Are shorts restricted when options are an option?

Evidence from SEC Rule 201

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Abstract

This paper investigates the effect of the current short-sale regulation, SEC Rule 201, on cross-market trading and its impact on market quality. The evidence suggests that after Rule 201 is triggered, shorting activity decreases and put option activity increases. Call option activity, option bid-ask spreads, and pressure on put option prices increase as well. This evidence is consistent with informed short sellers migrating from the equity market to the options market after short-sale restrictions become binding and contributes to a long-standing debate on the topic. Further, we document an increase in equity bid-ask spreads and equity price dispersion, indicative of deterioration in the market quality of the underlying stocks. The evidence highlights the need of additional disclosure requirements related to large synthetic short-sale positions through options.

JEL-Classification: G12, G14.

Keywords: option markets, short-sale regulation, Rule 201, market quality, trader migration

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1. Introduction

Short-selling regulation has been a topic of considerable debate in the recent past.[1] The current short-selling regulation, US Securities and Exchange Commission ("SEC") Rule 201 of Regulation SHO, requires exchanges to restrict short selling once a stock experiences a negative intraday return greater than or equal to 10%.[2] The objective of this regulation is to prevent excessive downward price pressure on individual securities, thereby decreasing volatility, promoting liquidity and, ultimately, maintaining market quality and protecting investors' confidence in financial markets.[3] The debate has also focused on options markets and the extent to which they contribute to distortions in equity market quality.[4] Despite the recent surge in attention on the inter-linkages between short selling, equity markets, and options markets, there is no large-sample evidence whether traders migrate to the options market in order to circumvent the current short-selling regulation, SEC Rule 201, and, importantly, what is the impact of trader migration on the market quality of the underlying equity market and the options market. This gap is surprising because a trader can easily replicate an equity short sale strategy in the options market by entering a long put option and short call option position on the same underlying.[5]

In this study, we fill this gap by investigating the effect of Rule 201 on short selling activity and market quality in the equity market, and trading activity and market quality in the corresponding options market. Importantly, we also investigate the channels through which Rule 201 impacts equity and option market quality. To this end, we construct a detailed data set that combines stock-level information covering equity trading activity and the corresponding option market trading activity. We combine these data with securities lending market information and

[1] See e.g., "SEC Proposes Rules for More Disclosure From Short Sellers," Wall Street Journal, February 25, 2022, Link.

[2] See "Division of Trading and Markets: Responses to Frequently Asked Questions Concerning Rule 201 of Regulation SHO" Link.

[3] See Securities Exchange Act Release No. 61595 (Feb. 26, 2010), 75 FR 11232 (Mar. 10, 2010) ("Rule 201 Adopting Release").

[4] See e.g., "Staff Report on Equity and Options Market Structure Conditions in Early 2021," Securities and Exchange Commission, October 14, 2021, Link.

[5] See e.g., "Strengthening Practices for Preventing and Detecting Illegal Options Trading Used to Reset Reg SHO Close-out Obligations" SEC Office of Compliance Inspections and Examinations, August 9, 2013, Link.

information about individual stocks that have been impacted by Rule 201 sourced directly from NYSE and NASDAQ.

Our analyses provide four primary results. First, we document a sharp decrease in equity short interest when Rule 201 is triggered of approximately 78% for companies without options, and a lower decrease of approximately 6.7% for companies with options. This evidence provides support for the effectiveness of SEC Rule 201 to deter short selling once a stock's intraday return decreases by 10% or more. Our evidence also suggests that the lower decrease in short interest for companies with options is likely due to option market makers hedging an increased demand for put options by shorting the underlying stock. Second, we find that concurrently with the decrease in equity short interest there is an increase in both put and call option open interest and trading volume. In particular, we find an increase in put option open interest and trading volume for stocks experiencing a Rule 201 trigger of 61% and 87%, respectively. This evidence supports the conjecture that stocks with options experience a migration of short sellers from the stock market to the options market after a short-selling restriction. We also find that call option open interest and call option trading volume for stocks experiencing a Rule 201 trigger increased by 40% and 80%, respectively. This evidence is consistent with option market makers selling call options to remain delta-neutral due to the increased demand for put options. Further, the evidence is consistent with traders utilizing call options to express their positive view on potentially rebounding prices of the underlying stocks. Third, we find a significant increase in relative put (call) option bid-ask spreads of 19.2% (20.7%) and an increase in put option prices pressure, as indicated by an increase in the implied volatility spread and the implied volatility skew for companies that experience a Rule 201 trigger. This evidence provides further support for the conjecture that informed short sellers were migrating into put options after short-selling restrictions became binding. Fourth, we document an increase of relative equity bid-ask spreads and price dispersion for companies that experience a trigger event. In particular, equity bid-ask spreads increase by 108% for companies without options and by 139% for companies with options that experience a Rule 201 trigger. Further, we find an increase in equity price dispersion for both companies without and with options of about

179% and 142%, respectively. Overall, this evidence implies that a Rule 201 circuit breaker distorts market quality in both the equity and the option markets.

