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Frictions, the Flow of Information, and the Distribution of Liquidity

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by

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Abstract

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Spencer A Montgomery, Master of Science

Utah State University, 2015

Major Professor: Dr. Tyler Brough
Department: Jon M. Huntsman School of Business

This paper examines the effects of short sale deregulation on market quality by examining the implementation of regulation SHO, which removed the uptick rule for a subset of pilot securities. This created an exogenous event, allowing a direct examination of the effect of short sale constraints on the markets. This study builds on Roll and Subrahmanyam (2010) in examining the skewness of bid-ask spreads as they represent information asymmetry and market maker competition. We find that the price tests conducted in regulation SHO evenly effected both pilot and non-pilot securities, including a widening of bid-ask spreads and a decrease in spread skewness. These findings suggest that short sellers are shifting from liquidity demanders in the market to liquidity providers in the markets. This change is associated with positive effects in the price discovery process and overall market quality.

Public Abstract

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The paper examines how financial regulations effect market quality by examining the roles of short sellers in the market. Past research has demonstrated that short sellers can be generally broken into two categories; liquidity demanders, who generally act on short term price fluctuations in the market and are known as momentum traders, and liquidity suppliers, who are generally contrarian traders, and research has shown improve market quality and aid in the process of information being incorporated into prices. The implementation of regulation SHO temporarily suspended the uptick rule, a regulation which prohibited short sellers from executing trades until the stock price has gone up, for a set of randomly selected securities. We find that short sellers increasingly become liquidity providers, a change which is associated with increases in market efficiency and aiding in price discovery.

Contents

0.1 Introduction

Few topics in financial markets are more evocative and fiercely debated by regulators, politicians, academics, and the media than short selling. On one hand a majority of academic research has found that short selling can play a positive role in the markets; correcting short term price deviations away from fundamental value, provide liquidity, and aid in the price discovery process. Media outlets have stated on the other hand that "Wall Streets short sellers are worse than ambulance-chasing lawyers. Not only do they seek profit from others misfortunes, butspecialize in sinking vulnerable stocks with barrages of bad-mouthing." [1] Additionally politicians, such as Barney Frank (former Congressman from Massachusetts) have pushed for increased short sale regulation to avoid market manipulation through short selling.[2]In response, regulators have been quick to employ rules and regulations to discourage and/or limit short selling in markets. This paper examines the effects of a temporary relaxation of short sale constraints and the subsequent effects on the markets.

During the height of the great depression in the summer of 1934 the Securities Exchange Act was passed, establishing the regulation of secondary markets and the creation of the Securities and Exchange Commission (SEC). An investigation into the market break of 1937 prompted the SEC to implement rule 10a-1 (the uptick rule) in 1938 which provisioned that a listed security may be sold short: (i) at a price above the price at which the immediately preceding sale was effected (plus tick), or (ii) at the last sale price if it is higher than the last different price (zero-plus tick). Conversely, short sales are not permitted on minus ticks or zero-minus ticks, subject to narrow exceptions.[3] This rule was established with the aim of preventing short sellers from pouncing on securities in sharp declines, further adding to the downward momentum and destabilizing the markets. Though financial markets would undergo dramatic technological evolutions, tick size changes, and market changes over the following 69 years, the uptick rule remained unchanged.

[1] https://ii-uploads.s3.amazonaws.com/share$_a dvisor/splreports/II_S R_J im_C hanos_M asterclass_{D ec_1 4.pdf}$

[2] https://www0.gsb.columbia.edu/faculty/lglosten/papers/Fox%20et%20al%2054.3.pdf

[3] https://www.sec.gov/rules/concept/34-42037.htm

On January 3rd 2005, the SEC implemented a new regulation regarding short selling, Regulation SHO (Reg SHO). This regulation established a short selling circuit breaker which halted trading after dramatic declines in security prices, and location and close out requirements aimed at preventing naked short selling. Along with these new rules, Reg SHO also created Rule 202T, a Pilot program with the goal of evaluating the overall effectiveness of price test restrictions on short sales. The Pilot will allow the Commission to obtain data on the impact of short selling in the absence of a price test.[4] This meant the SEC would, for certain securities, suspend the uptick rule in order to study the effects the absence of this price test regulation would have on the market. This program was originally intended to be in place for one year, beginning on May 2nd 2005 and ending on April 28th 2006. The program however was extended through August 6th 2007. [5]

In order to create a sample of securities which would have the uptick rule suspended, the SEC selected roughly 1,000 stocks, comprising every third security of the Russell 3000 index, which comprises the largest 3,000 U.S. companies, when sorted by volume. The non-pilot, or control stocks, comprised the remainder of the Russell 3000 index, as well as the rest of the universe of stocks. The random selection of the pilot stocks created an exogenous event which allowed the direct comparison of stocks pre and post SHO implementation. This removal of the short sale restrictions enables the examination of the effects short sale regulations on price efficiency, the price discovery process, market volatility and market liquidity.

