$. The variable of interest, $Treat\ x\ SR$, has a coefficient of -1.012 and is significant, suggesting that treatment firms, on average, see a decrease in returns of 101.2 basis points for every 1 percentage point increase in the short ratio. Column [4] is the full regression model. The coefficient of the interaction term $Treat\ x\ SR$ is -0.841 and is significant, suggesting that treatment firms, on average, see a decrease in returns of 84.1 basis points for every 1 percentage point increase in the short ratio. All four regression models from Table 7 suggest the same thing, stocks that have a reverse stock split significantly underperform the market in the 20 days following the reverse stock split.

4. Conclusion

In this study, I develop the hypotheses that short selling increases around reverse stock splits, and that short selling puts additional downward pressure on the prices of stocks that reverse split their shares. Diether, Lee, and Werner (2009) show that short sellers correctly predict future negative abnormal returns generating significant positive returns. Woolridge and Chambers (1983) and Lamoureax and Poon (1987) show that reverse splits result in significantly negative stock returns. From these findings, it can reasonably be inferred that short sellers will be attracted to reverse splits.

To control for endogeneity and to create a benchmark for the firms that perform a reverse split, I match each firm that had a reverse split in 2019 to a control firm one-to-one, without replacement based on market capitalization, price, and short ratio. I find that the average short ratio significantly increases for firms that reverse split their stock, relative to matched control firms that do not, other factors held constant. In economic terms, stocks that perform a reverse split see an average increase in short ratio between 2.9% and 4.1%, other factors held constant. I also estimate cumulative abnormal returns in various event windows after the reverse splits and pseudo reverse splits. I find that the average CARs for stocks that perform a reverse split are negative and significant, while those for control firms are generally positive or insignificant. These findings are consistent with Woolridge and Chambers (1983) and Lamoureax and Poon (1987). More importantly, I find that short selling puts additional downward pressure on the prices of stocks that reverse split their shares.

I believe this research is of particular importance for short sellers and for firms that are considering a reverse stock split. It appears that short sellers can capture profits from a trading strategy of selling short stocks that perform a reverse split. These results also suggest that short sellers are informed and correctly predict future negative abnormal returns. For firms contemplating a reverse stock split, they should be aware that short sellers will likely place downward pressure on their stock prices.

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Table 1. Sample Filters

This table reports the filters used to arrive at the final sample. The data are obtained from the Center for Research in Security Prices (CRSP) database for all trading days in 2019.

Filter	# of Stocks
Reverse stock splits in 2019 according to the CRSP database	196
Exclude stocks with more than one reverse stock split in 2019	6
Exclude January and December reverse stock splits in 2019	27
Exclude stocks without positive short sale volume in month prior to reverse stock split	2
Control firms that did not have a reverse stock split in 2019	161
Final Sample	322

Table 2. Summary Statistics

This table reports summary statistics that describe the sample. The following statistics are produced using stock-day observations in the 20 days before the reverse stocks splits for the 161 treatment firms (Panel A) and the 20 days before the pseudo reverse stock splits for the 161 matched control firms (Panel B). *SR* is the ratio of daily short volume to total volume. *Price* is the daily closing price. *Volume* is the daily share volume. *MCAP* is the daily market capitalization, which is the daily closing price times shares outstanding. *Rvolt* is the daily range-based volatility, or the natural log of the daily high ask price minus the natural log of the daily low bid price. *% Spread* is the daily closing spread, or the difference between the closing ask and bid prices, scaled by the closing quote midpoint. *Illiq* is the daily absolute return divided by dollar volume.

Panel A. Treatment Stocks

	Mean	Std. Dev.	p25	Median	p75
SR	0.3771	0.0841	0.3260	0.3714	0.4443
Price	2.4152	6.2718	0.3101	0.4980	1.0881
Volume	2,676,314	5,562,480	206,450	653,269	2,057,840
MCAP	673,207,788	5,637,486,159	7,274,506	16,292,320	55,297,357
Rvolt	0.0968	0.0530	0.0703	0.0894	0.1238
% Spread	0.0164	0.0126	0.0060	0.0139	0.0228
Illiq	0.6076	1.1609	0.0528	0.1810	0.6544

Panel B. Control Stocks

	Mean	Std. Dev.	p25	Median	p75
SR	0.3799	0.0882	0.3094	0.3868	0.4452
Price	2.6380	6.2278	0.5189	0.7921	1.3591
Volume	596,615	1,211,325	60,873	192,037	422,782
MCAP	615,930,681	4,979,064,965	9,721,896	14,618,074	60,711,251
Rvolt	0.0777	0.0409	0.0503	0.0725	0.1008
% Spread	0.0185	0.0131	0.0093	0.0158	0.0257
Illiq	0.9945	1.9067	0.0907	0.3649	1.0504