Our study contributes to different strands of literature. First, our findings shed light on a long-standing academic debate whether investors use options to circumvent equity short-selling restrictions. Option markets can be used to take a synthetic short position when short selling in the equity market is either restricted through regulation or costly (see e.g., Diamond and Verrecchia (1987), Figlewski and Webb (1993), Easley, O'hara, and Srinivas (1998)). However, recent empirical evidence on the topic provides mixed results (see e.g., Battalio and Schultz (2011), Grundy, Lim, and Verwijmeren (2012), Chen, Chen, and Chou (2020), Jones, Reed, and Waller (2021), Allen, Haas, Nowak, Pirovano, and Tengulov (2021)). On one hand Battalio and Schultz (2011) and Grundy et al. (2012), among others, provide evidence that during the short-sale ban in 2008 put options did not act as substitutes for equity short sales, because options markets became too expensive. Further, DeLisle, Lee, and Mauck (2016) and Blau and Brough (2015) argue that put options and short sales are rather complements than substitutes.[6] Also, Li, Zhao, and Zhong (2016) find no significant change in option trading volume for designated pilot stocks of SEC's Pilot Program of Regulation SHO, i.e., for stocks for which short sale price tests are repealed during that period. On the other hand Chen, Chen, and Chou (2020) provide evidence that during the temporary suspension of short-sale tests under Reg SHO put options trading did substitute for short selling. Allen, Haas, Nowak, Pirovano, and Tengulov (2021) show that during the January 2021 short-squeeze events that impacted meme stocks, such as GameStop, short-sellers migrated to the options market in order to circumvent the short-sale constraints in the equity market. Further, Hayunga, Lung, and Nishikawa (2010), Cakici, Goswami, and Tan (2018), Ni and Pan (2020), among others, provide evidence that violations of call-put parity relations are more frequent when short selling is restricted, evidence consistent with an increased demand for put options in the presence of short selling restrictions. Our findings contribute to the debate whether investors use options to circumvent equity short-

[6] Blau and Brough (2015) find that put-call ratios and short sale restrictions are inversely related and DeLisle et al. (2016) provide evidence for an inverse relationship between short interest and option open interest.

selling restrictions by providing systematic empirical evidence for trader migration under the current US short-sale regulation. In particular, to our knowledge we are the first to examine simultaneously variables related to shorting demand in the equity market and the options market when SEC Rule 201 becomes binding. Importantly, given that our sample period covers 2011 through 2020, our results are not influenced by turbulent market conditions such as the 2008-2009 financial crisis.

We also contribute to the literature that examines market quality in the presence of short-sale constraints.[7] On one hand, Beber and Pagano (2013) show that short selling bans increase equity bid-ask spreads in 30 equity markets around the world in 2008 and 2009. Similarly, Boehmer, Jones, and Zhang (2013) document a significant increase in equity bid-ask spreads for all but small banned stocks during the US short sale ban in 2008. On the other hand, Diether, Lee, and Werner (2009a) find that the suspension of short selling restrictions during Regulation SHO's pilot program increases bid-ask spreads for pilot stocks in the equity market. Jain, Jain, and McInish (2012) report a decrease in equity bid-ask spreads for stocks that trigger the short sale restriction during the compliance period of SEC Rule 201. However, they show that the decrease is the same compared to the pre-approval period of SEC Rule 201 considering days on which a stock experiences a 10% price decline. Similarly, Barardehi, Bird, Karolyi, and Ruchti (2019) provide evidence that equity bid-ask spreads decrease for stocks that trigger a short sale restriction under SEC Rule 201. Investigating short sale eligibility criteria on the Hong Kong stock exchange from 2001 to 2014, Crane, Crotty, Michenaud, and Naranjo (2019) do not find a clear impact of short selling restrictions on market quality.[8] Whether equity market quality improves or deteriorates for stocks for which short sellers migrate into the options market is a question that, to our knowledge, has not been analyzed in the literature. Therefore, we

[7] Short selling restrictions, that ultimately lead to trader migration, can affect equity and option market quality in various ways. The magnitude of these potential effect depends on the proportion of short selling to trading activity. Diether, Lee, and Werner (2009b) report that short selling represents 24% of NYSE and 31% of Nasdaq share volume in 2005.

[8] Empirical evidence on the impact of short selling restrictions on option market quality provides a clearer conclusion: the more binding a short selling restriction, the higher are option bid-ask spreads. Thus, option bid-ask spreads are higher for stocks that cannot be sold short during the 2008 US short sale ban (Battalio and Schultz (2011), Cakici et al. (2018), Lin and Lu (2016)). Additionally, option bid-ask spreads are increasing when short selling is more costly (Evans, Geczy, Musto, and Reed (2009), Lin and Lu (2016)).

contribute by providing evidence linking equity market quality and option market quality. In particular, we document an increase of relative equity bid-ask spread for both companies with and without options that experience a Rule 201 trigger. Further, we document an increase in put option bid-ask spreads.