Evaluating the past literature of the effects on short selling and market efficiency reveals a wealth of information. Diether, Lee and Werner (2008) find short sellers compose a significant segment of share volume on both the Nasdaq and NYSE at 31% and 24% respectively. These findings also indicate that short selling strategies, such as short selling during periods of high asymmetric information, after periods of high positive returns, and days with significant buying pressure, generate positive abnormal returns of 1.39% per month. Boehmer, Jones, and Zhang (2008) examine the ban or short sales for nearly 1000 financial stocks in

[4] https://www.sec.gov/spotlight/shopilot.htm

[5] 3. Securities and Exchange Act Release No. 53684 (April 20, 2006).

September of 2008. They find that shorting activity drops by an average of 77% for large cap stocks. They further find that market quality was worsened due to high frequency traders inability to act as market makers during the ban.

Boehmer and Wu (2010) examine the role of short selling in the price discovery process, which is how information is incorporated into security prices. Their findings suggest that short selling increases market efficiency and keep prices more in line with fundamentals. Blau and Brough (2011) examine bear raids, or periods of consecutive abnormal short selling, a concern which originally prompted the implementation of the uptick rule. They find that these bear raids occur after periods of steep positive returns, rather than negative. This implies that short sellers are acting as contrarian traders knocking prices back down to fundamental levels, rather than ambushing companies under steep price duress.

Diether, Lee and Werner (2009b) examined the effects of Reg SHO and found increases in short selling activity for securities listed under both the NYSE and NASDAQ, but measures of market quality such as returns and daily volatility were not affected by the increase in short sales. Roll and Subrahmanyam (2010) find that Bid-ask spreads become increasingly right skewed according due to competition between market makers, inhibiting the ability of market makers to cross subsidize during periods of high and low asymmetric information. Finally, Comerton-Forde, Jones, and Putni (2011) find that short sellers fall into two distinct groups, liquidity demanders, and liquidity providers. Liquidity demanders are generally momentum traders, whereas liquidity providers are contrarian traders, who often step in when spreads for a security are abnormally wide. Building on this research, this paper aims to examine the effects that the relaxation of short sale constraints, by removing the uptick rule, have on market quality.

0.2 Data Description

The data in this analysis was obtained from the Center for Research on Security Prices (CRSP). This data contained information on the universe of stocks from February 2nd 2005 to July 26th 2005, or 60 trading days prior to and post price test implementation of May 2nd 2005. This 60 day sample size was chosen

to focus on the immediate effects of Reg SHO, while still providing an adequately large sample size. Along with the information provided by CRSP, the following variables were calculated:

Closing Spreads: The calculation of closing spreads was conducted by differencing the ask and bid prices, scaled by the midpoint as such: $\frac{AskPrice-BidPrice}{(AskPrice+BidPrice)/2}$

Market Capitalization: Market Cap was obtained by multiplying the security price by the shares outstanding. This result was then scaled by the natural log to obtain the lognormal daily market capitalization of each security.

Turnover: Share turnover was calculated by taking the quotient of daily volume and shares outstanding.

High Price: The high priced was calculated as the absolute value of the highest daily trading price.

Low Price: The low price was calculated as the absolute value of the lowest daily trading price.

Price Volatility: Price volatility was calculated following the research of Diether, Lee, and Werner (2009) by taking the difference between the daily high and low prices and dividing by the high price as such: $\frac{highprice-lowprice}{highprice}$

Illiquidity: The illiquidity estimate was calculated as proposed by Amihud (2002) as a proxy for illiquidity. This is calculated by using the realized scaled volatility as: $\frac{|DailyReturn|}{DailyVolume} * 100{,}000$

Beta: CAPM betas(β) were estimated in the pre/post SHO time periods.