Panel C. Difference in Means (Treatment - Control)

	Difference	t-stat
SR	-0.0029	-0.30
Price	-0.2229	-0.32
Volume	2,079,699	4.64
MCAP	57,277,107	0.10
Rvolt	0.0191	3.63
% Spread	-0.0021	-1.47
Illiq	-0.3869	-2.20

Table 3. Correlation Matrix

This table reports pooled correlation coefficients for the variables used throughout the analysis. The correlations are produced using stock-day observations in the 20 days before the reverse stocks splits for the 161 treatment firms and the 20 days before the pseudo reverse stock splits for the 161 matched control firms. *SR* is the ratio of daily short volume to total volume. *Price* is the daily closing price. *Volume* is the daily share volume. *MCAP* is the daily market capitalization, which is the daily closing price times shares outstanding. *Rvolt* is the daily range-based volatility, or the natural log of the daily high ask price minus the natural log of the daily low bid price. *% Spread* is the daily closing spread, or the difference between the closing ask and bid prices, scaled by the closing quote midpoint. *Illiq* is the daily absolute return divided by dollar volume. P-values are reported in brackets.

	SR	Price	Volume	MCAP	Rvolt	% Spread	Illiq
SR	1						
Price	-0.2207	1					
	<.0001						
Volume	0.1212	0.1472	1				
	0.0297	0.0081					
MCAP	-0.1712	0.4916	0.1959	1			
	0.0021	<.0001	0.0004				
Rvolt	0.2592	-0.3884	0.1032	-0.1631	1		
	<.0001	<.0001	0.0644	0.0033			
% Spread	0.0325	-0.3481	-0.2998	-0.1537	0.3448	1	
	0.5614	<.0001	<.0001	0.0057	<.0001		
Illiq	-0.1067	-0.1347	-0.1758	-0.0598	0.0249	0.7034	1
	0.0558	0.0155	0.0015	0.2845	0.6558	<.0001	

Table 4. Short Selling around Reverse Stock Splits – Univariate

This table reports the results from univariate tests on short selling around reverse stock splits. The means and medians are produced using stock-day observations in the 20 days before and after the reverse stocks splits for the 161 treatment firms and the 20 days before and after the pseudo reverse stock splits for the 161 matched control firms. *SR* is the ratio of daily short volume to total volume. T-statistics are reported in parentheses, while p-values are reported in brackets.

Panel A. Difference in Means

	Treatment	Control	Diff (Treatment - Control)	t-stat
Pre	37.71%	38.00%	-0.29%	-0.30
Post	42.15%	39.57%	2.58%***	2.55
Diff (Post - Pre)	4.45%***	1.57%	2.87%**	2.06
t-stat	4.59	1.57		

Panel B. Difference in Medians

	Treatment	Control	Diff (Treatment - Control)	p-value
Pre	37.14%	38.69%	-1.55%	0.7739
Post	43.99%	40.46%	3.53%***	0.0064
Diff (Post - Pre)	6.85%***	1.77%	5.08%***	0.0090
p-value	0.0001	0.1208		

Table 5. Short Selling around Reverse Stock Splits – Simple Regressions

This table reports the results from estimating the following regression equation on stock-day observations in the 20 days before and after reverse stock splits for 161 treatment firms and pseudo reverse stock splits for 161 matched control firms.

$$SR_{i,t} = \beta_1 Treat_i + \beta_2 Post_{i,t} + \beta_3 Treat_i \times Post_{i,t} + \beta_4 Price_{i,t} + \beta_5 MCAP_{i,t} + \beta_6 Rvolt_{i,t} + \beta_7 \%\,Spread_{i,t} + \beta_8 Illiq_{i,t} + \alpha + \varepsilon_{i,t}$$

where the dependent variable, *SR*, is the ratio of daily short selling volume to total volume. *Treat* is an indicator variable equal to one if the stock had a reverse split during 2019 and zero if the stock is a matched control firm. Post is a dummy variable equal to one if the treatment (control) firm observation is during the 20 days after the reverse stock split (pseudo reverse stock split) and zero otherwise. *Price* is the daily closing price. *Volume* is the daily share volume. *MCAP* is the daily market capitalization, which is the daily closing price times shares outstanding. *Rvolt* is the daily range-based volatility, or the natural log of the daily high ask price minus the natural log of the daily low bid price. *% Spread* is the daily closing spread, or the difference between the closing ask and bid prices, scaled by the closing quote midpoint. *Illiq* is the daily absolute return divided by dollar volume. T-statistics are in parentheses obtained from robust standard errors clustering at the stock level. ***, *, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

	[1]	[2]
Treat	-0.003	-0.007
	(-0.321)	(-0.767)
Post	0.015**	0.015**
	(2.539)	(2.476)
Treat x Post	0.029***	0.041***
	(3.338)	(4.232)
Price		-0.002***
		(-2.970)
MCAP (in $billions)		-0.002***
		(-3.791)
Rvolt		0.142**
		(2.567)
% Spread		-0.204
		(-1.407)
Illiq		-0.001**
		(-2.093)
Constant	0.380***	0.381***
	(55.028)	(44.810)
Adj. R2	0.011	0.041
N	13,075	13,075

Table 6. CARs around Reverse Stock Splits

This table reports returns following the reverse stock splits for the 161 treatment firms and the pseudo reverse stock splits for the 161 matched control firms. The abnormal returns are cumulated over various event windows.