In addition, our study contributes to the current policy debate about the disclosure of equity short positions by large market participants. In particular, the SEC has recently issued a proposal that "would require market participants that carry large short positions in equity securities to report those positions and related short sale activity to the [SEC] on a monthly basis."[9] The aim of this regulatory proposal is to provide more information and transparency for the short selling activity of market participants, especially in times of stress or volatility, and will allow the SEC to address future market events in as swift manner. Our findings suggest that short-sellers use options markets to execute short-sale strategies which, in turn, influences the market quality of the underlying equity market. Therefore, in addition to equity short-sale disclosures regulators would benefit from monitoring large synthetic short sale positions through options. These additional disclosure requirements might be particularly beneficial since a big portion of equity options are traded on over-the-counter markets, which are less transparent and less regulated.[10]

The remainder of this paper is organized as follows. Section 2 discusses the institutional background and formulates testable hypotheses. Section 3 describes the underlying data, sample selection procedure, and summary statistics. Sections 4, 5, 6, and 7 investigate the effect of SEC Rule 201 on equity short interest, options open interest and trading volume, options relative bid-ask spreads and options prices, and equity relative bid-ask spreads and price dispersion, respectively. Section 8 concludes.

[9] See "Statement on Rules to Increase Transparency of Short Sale Activity" SEC, February 25, 2022, Link.
[10] See, e.g., the Bank for International Settlement's global OTC derivatives markets statistics: Link.

2. Institutional background and hypotheses

2.1. Institutional background

The SEC has the authority to regulate short sales of securities registered on US national exchanges. Rule 10a-1 was the first market-wide short sale restriction the SEC has implemented. It was adopted in 1938 after the SEC conducted an investigation of the effects of concentrated short selling during the market break of 1937. The rule was designed to prevent short sellers from accelerating the downward momentum of securities prices, that were already in a steep decline.

According to the rule short sales had to be conducted at a price higher than the previous trade. By entering a short sale order with a price above the current bid, a short seller essentially filled an order on an uptick, hence the rule was also known as the "Uptick Rule." The main provisions of the rule remained unchanged for about seventy years. However, over the years, as securities markets changed, the SEC added exceptions and reliefs from the restrictions of the rule.[11]

In 2004 the SEC adopted Rule 202T of Regulation SHO. Based on that rule the SEC created the "Pilot," which temporarily suspended the Uptick Rule for short sales of a randomly selected group of securities. This Pilot was designed to assist the SEC in examining the overall effect of the Uptick Rule on short selling, liquidity, volatility and price efficiency, and ultimately assessing whether changes to the Uptick Rule were necessary. The findings of the SEC supported removal of the short sale price test restrictions that were in effect at the time. As a result, in December 2006, the SEC proposed to eliminate the Uptick Rule. Effective July 2007 the SEC eliminated the Uptick Rule, essentially prohibiting any exchange from having a short sale price test.

[11] Securities markets changes include the decimalization and the emergence of alternative trading systems ("ATS") that match buying and selling interest among institutional investors and broker-dealers at various set times during the day, among others.

Less than two years later, in April 2009, the SEC sought comments on whether to impose again price test restrictions or circuit breaker restrictions on short selling.[12] This step was in response to the steep increase in market volatility and a deterioration in investor confidence during the 2007-2008 financial crisis in the US.[13] On Feb 26, 2010 the SEC adopted Rule 201 of Regulation SHO ("the Alternative Uptick Rule"). Compliance with this Rule was required as of February 28, 2011. In essence, the Rule is triggered when a stock price falls at least 10% intra-daily. At that point, short selling is restricted and only permitted if the price of that security is above the current best bid. This restriction applies to short sale orders in that security for the remainder of the day and the following day, unless an exception applies.[14] Although the Alternative Uptick Rule does not provide an exemption for options market makers, options market makers are still able to sell short to hedge their positions even when the restriction is in place.[15]

2.2. Hypotheses

In a first step, we examine the effectiveness of SEC Rule 201: if a stock experiences a negative intraday return of greater than or equal to 10%, Rule 201 is triggered and restricts short selling of that stock. If the rule works effectively, short selling activity is reduced in case of a Rule 201 trigger event. We therefore test the following hypothesis:

Hypothesis 1: When SEC Rule 201 is triggered stocks experience a decrease in short interest.

[12] In response, the SEC received more than 4,300 comments letters. See Link.

[13] In the meantime, on September 18, 2008, the SEC issued an emergency order prohibiting short selling in the publicly traded securities of certain financial institutions through Oct. 2, 2008. This was done due to concerns regarding the impact of short selling on the prices of securities of financial institutions.