In total, 742,602 observations across 43 variables were analyzed with 112,013 observations of pilot securities and 630,589 observations of control securities. The variation in the size between the pilot and non-pilot securities arises from the fact that pilot securities were drawn strictly from the Russell 3000 index, whereas the

non-pilot control securities comprise the entire universe of stocks. To reduce the likelihood of results being influenced and biased by outlying securities, stocks below $2.00 were removed from the sample. A list of securities which were chosen to be in the pilot program was obtained online from the SEC.

Table 1 reports the summary statistics for the pre/post SHO time period for all stocks, both pilot and non-pilot. This allows an examination of the market as a whole before isolating for pilot and control securities. Summary statistics were calculated for variables of interest including: price volatility, share turnover, illiquidity (as measured by Amihuds illiquidity measure), dollar spreads, and the moments of the spread distribution as spread mean, standard deviation, skewness and kurtosis.

Panel A. of Table 1 reports securities in the pre SHO time period. In this period the average market cap of companies was $2.74 billion with a median value of $356 million. The daily price volatility was 2.87%, with an illiquidity measure of 0.25 and share turnover of 8.3235. The moments of spread include an average spread of 0.0056, spread standard deviation (or spread volatility) of 0.0043, spread skewness of 1.48, and spread kurtosis of 7.05. The post SHO time period is reported in Panel B. The average market cap during this time period decreased to $2.71 billion with a median value of $356 million. Price volatility is 2.7%, illiquidity of 0.29, and share turnover of 7.95. The spread moments included an average spread of 0.0062, spread volatility of 0.0044, skewness of 1.39 and kurtosis of 6.65.

0.3 Empirical Results

In Table 2 the data was broken down to analyze market wide changes before taking into consideration the individual changes by pilot/control securities. The mean for each variable was calculated for both the pre and post SHO time periods, which make up columns 1 and 2 respectively. Column 3 represents the difference between the two time periods, as calculated by differencing the post and pre values. Column 4 represents the same change calculated in column 3, expressed as a percentage change. The significance in each change was then measured by performing a T-test assuming equal variances. The statistical significance is then

reported, as well as the corresponding P-value in parenthesis. This showed that the spread for all securities increased by over 10%, illiquidity increased by over 14%, share turnover decreased by 4.51%, spread skewness decreased by 6.42% and spread volatility increased by 2.77%. All of these changes are statistically significant with P-values (¡.0001). These results demonstrate that significant differences existed between the pre and post SHO implementation periods.

To examine how the pilot and control securities changed with the implementation of Reg SHO, the data was broken into sub-datasets for pilot and control stocks. The pilot stock dataset included 55,870 observations pre SHO, and 56,143 post SHO. The control stock dataset contained 311,883 observations pre SHO, and 318,756 post SHO. The variables analyzed include: spread, dollar spread, price volatility, illiquidity, spread skewness, spread kurtosis, and spread standard deviation.

Pilot securities registered an increase in average spreads by 8.25%, dollar spread increases of 5.73%, and price volatility decreases of 6.13%, all of which are significant at the 1% level. The moments of the bid-ask spread distribution also underwent statistically significant changes, with spread skewness decreasing by 7.58%, spread kurtosis decreasing by 5.38% and spread standard deviation decreasing by 4.99%. These changes line up with prior research into the effects of Reg SHO [6] which showed a small, but statistically significant increase in spreads for both pilot and control securities. Illiquidity increased by 19.15%, though at a less significant level (P-value of 0.0513) for pilot securities. The non-pilot control securities registered an increase in spreads by 10.71%, dollar spreads increased by 3.58%, however this increase was not statistically significant, price volatility decreased by 5.45% and illiquidity increased by 14.36%. Spread skewness decreased by 6.20%, kurtosis decreased by 5.52% and spread volatility increased by 3.18% These numbers follow the same direction of movements as the pilot securities, with the exception of spread volatility, indicating that Reg SHO does have a statistically significant effect on the variables of interest, in most cases the changes for both pilot and control securities experience changes in the same direction.

[6] Diether, Lee, and Werner (2009)

Table 4 examines how the changes in the pre and post SHO time periods for both pilot and control securities compare. This is accomplished by taking the change undergone in the pilot securities, the change undergone in the control securities, and differencing these two values, creating a difference in differences value. Column 1 represents the difference between the pre and post SHO implementation for spread, dollar spread, price volatility, illiquidity, spread skewness, kurtosis and volatility for pilot securities. Similarly column 2 represents these same differences undergone by the control securities. Column 3 represents a new value, a difference in differences, which takes the difference between the control securities and the pilot securities. This value can then be tested to see if the changes undergone by pilot and control securities are statistically different from each other. For all variables, with the exception of price volatility, the pilot and control variables underwent statistically different changes, or levels of change under SHO implementation. This allows us to conclude that even if the direction of movements were the same for pilot and control securities, the level of the movements was different enough to be statistically significant. This could be potentially explained by the sample differences between the pilot and control securities, however the results are still significant in examining the changes in pilot and control securities.