Panel A. Raw Returns			
Event Window	Treatment	Control	Diff (Treatment - Control)
[0, +1]	-4.15%	1.63%	-5.78%***
[0, +3]	-5.46%	2.66%	-8.12%***
[0, +5]	-7.81%	3.35%	-11.16%***
[0, +20]	-11.66%	10.07%	-21.73%***
Panel B. Market Adjusted Returns			
Event Window	Treatment	Control	Diff (Treatment - Control)
[0, +1]	-4.42%	1.36%	-5.78%***
[0, +3]	-5.80%	2.31%	-8.11%***
[0, +5]	-8.25%	2.91%	-11.16%***
[0, +20]	-13.19%	8.53%	-21.72%***
Panel C. Market Model Returns			
Event Window	Treatment	Control	Diff (Treatment - Control)
[0, +1]	-3.81%	1.71%	-5.52%***
[0, +3]	-4.60%	2.83%	-7.43%***
[0, +5]	-6.77%	3.77%	-10.54%***
[0, +20]	-6.92%	12.17%	-19.09%***
Panel D. FF4-Factor Alphas			
Event Window	Treatment	Control	Diff (Treatment - Control)
[0, +1]	-3.66%	1.84%	-5.50%***
[0, +3]	-4.36%	3.06%	-7.42%***
[0, +5]	-6.58%	3.66%	-10.24%***
[0, +20]	-6.08%	12.01%	-18.09%***

Table 7. CARs around Reverse Stock Splits – Cross-Sectional Regressions

This table reports the results from estimating specifications of the following cross-sectional regression equation:

$$CAR_i = \beta_1 Treat_i + \beta_2 SR_i + \beta_3 Treat_i \times SR_i + \beta_4 Price_i + \beta_5 MCAP_i + \beta_6 Rvolt_i + \beta_7 \%\,Spread_i + \beta_8 Illiq_i + \alpha + \varepsilon_i$$

where the dependent variable is the value-weighted market model cumulative abnormal returns in the 20 days following the reverse stock splits for the 161 treatment firms and the pseudo reverse stock splits for the 161 matched control firms. *Treat* is an indicator variable equal to one if the stock had a reverse split during 2019 and zero if the stock is a matched control firm. *SR* is the ratio of daily short selling volume to total volume. The following variables are averaged over the 20-day post-event sample period by stock. *Price* is the average daily closing price. *Volume* is the average daily share volume. *MCAP* is the average daily market capitalization, which is the daily closing price times shares outstanding. *Rvolt* is the average daily range-based volatility, or the natural log of the daily high ask price minus the natural log of the daily low bid price. *% Spread* is the average daily closing spread, or the difference between the closing ask and bid prices, scaled by the closing quote midpoint. *Illiq* is the average daily absolute return divided by dollar volume. T-statistics are reported in parentheses obtained from robust standard errors. ***, *, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively.

	[1]	[2]	[3]	[4]
Treat	-0.191***	-0.386***	0.213	-0.034
	(-3.610)	(-5.604)	(1.181)	(-0.169)
SR			0.873***	0.194
			(2.878)	(0.652)
Treat x SR			-1.012**	-0.841*
			(-2.037)	(-1.689)
Price		0.010***		0.009***
		(4.223)		(4.010)
MCAP (in $billions)		-0.007**		-0.007*
		(-2.510)		(-1.940)
Rvolt		3.483***		3.622***
		(3.436)		(3.422)
% Spread		-1.025		-1.096
		(-0.472)		(-0.505)
Illiq		-0.001		-0.000
		(-0.111)		(-0.003)
Constant	0.122***	-0.170**	-0.224**	-0.256**
	(3.360)	(-2.248)	(-2.216)	(-2.432)
Adj. R2	0.036	0.133	0.044	0.135
N	322	322	322	322

Figure 1. Short Selling around Reverse Stock Splits

This figure displays average *SR* in the 20 days before and after reverse stock splits for 161 treatment firms and pseudo reverse stock splits for 161 matched control firms. *SR* is the ratio of daily short selling volume to total volume.