[14] For detailed information we refer the reader to the "Responses to Frequently Asked Questions Concerning Rule 201 of Regulation SHO" See Link.

[15] According to Rule 201 Adopting Release, 75 FR 11232, 11275 "[a]lthough a number of commenters expressed concerns regarding the lack of an options market maker exception from a price test restriction, [SEC does] not believe that such an exception under Rule 201 is necessary because, unlike with a ban on short selling, options market makers will be able to sell short to hedge their positions even when the restriction is in place"

Next, we are interested in whether short-sellers migrate to the options market in order to circumvent short-selling constraints resulting in the equity market. Ex ante, it is not clear, if trading options is a substitute or a complement for equity short sales. On one hand, an informed short seller would try to bypass short-selling constraints by increasing demand for put options (see e.g., Figlewski and Webb (1993); Chen et al. (2020)). On the other hand, if short-selling constraints in the equity market make hedging for options market makers more costly, then options market makers will pass through these costs and ultimately make options trading more costly, which potentially deters short sellers from migrating to the options market (see e.g., Grundy et al. (2012); Battalio and Schultz (2011)). We therefore test the following related hypothesis:

Hypothesis 2: Stocks with listed options subject to SEC Rule 201 trigger will either experience an increase or no increase in put option open interest and trading volume.

Further, if stocks with listed options subject to SEC Rule 201 trigger experience an increased demand for put options, option market makers would need to hedge the increase in put option writing activity. To remain delta-neutral, option market makers can either sell the underlying stock short or sell call options with an offsetting delta profile. Therefore, for stocks that experience SEC Rule 201 trigger, we expect that short-selling activity for stocks with options will decrease by less and call option activity will increase. Moreover, we expect an additional increase in call option activity since SEC Rule 201 trigger events are associated with depressed stock prices, which, in turn, might induce traders, who want to profit from the expected price reversal, to use call options. We therefore test the following additional related hypotheses:

Hypothesis 3: When SEC Rule 201 is triggered stocks with options experience a lower decrease in short interest compared to stocks without options.

Hypothesis 4: When SEC Rule 201 is triggered stocks with options experience an increase in call option open interest and trading volume.

We also examine the market quality of the options market and the underlying stock market for stocks experiencing SEC Rule 201 triggers. Similar to before, it is ex ante not clear if the quality of the equity market and the options market is going to improve or deteriorate. If informed short sellers migrate to the options market, we expect less trading and competition in the equity market, resulting in lower volume, lower market depth, and ultimately an increase in relative bid-ask spreads. Simultaneously, with more short sellers migrating to the options market we expect to see an increase in trading and competition in the options market, resulting in higher trading volume, higher market depth and ultimately, a decrease in relative bid-ask spreads. On the other hand, the effect of decreased competition in the equity market on bid-ask spreads will be countered by the effect of outflow of informed investors to the options market. In particular, this outflow will result in lower adverse selection risk to equity market makers, and, as a result lower bid-ask spreads (see e.g., Glosten and Milgrom (1985), Madhavan, Richardson, and Roomans (1997)). Further, the effect of increased competition in the options market on bid-ask spreads will be countered by the increase in informed traders in the options market resulting in higher adverse selection risk for option market makers and, ultimately, higher spreads. We therefore test the following related hypotheses:

Hypothesis 5: Stocks with listed options experiencing SEC Rule 201 trigger will have either an increase or decrease of equity relative bid-ask spreads, and either an increase or decrease in options bid-ask spreads.

3. Data

We compile our sample from several data sources. Options market data are from OptionMetrics. For stock market information we use CRSP. We obtain securities lending market data

from IHS Markit Securities.[16] Market volatility is from Chicago Board of Option Exchange (CBOE) Volatility Index (VIX). The data frequency of our sample is daily.

We categorize the stocks into "triggered" and "non-triggered" by utilizing data that records day and time when a stock triggers the Rule 201 circuit breaker. We source these data directly from the respective exchanges: for stocks trading on Nasdaq information is available starting February 28, 2011 and for stocks trading on NYSE this information is available starting March 25, 2015. We obtain information from both exchanges through the end of calendar year 2020. Our sample period therefore covers February 28, 2011 through December 31, 2020 for Nasdaq-listed stocks and March 15, 2015 through December 31, 2020 for NYSE-listed stocks. For brevity, we perform all our estimations on a sample that combines the information from both exchanges. In additional robustness tests we confirm that our results hold on sub-samples containing information only from the respective exchange.[17] For some analyses, we partition our sample into stocks with exchange-traded options and stocks without exchange-traded options. Unique firms with options represent approximately 25% of the total number of unique firms in our final full sample.