In order to test if differences in the bid-ask spread skewness effected other variables, the data was sorted and divided into quintiles by the change in spread skewness pre/post SHO. These results are reported in Table 5. Panel A represents the data for all securities broken into quintiles regardless of pilot or control stock status. Panel B reports the first and fifth quintiles (top and bottom 20%) of pilot securities. Panel C represents the same analysis for control securities. For pilot securities, as reported in Panel B, there are statistically significant differences in the highest and lowest quintiles for all variables with the exception of illiquidity. Stocks which were in the top 20% of spread skewness changes showed an average of 14.55% lower spreads compared to the bottom quintile. Similarly dollar spreads for the top quintile were 18.63% lower than the bottom quintile. Price volatility is a small, but statistically significant 2.49% for the high quintile, and stock turnover is 27% higher for the top 20% of securities. Similarly, spread volatility

and spread kurtosis are lower by 20.38% and 29.27% respectively for the highest quintile compared to the lowest quintile.

Panel C similarly contains the top and bottom quintiles of the change in spread skewness for control securities. Similar to the pilot securities, stocks in the highest quintile had 19.61% lower spreads, 8.87% lower dollar spreads, 3.96% lower price volatility and 20.29% lower illiquidity (higher liquidity). This measure is very large, and significant for the control securities, which is intriguing as illiquidity for pilot securities stayed constant, indicating either an effect of the regulation on the control securities, or changes in the sampling distribution as the control securities contain many more small companies. Finally spread volatility and spread kurtosis decreased by 13.26% and 8.56% respectively.

The final test in this analysis is a difference in difference regression. Using data for all securities, a new variable was created capturing the change in bid-ask spread skewness pre and post SHO. This new difference variable is then used as the dependent variable in a regression, and the following equation:

$$SpreadSkewChange = \beta_0 + \beta_1 Pilot + \beta_2 LogPrice + \beta_3 LogVol + \beta_4 LogMktCap + \beta_5 PVolt + \beta_6 Illiq + \beta_7 Turn + \beta_8 SpreadStDev + \beta_9 BetaChange + \beta_{10} Nasdaq$$

The independent variables in this regression include: a dummy variable signifying if the security is a pilot or control stock, the natural logarithm of stock price (LogPrice), volume (LogVol), and market capitalization (LogMktCap). Other variables include price volatility (PVolt), illiquidity (Illiq), turnover (Turn), spread standard deviation (SpreadStDev), CAPM beta change (BetaChange), and a dummy variable if the security is listed on NASDAQ as opposed to the NYSE (Nasdaq).

This regression was run by adding variables individually, allowing the analysis of the effects that subsequent independent additions have on existing variables. When all variables are accounted for, every variable is statistically significant at the less than 1% level. The results of the regression conclude that ceteris paribus, a pilot security is associated with a decrease in the change of the spread skewness by 0.097. The log of price is associated with an increase in the change of skewness by 9.9%, the log of trade volume is associated with a positive change in spread

skewness of 2.8%, and the log of market cap is associated with a decrease in the change of spread skewness by 0.99%. Interestingly, the price of the security is associated with a positive change, whereas the market cap is associated with a negative change. The measures for price volatility, spread volatility, and change in beta all are associated with negative changes in spread skewness, whereas illiquidity, turnover, and the dummy variable for Nasdaq are associated with positive spread skewness changes. Overall these results correspond to the univariate counterparts in the direction of the movements. Holding other variables constant, the results show that variables such as price, volume, illiquidity, and turnover increase the change in skewness for securities.

These results show that the implementation of Reg SHO have vastly similar effects on both pilot and non-pilot securities. We see that pilot securities showed a statistically significant increase for spread and dollar spreads by 8.26% and 5.75% respectively, and control securities showed a statistically significant increase of 10.71% for bid-ask spreads (but not dollar spreads). These increases in overall spreads may be associated with changes in the market during the post SHO timeframe, however other explanations are possible. One explanation is market makers, unsure how the regulations implementation would affect markets, temporarily widened spreads for both pilot and control securities to lower their risks, and evaluate how the marketplace reacts. Because the ability of informed short sellers to act on pilot stocks without the uptick rule, the potential for market makers to lose out during periods of high asymmetric information became more likely.