We follow the literature (see e.g., Grundy et al. (2012), Lin and Lu (2016), Barardehi et al. (2019), Chen et al. (2020)) and apply the following filters: i) we require stocks to have data during the whole sample period - firms that changed listing venues or were involved in mergers or acquisitions are excluded; ii) we exclude observations where the option price violates the no-arbitrage bound ($bid > \max[Ke^{-r_f T} - S, 0]$ for put options and $bid > \max[S - Ke^{-r_f T}, 0]$ for call options); iii) observations with zero option open interest or zero option trading volume are excluded; iv) both, bid and ask prices of options have to be larger than zero and ask prices have

[16] According to IHS Markit the data they provide is recorded as of settlement, i.e., securities lending activity is recorded as of the settlement date when it becomes known to the market. In the U.S. the settlement date was the trade date plus three trading days up until September 5, 2017. Afterwards, the SEC shortened the settlement period to two trading days (Release No. 34-80295). Therefore, in order to match securities lending activity with the date when the underlying short sale happened, we incorporate the trade settlement period by shifting short loan transactions back by two or three trading days.

[17] In Table A1 through Table A6 in the Internet Appendix we replicate all our analyses on sub-samples containing either Nasdaq-listed or NYSE-listed stocks. The results are quantitatively and qualitatively similar to those reported in the paper.

to be larger than bid prices; v) observations with an option bid-ask spread larger than 50% are excluded; vi) options that expire in more than 365 days are excluded;[18] vii) we exclude options with contract size different from 100 shares to ensure consistency. Table I provides a detailed overview of the sample construction.

[Insert Table I here.]

Table II provides summary statistics for the full sample and for two additional sub-samples: stocks with options and stocks without options. The full sample consists of 9,319 unique firms, 2,342 with options and 6,977 without. We have a total of 243,816 trigger events which account for approximately 3% of the firm-day observations in the full sample. Figure 1 depicts the distribution of SEC Rule 201 trigger events over time for the full sample. Average open interest per stock and average delta open interest per stock, both scaled by shares outstanding, are 0.42% and 0.18%, respectvely. OVS is the total option trading volume for a stock per day with an average of 1,993.24 contracts. These summary statistics are in line with the literature (see e.g., Grundy et al. (2012)).[19] Stocks without options have an average relative equity bid-ask spread of 0.72%, and stocks with options have an average relative equity bid-ask spread of 0.084%. The average shares on loan scaled by shares outstanding is 4% for stocks with options and 2% for stocks without options, which is in line with the literature (see e.g., Grullon, Michenaud, and Weston (2015)). The average relative options bid-ask spread is 19.2% and is in line with the literature (see e.g., Grundy et al. (2012)). The mean daily return in all three samples is around 0. Daily average stock trading volume in the full sample, the sample consisting of companies with options, and the sample consisting of companies without options is 1.09 mill., 2.58 mill., and 0.57 mill, respectively.

[Insert Table II here.]

[18] We keep options that expire in less than 30 days, due to the short-term nature of the trigger events; The results are robust to excluding options with maturity less than 30 days.

[19] Our summary statistics are similar to those reported by Chen et al. (2020) for the period November 1, 2004 through October 31, 2005 and Grundy et al. (2012) for the period January 2, 2008 to January 28, 2009. However, we note that our sample differs on multiple dimensions, such as the time period covered.

[Insert Figure 1 here.]

4. The effect of SEC Rule 201 on short interest

First, we investigate whether short-selling activity decreases for stocks that trigger SEC Rule 201.

Figure 2 shows the average daily short loan quantity around the first day of SEC Rule 201 trigger event (day 0) for companies with and without exchange-traded options. It can be seen that for stocks with options short loan quantity decreases from approx. 5,800 shares to 5,300 shares in the first trigger event day. This is a decrease of about 9%. For stocks without options, short loan quantity decreases from approx. 1,870 shares to 1,720 shares in the first day after a trigger event, a decrease of about 8%.

[Insert Figure 2 here.]

Next, we examine the effect of an SEC Rule 201 trigger event on short interest for companies with and without options in a multivariate regression setting. In particular, we consider a set of important firm and market characteristics (see e.g., Grundy et al. (2012)) and estimate the following ordinary least squares (OLS) regression:

$$Y_{i,t} = \alpha + \beta_1 Trigger_{i,t} + \beta_2 Options_{i,t} + \beta_3 Trigger_{i,t} \times Options_{i,t} + \beta_4 Controls_{i,t} + FE + \varepsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ measures the number of shares shorted of company i at day t, by taking the natural logarithm of short loan quantity. $Trigger_{i,t}$ is a dummy variable that equals one if the company is subject to the SEC Rule 201 circuit breaker and zero otherwise; $Options_{i,t}$ is a

dummy variable that equals one if the company has options listed on it and zero otherwise, and $Trigger_{i,t} \times Options_{i,t}$ is the interaction term between the two. $Controls_{i,t}$ is a vector of important firm- and market-level, time-varying characteristics. In particular, we include i) the natural logarithm of daily trading volume of the stock in millions, ii) the daily stock return, iii) the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (Amihud (2002)). We further include industry and time dummies (FE) in our most restrictive specification to take into account fixed industry-level differences among companies and time trends. In all specifications we follow standard practice and cluster standard errors by firm and year (see Petersen (2009)). Variable definitions are presented in the Appendix.