From Table 3, we see that spread volatility decreased for pilot securities by 4.99%, and increased for control securities by 3.18%. The decrease in spread volatility for pilot securities, while leading to a lower premium in expected stock returns, as would be suggested by Blau and Whitby (2013), could also potentially be explained by the role of short sellers and the flow of information into markets. A decrease in the standard deviation of bid-ask spreads could signify that the price discovery process is becoming more efficient, and therefore market makers are able to, with more surety, set spreads. The inverse is true with the control

securities, with the uptick rule still in place, short sale information is not able to be as efficiently passed into markets through the pricing mechanism, and therefore the standard deviation of spreads increases to accommodate less surety by market makers.

Throughout this analysis, the decreasing of spread skewness has been consistent for both pilot and control securities. The original hypothesis that informed short sellers would create higher asymmetric information in the markets, and spreads would therefore become more right skewed, as would be suggested by Roll and Subrahmanyam (2010) did not occur as originally hypothesized. The best explanation for why spreads became less right skewed comes from the research of Comerton-Forde, Jones, and Putni (2011) on the roles of short sellers in the markets. Short sellers have the ability to provide liquidity to the market by stepping in as unofficial market makers when spreads are abnormally wide, and by stepping in to short securities after steep price increases. Because spreads are becoming less skewed upon the implementation of Reg SHO, it appears that short sellers are changing from liquidity demanders to liquidity suppliers. This change overall is associated with higher market quality, with short sellers stepping in when others are unwilling to do so.

0.4 Conclusion

The debate over short selling is not likely to diminish anytime soon, with political views and regulatory actions implying that short selling manipulates markets, and systematic sort selling, such as in bear raids, can force companies out of business, the majority of academic research continues to find market-wide benefits to short sellers. Short sellers, especially so called liquidity providing short sellers do not generally pounce on ailing stocks undergoing a price decline, but rather act as contrarian traders keeping prices more in line with fundamental values by shorting stocks undergoing steep price increases, and jump in when spreads for a security become abnormally wide (Diether, Lee Werner (2008), Blau and Brough (2011), Comerton-Forde, Jones, and Putni (2011)). Short selling has also been shown to increase market quality by acting as informal market makers, and improving the

price discovery process by changing trading activity around extreme events.

This research aims to examine how a relaxation of short sale constraints by the removal of the uptick rule (Rule 10a-1), which has been in existence since 1938, effects the skewness of bid ask spreads. Results in this study find that for both pilot and control securities, the skewness of bid-ask spreads decreased, with most other measures moving in the same direction. This research results in the conclusion that with the lack of the price test rule for short selling, short sellers moved from liquidity demanders, to liquidity providers. The shift to liquidity providing short sellers stabilizes markets, and provides increases in market quality overall.

Research into the effects of short selling will need to continue being conducted as the SEC has continued the use of short sale restrictions to try to stabilize markets, such as the short selling ban during the 2008 financial crisis. Academic literature has found that though short sellers have the potential to degrade market quality and manipulate markets, the large majority of literature has found short selling a benefit to markets. The information provided by short sellers is beneficial to the price discovery process, contrarian trading keeps security prices closer to fundamental values, and the ability of short sellers and high frequency traders to act as informal market makers are all potential benefits of short sellers. The relaxation of the short sale constraint of the uptick rule according to this research, and prior research has found that important measures of market quality were either improved, or unchanged after the implementation. The many positive benefits of short selling in the markets therefore need to be considered by regulators when deciding future regulation.

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Table 1: Summary Statistics

This table presents the summary statistics of the data used in this analysis. The data includes the universe of stocks traded on Nasdaq or the NYSE which had an average price above $2.00 for the duration of the study. The time frame of the data includes the 60 days prior to, and post the implementation of Regulation SHO on May 2nd 2005. The data included in this table is broken into two panels, Panel A includes the statistics for the 60 days pre SHO, and Panel B includes statistics for the 60 days post SHO. These panels include the variables of Market Capitalization (Market Cap), Bid-Ask spreads (spread), Bid-Ask dollar spread (dollar spreads), price volatility, illiquidity, daily share turnover (turnover) and three moments of the spread distribution (spread skewness, kurtosis, and standard deviation). Price volatility is calculated as the daily high price minus the daily low price, divided by the daily high price. The measures of Mean, Median, Standard Deviation, Minimum, and Maximum are reported for each of the aforementioned variables.