Table III presents the regression results. Column (1) suggests that a trigger event is associated with a significant decline in short interest for companies without options. Column (3) confirms these results. It presents the most restrictive specification adding industry and time dummies. The results suggest that a trigger event is associated with a relative decline in shares shorted of approximately 78% for companies without options. For companies with options, the decline in short interest is reduced to 6.7%. This evidence indicates that companies with options experience a lower decrease in short interest compared to companies with options. One potential explanation is that option market makers were hedging an increased demand for put options by shorting the underlying stocks. We explore this conjecture further in the next sections.

Overall, the evidence supports the purpose of SEC Rule 201 to provide an effective halt on short selling once a stock's intraday return decreases by 10% or more.

[Insert Table III here.]

5. The effect of SEC Rule 201 on put and call options open interest and trading volume

Next, we examine the effect of SEC Rule 201 on put and call options open interest and options trading volume.

Figure 3 and Figure 4 show the average daily delta-adjusted put and call option open interest and put and call option trading volume around the first day of SEC Rule 201 trigger event (day 0) for companies with options. We perform the delta adjustment for open interest in order to examine the share-equivalent options open interest. It can be seen that the put option delta-adjusted open interest increases from about 0.06% to 0.08% in the first day of a trigger event. This corresponds to a 33% increase relative to the pre-trigger event level. Further, put option trading volume increases from about 700 contracts to about 900 contracts, a 29% increase in the first day after a trigger event. Call option trading volume increases from about 750 contracts to about 810 contracts, a lower increase of 8% in the first day after a trigger event.

[Insert Figure 3 here.]

[Insert Figure 4 here.]

To examine the effect of SEC Rule 201 trigger on delta-adjusted option open interest and option trading volume, similar to before, we estimate the following ordinary least squares (OLS) regression on a sample containing only stocks with options:

$$Y_{i,t} = \alpha + \beta_1 Trigger_{i,t} + \beta_2 Controls_{i,t} + FE + \varepsilon_{i,t} \tag{2}$$

where $Y_{i,t}$ represents either daily option delta-adjusted open interest per stock scaled by shares outstanding or the daily option trading volume per stock. All other variables are identical

to Equation 1. As in Equation 1, we cluster standard errors by company in all specifications (see Petersen (2009)).

Table IV presents the regression results for put and call option open interest. Column (1) in Panels A and B in Table IV suggests that a trigger event is associated with a significant increase in both put and call option open interest indicating that traders migrate to the options market after a SEC Rule 201 trigger in the stock market. Column (3) in both panels confirms these results. It presents the most restrictive specification adding industry and time dummies. The results suggest that a trigger event is associated with a 0.11 (0.11) percentage points increase in delta-adjusted open interest for put (call) options. To gauge the economic significance of these estimates we compare them to the average delta-adjusted put (call) open interest for all companies with options in our sample of 0.18% (0.29%). This comparison suggests that companies experience an increase in put (call) option open interest of approximately 61% (40%) when SEC Rule 201 is triggered.

Further, Table VI presents the regression results for put and call option trading volume. Column (3) in both panels of Table VI shows positive and statistically significant estimates suggesting that a trigger event is associated with an increase of 1,740 (1,625) put (call) option contracts or a relative increase of approximately 87% (80%), when compared to the respective average OVS in our sample. Overall, this evidence supports our conjecture that stocks with listed options that trigger SEC Rule 201 circuit breaker experience a migration of traders from the stock market to the options market. Part of these traders were likely short-sellers, and migrated to the options market in order to circumvent the short-sale restrictions and express their negative views, while another part of these traders used call options to express their positive views in anticipation of rebounding prices.

[Insert Table IV here.]

[Insert Table VI here.]

Next, we explore the cross-section of different option contracts in order to distinguish how costly the options are and whether traders migrated to a particular sub-set of options. We differentiate options along two important dimensions (i) moneyness, and (ii) maturity. In particular, we differentiate among in-the-money (ITM), at-the-money (ATM), and out-of-the-money (OTM) options, as well as short-term and long-term options. We estimate Equation 2 for each of the ten resulting combinations.

Table V and Table VII present the regression results for put and call option open interest and put and call option trading volume, respectively. The results in Table V suggest that a trigger event is associated with a statistically significant increase in put option open interest across all categories but M1/T2. Further, the results suggest that a trigger event is associated with a statistically significant increase in call option open interest across all categories but M1/T1. The coefficient magnitudes are significantly larger for short maturity options, which is in line with the short-lived nature of the trigger events. Further, the results in both panels in Table VII suggest that a trigger event is associated with a significant increase in option trading volume in all categories.[20] Overall, the evidence in Tables V and VII is consistent with traders migrating to the options market to express their negative and positive views about the underlying stocks.[21]

[Insert Table V here.]