Panel A. Pre SHO

	Mean	*Median*	*Std. Dev.*	*Min*	*Max*
	[1]	[2]	[3]	[4]	[5]
Average Price	38.99	17.63	805.92	2.01	44,421.79
Market Cap	2,741,686.56	356,443.20	12,940,647.38	95.70	394,328,106
Spread	0.0056	0.0023	0.0100	-0.0645	0.2881
Dollar Spread	0.1149	0.0400	2.4847	-0.5700	300.0000
Price Volatility	0.0287	0.0219	0.0260	0.0000	0.7935
Illiquidity	0.2523	0.0092	1.7603	0.0000	155.6600
Turnover	8.3235	3.6027	33.7532	0.0008	2747.5500
Spread Skewness	1.4842	1.1589	1.9018	-7.0342	7.6561
Spread Kurtosis	7.0462	2.6511	10.5625	-5.9873	65.1196
Spread Std. Dev.	0.0043	0.0025	0.0051	-0.0006	0.0666

Panel B. Post SHO

	Mean	*Median*	*Std. Dev.*	*Min*	*Max*
	[1]	[2]	[3]	[4]	[5]
Average Price	38.57	17.57	798.12	2.01	44,421.79
Market Cap	2,705,168.83	356,443.20	12,969,305.98	350,017.15	408,108,985.00
Spread	0.0062	0.0024	0.0115	-0.0814	0.5000
Dollar Spread	0.1194	0.0400	2.4440	-1.1100	300.0000
Price Volatility	0.0271	0.0203	0.0254	0.0000	0.8229
Illiquidity	0.2893	0.0088	2.0267	0.0000	190.6975
Turnover	7.9483	3.3340	45.1124	0.0004	11030.7800
Spread Skewness	1.3889	1.0631	1.8542	7.0342	7.8792
Spread Kurtosis	6.6540	2.4776	9.9371	-5.6333	73.0179
Spread Std. Dev.	0.0044	0.0025	0.0056	0.0000	0.0990

Table 2 Mean Changes Pre/Post SHO

This table reports the difference in means between the pre and post SHO implementation time periods for all stocks. Column 1 represents the mean before the SHO implementation, Column 2 represents the mean in the post SHO implantation. Column 3 represents the change between the pre and post time periods as calculated by the post minus the pre. Column 4 represents the percentage change between the two time periods in order to give context to the amount of change. Finally Column 5 represents the significance of these changes as measured by a T-test assuming equal variances with reported P values.

*** Significant at 1% level ** Significant at 5% level * Significant at 10% level

Table 2. Change Pre/Post SHO

	Pre Mean	*Post Mean*	*Change*	*Percent Change*	*Significance*
	[1]	[2]	[3]	[4]	[5]
Spread	0.00559	0.00619	0.0006	10.73%	*** (<.0001)
Dollar Spread	0.1149	0.1194	0.0045	3.92%	(0.43)
Price Vol.	0.0287	0.0271	-0.0016	-5.57%	*** (<.0001)
Illiquidity	0.2523	0.2893	0.037	14.67%	*** (<.0001)
Turnover	8.3235	7.9483	-0.3752	-4.51%	*** (<.0001)
Spread Skewness	1.4842	1.3889	-0.0953	-6.42%	*** (<.0001)
Spread Kurtosis	7.0462	6.654	-0.3922	-5.57%	*** (<.0001)
Spread Std. Dev.	0.00433	0.00445	0.00012	2.77%	***(<.0001)
Num. Observations	367,703	374,899			

Table 3 Comparison of Mean Changes Pre/Post SHO by Security Type

This table represents an analysis of the data by separating securities in the pilot group from securities which did not undergo any changes (control group). The average values for Spreads, Dollar Spreads, Price Volatility, Illiquidity, Spread Skewness, Spread Kurtosis, and Spread Standard Deviation are reported. Column 1 (Column 5) represents variable averages for securities in the pilot (control) program in the pre SHO time period, Column 2 (Column 6) reports the variables for pilot securities in the post SHO time frame. Column 3 (Column 7) represents the percentage change between the pre and post SHO time period for each variable. Finally Column 4 (Column 8) represent the significance of each change for both pilot and non-pilot securities. P-values are reported in parentheses.