[Insert Table VII here.]

[20] In additional robustness tests presented in Table A7 and Table A8 in the Internet Appendix we replace the delta-adjusted open interest with the unadjusted version of it. The results are quantitatively and qualitatively similar to those reported.

[21] Following Figlewski and Webb (1993) we also examine changes in implied volatility. In particular, we test the conjecture that if there is an increased demand for put options, this should manifest itself in an increase in put option implied volatilities. In additional robustness tests presented in Table A9 and Table A10 in the Internet Appendix we examine the effect of Rule 201 on put option implied volatility. We find an increase in put option implied volatilities after SEC Rule 201 is triggered. This evidence provides further support for the conjecture that traders migrate to the options market and increase their demand for put options.

6. The effect of SEC Rule 201 on put and call options bid-ask spreads and options prices

Next, we examine the effect of SEC Rule 201 on put and call options relative bid-ask spreads and distortions in options price.

Regarding options bid-ask spreads, ex ante it is not clear if bid-ask spreads in the options market are going to increase or decrease. With more short sellers migrating to the options market we expect to see an increase in trading and competition in the options market, resulting in a decrease in relative bid-ask spreads. On the other hand, the increase in informed short sellers in the options market will result in higher adverse selection risk for option market makers and, ultimately, they will increase bid-ask spreads.

Figure 5 shows the average daily put and call option relative bid-ask spread around the first day of an SEC Rule 201 trigger event (day 0) for companies with options. It can be seen that the relative put option bid-ask spread increases by one percentage point from about 21.5% to 22.5% in the first day of a trigger event. This corresponds to a 5% increase relative to the pre-trigger event level. It can be also seen that the relative call option bid-ask spread increases from about 24% to 27% in the first day of a trigger event, a relative increase of 12.5%.

[Insert Figure 5 here.]

To examine the effect of SEC Rule 201 trigger on relative put and call option bid-ask spreads for stocks with options, similar to before we estimate the following ordinary least squares (OLS) regression:

$$Y_{i,t} = \alpha + \beta_1 Trigger_{i,t} + \beta_2 Controls_{i,t} + FE + \varepsilon_{i,t} \tag{3}$$

where $Y_{i,t}$ represents the daily average option bid-ask spread per company. All other variables are identical to Equation 1. As in Equation 1, we cluster standard errors by company and year in all specifications (see Petersen (2009)).

Panels A and B in Table VIII present the regression results for the relative put and call option bid-ask spread, respectively. Column (1) shows that a trigger event is associated with a significant increase in bid-ask spreads. Column (3) confirms these results. It presents the most restrictive specification adding industry and time dummies. The results suggest that a trigger event is associated with a 2.19 (3.61) percentage points increase in the relative put (call) option bid-ask spread. We compare the estimate to the average relative put (call) option bid-ask spread for all companies with options in our sample of 19.2% (20.7%). This comparison yields that companies experience an increase in the relative put (call) bid-ask spread of approximately 11.4% (17.4%) when SEC Rule 201 is triggered. Overall, this evidence supports our conjecture that informed traders migrate to the options market, which, in turn, increases adverse selection risk for option market makers and, ultimately, increases option bid-ask spreads.

[Insert Table VIII here.]

Figlewski and Webb (1993) argue that short-sale constrains in the market of the underlying might lead to distortions in put and call options prices. If short-sellers migrate to the options market in the case of a SEC Rule 201 trigger event, we expect a disproportionately larger increase in demand for put options. To investigate the effect of SEC Rule 201 on put and call option prices, we apply two commonly used options valuation metrics, the implied volatility spread (*IV Spread*) and the implied volatility skew (*IV Skew*). Both metrics gauge the difference in put and call options implied volatilities for different option categories. Higher *IV Spread* and *IV Skew*, i.e., higher put than call implied volatilities, suggests that put options are experiencing higher demand than call options and therefore they are relatively more expensive.

We follow the literature (see e.g., Figlewski and Webb (1993)) and measure the *IV Spread* for put-call option pairs on the same stock with identical times to expiration and strike prices. We further limit the analysis to ATM pairs of puts and calls, which are the most actively traded options class and less subject to distortions associated with market frictions. Further, we measure the *IV Skew* as the difference in the implied volatilities of out-of-the-money put and at-the-money call options for put-call option pairs on the same stock with identical times to expiration and strike prices (see e.g., Xing, Zhang, and Zhao (2010)).

To examine the effect of SEC Rule 201 trigger on the *IV Spread* and the *IV Skew* for stocks with options we estimate the following ordinary least squares (OLS) regression:

$$Y_{i,t} = \alpha + \beta_1 Trigger_{i,t} + \beta_2 Controls_{i,t} + FE + \varepsilon_{i,t} \tag{4}$$

where $Y_{i,t}$ represents the daily average *IV Spread* or the daily average *IV Skew*. All other variables are identical to Equation 1. As in Equation 1, we cluster standard errors by company and year in all specifications (see Petersen (2009)).