*** Significant at 1% level ** Significant at 5% level * Significant at 10% level

Panel A: Pilot Securities

	Pre	*Post*	*Difference*	*Significance*
	[1]	[2]	[3]	[4]
Spread	0.0019	0.0021	8.25%	*** (<.0001)
Dollar Spread	0.0545	0.0576	5.73%	*** (0.0051)
Price Vol.	0.0285	0.0268	-6.13%	*** (<.0001)
Illiquidity	0.0293	0.0349	19.15%	* (0.0513)
Spread Skewness	1.5596	1.4413	-7.58%	*** (<.0001)
Spread Kurtosis	9.1704	8.6768	-5.38%	*** (<.0001)
Spread Std. Dev.	0.0023	0.0022	-4.99%	*** (<.0001)
Num Observations	55,870	56,143		

Panel B: Control Securities

	Pre	*Post*	*Difference*	*Significance*
	[5]	[6]	[7]	[8]
Spread	0.0062	0.0069	10.71%	*** (<.0001)
Dollar Spread	0.1258	0.1303	3.58%	(0.5035)
Price Vol.	0.0287	0.0271	-5.45%	*** (<.0001)
Illiquidity	0.2922	0.3342	14.36%	*** (<.0001)
Spread Skewness	1.4707	1.3796	-6.20%	*** (<.0001)
Spread Kurtosis	6.6656	6.2977	-5.52%	*** (<.0001)
Spread Std. Dev.	0.0047	0.0048	3.18%	*** (<.0001)
Num Observations	311,833	318,756		

Table 4 Difference in Differences

Table 4 shows an analysis examining the difference in differences between pilot and control securities. This is represented by the changes in pilot securities in the pre and post SHO time periods for both pilot and control securities (Columns 1 and 2). Column 3 represents the difference between the pilot and control securities, and Column 4 represents the statistical significance of these findings. This difference in differences allows us to examine if pilot and control securities underwent significantly different changes under the implementation of regulation SHO.

*** Significant at 1% level ** Significant at 5% level * Significant at 10% level

	Pilot Post - Pre	*Control Post - Pre*	*Diff - Diff*	*Significance*
	[1]	[2]	[3]	[4]
Spread	0.000159	0.0006686	0.0005096	*** (<.0001)
Dollar Spread	0.003122	0.0045033	0.0013813	*** (<.0001)
Price Vol.	-0.0017502	-0.0015631	0.0001871	(0.97)
Illiquidity	0.0056056	0.04196	0.0363544	*** (<.0001)
Spread Skewness	-0.1182527	-0.0911337	0.027119	*** (<.0001)
Spread Kurtosis	-0.4935973	-0.3678852	0.1257121	*** (<.0001)
Spread Std. Dev.	-0.0001171	0.0001492	0.0002663	*** (<.0001)

Table 5 Spread Skewness Quintiles

Table 5 represents an analysis of securities when broken into equal quintiles based on the overall change in spread skewness undergone during the SHO implementation. The data is further broken into three panels, Panel A shows the overall changes for both pilot and control securities when broken into quintiles. Panel B represents the top and bottom quintile (top and bottom 20%) for pilot securities, and Panel C represents the top and bottom quintiles for control securities. The variables examined as they related to the change in spread skewness are Spreads, Dollar Spreads, Price Volatility, Illiquidity, Turnover, Spread Standard Deviation, and Spread Kurtosis. P-values are reported in parentheses. *,**, *** denote statistical significant at the 10%, 5%, and 1% levels.

Panel A. Quintiles of Spread Skewness Change

	Spread	*Dollar Spread*	*Price Vol.*	*Illiquidity*	*Turnover*	*Spread St.Dev*	*Spread Skew*	*Spread Kurt*
	[1]	[2]	[3]	[4]	[5]	[7]	[8]	[9]
Q I (Low)	0.0051	0.0774	0.0279	0.2007	7.6555	0.0042	1.8872	11.3075
Q II	0.0071	0.0983	0.0983	0.3690	8.5949	0.0050	1.2852	4.7500
Q III	0.0069	0.2540	0.0281	0.3299	6.7815	0.0048	1.0765	3.8019
Q IV	0.0060	0.0867	0.0278	0.2874	7.9593	0.0043	1.2136	4.6662
Q V (High)	0.0041	0.0694	0.0268	0.1598	9.5560	0.0036	1.7221	9.8374
Q V - Q I	-0.000996 ***	-0.00797 ***	-0.00104 ***	-0.0409 ***	1.9005 ***	-0.000674 ***	-0.1652 ***	-1.4701 ***
Significance	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
% Change	-19.57%	-10.34%	-3.94%	-20.38%	24.83%	-16.08%	-8.75%	-13.00%

Panel B. Top and Bottom Quintiles of Spread Skewness Change for Pilot Securities

	Spread	*Dollar Spread*	*Price Vol.*	*Illiquidity*	*Turnover*	*Spread St.Dev.*	*Spread Skew*	*Spread Kurt*
	[1]	[2]	[3]	[4]	[5]	[7]	[8]	[9]
Pilot Q I (Low)	0.0022	0.0585	0.0281	0.0162	7.7783	0.00265	2.202	14.2922
Pilot Q V (High)	0.00188	0.0476	0.0274	0.0162	9.8788	0.00211	1.6143	10.1087
Pilot Q V - Q I	-0.0003 ***	-0.0109 ***	-0.0006 ***	0.0000	2.1005 ***	-0.0005 ***	-0.5877 ***	4.1835 ***
Significance	(<.0001)	(<.0001)	(0.0002)	(0.9393)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
% Change	-14.55%	-18.63%	-2.49%	0.00%	27.00%	-20.38%	-26.69%	-29.27%

Panel C. Top and Bottom Quintiles of Spread Skewness Change for Control Securities

	Spread	*Dollar Spread*	*Price Vol.*	*Illiquidity*	*Turnover*	*Spread St.Dev.*	*Spread Skew*	*Spread Kurt*
	[1]	[2]	[3]	[4]	[5]	[7]	[8]	[9]
Pilot Q I (Low)	0.00571	0.0812	0.0278	0.2385	7.6304	0.00445	1.8227	10.6958
Pilot Q V (High)	0.00459	0.074	0.0267	0.1901	9.4879	0.00386	1.7448	9.7802
Pilot Q V - Q I	-0.0011 ***	-0.0072 ***	-0.0011 ***	0.0485 ***	1.8575 ***	-0.0007 ***	-0.0779 ***	0.9156 ***
Significance	(<.0001)	(<.0001)	(0.0002)	(<.0001)	(<.0001)	(<.0001)	(<.0001)	(<.0001)
% Change	-19.61%	-8.87%	-3.96%	-20.29%	24.34%	-13.26%	-4.27%	-8.56%

Table 6 Difference in Differences Regression

This table was created by running a difference in difference regression. This regression used the change in spread skewness pre and post SHO as the dependent variable, with the variables including a dummy variable for pilot securities, normal logarithm of price, volume, and market cap. Other independent variables include price volatility, illiquidity, turnover, spread standard deviation, change in CAPM Beta, and a dummy variable if the security was listed on the Nasdaq exchange. The regression was run in a sequence, adding variables individually as to analyze how the addition of variables effects the given variables. Column 10 represents the regression with all variables included. Significances are shown including P-values in parenthesis. *, **, ***, denote significance at the 10%, 5%, and 1% levels.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	
Intercept	-0.0907	-0.3645	-0.5736	-0.5142	-0.4807	-0.4926	-0.4965	-0.4633	-0.4664	-0.5531	*** (<.0001)
Pilot	-0.2766	-0.0666	-0.0967	-0.0948	-0.0943	-0.0947	-0.0935	0.0052	-0.0896	-0.0965	*** (<.0001)
logPrice		0.9970	0.0909	0.1031	0.1012	0.1022	0.0973	0.0030	0.0974	0.1000	*** (<.0001)
logVol			0.0008	0.0278	0.0315	0.0336	0.0304	0.0016	0.0282	0.0281	*** (<.0001)
logMktCap				0.0021	-0.0172	-0.0185	-0.0144	0.0023	-0.0143	-0.0099	*** (<.0001)
Price Volatility					-0.5061	0.0821	-0.0593	0.0849	-0.5001	-0.8800	*** (<.0001)
Illiquidity						0.0010	0.0055	0.0010	0.0063	0.0050	*** (<.0001)
Turnover							0.0004	0.0000	0.0004	0.0004	*** (<.0001)
Spread Std. Dev								0.4512	-2.3024	-2.1906	*** (<.0001)
Beta Change									-0.0354	-0.0359	*** (<.0001)
Nasdaq										0.0743	*** (<.0001)
R Squared	0.00	0.0035	0.0044	0.0045	0.0045	0.0046	0.0047	0.0047	0.005	0.0055	