Table IX presents the regression results for the *IV Spread*. Column (1) shows that a trigger event is associated with a significant increase in the spread. Column (3) confirms these results. It presents the most restrictive specification adding industry and time dummies. The results suggest that a trigger event is associated with a 0.006 increase in the *IV Spread* or a 600% relative increase. Overall, this evidence is consistent with the conjecture that the SEC Rule 201 trigger prevents short sellers from expressing their pessimistic view in the equity market and thereby increases the demand for put options, which, in turn, increases put options prices and the implied volatility differential between put options and call options.

[Insert Table IX here.]

Further, Table X presents the regression results for the *IV Skew*. Column (1) shows that a trigger event is associated with a significant increase. Column (3) confirms these results. The results suggest that a trigger event is associated with a 0.025 increase in the *IV Skew* or a 36% relative increase. Overall, this evidence provides further support for a relative increase in put options prices and the corresponding implied volatility differential between put options and call options.[22]

[Insert Table X here.]

7. The effect of SEC Rule 201 on equity bid-ask spreads and price dispersion

Finally, we examine the effect of SEC Rule 201 on equity relative bid-ask spreads and equity price dispersion. As mentioned before, it is not ex ante clear if bid-ask spreads and price dispersion in the equity market are going to increase or decrease. If informed short sellers migrate to the options market, we expect less trading and competition in the equity market, which will result in an increase in relative bid-ask spreads. On the other hand, the effect of decreased competition in the equity market on bid-ask spreads will be countered by the effect of outflow of informed traders to the options market. As a result adverse selection for equity market makers will decrease and they will lower the bid-ask spreads. Similarly, equity price dispersion might either increase or decrease, depending on the relative influence of the trader migration and competition effects.

Figure 6 shows the average daily relative equity bid-ask spread around the first day of an SEC Rule 201 trigger event (day 0) for companies with and without options. It can be seen that

[22] In Table A11 in the Internet Appendix we provide further evidence for put-call parity violations. The evidence is consistent with more frequent violations of the put-call parity relation when short selling is restricted. These results provide further support for an increased demand for put options in the presence of Rule 201 short selling restrictions.

the average relative bid-ask spread for companies with options increases from about 0.21% to 0.22%, a relative increase of about 5% in the first day of a trigger event. Companies without options experience a slight increase in the relative bid-ask spread on a trigger event day. Further, Figure 7 shows the average daily price dispersion around SEC Rule 201 trigger event (day 0) for companies with and without options. It can be seen that the average price dispersion for companies with options increases from about 0.07% to 0.12%, a relative increase of about 71% in the first day of a trigger event. Companies without options experience a lower increase from about 0.085% to 0.12%, a relative increase of 41% in the first day of a trigger event.

[Insert Figure 6 here.]

[Insert Figure 7 here.]

To examine the effect of SEC Rule 201 trigger on the relative equity bid-ask spread and price dispersion for stocks with and without options we estimate the following ordinary least squares (OLS) regression:

$$Y_{i,t} = \alpha + \beta_1 Trigger_{i,t} + \beta_2 Options_{i,t} + \beta_3 Trigger_{i,t} \times Options_{i,t} + \beta_4 Controls_{i,t} + FE + \varepsilon_{i,t} \tag{5}$$

where $Y_{i,t}$ represents the daily average equity bid-ask spread per stock or daily price dispersion. $Trigger_{i,t}$ is a dummy variable that equals one if the company is subject to the SEC Rule 201 circuit breaker and zero otherwise. $Options_{i,t}$ is a dummy variable that equals one if the company has options listed on it and zero otherwise, and $Trigger_{i,t} \times Options_{i,t}$ is the interaction term between the two. All other variables are identical to Equation 1. As in Equation 1, we cluster standard errors by company and time in all specifications (see Petersen (2009)).

Table XI presents the regression results for the relative equity bid-ask spread. Column (3) presents the most restrictive regression specification and suggests that a trigger event is associated with a significant increase in equity bid-ask spreads. The results suggest that a trigger event is associated with a 77.4 basis points (bps) increase in the relative equity bid-ask spread for companies without options. To gauge the economic significance of this estimate, we compare the estimate to the average relative equity bid-ask spread for all companies without options in our sample of 72 bps. This comparison suggests that companies without options experience an increase in the relative equity bid-ask spread of approximately 107.6% when SEC Rule 201 is triggered.

Importantly, the interaction term, $Trigger_{i,t} \times Options_{i,t}$, shows a negative and significant coefficient. The interpretation is that, relative to companies without option that experience a trigger event, companies with options that experience a trigger experience a lower increase in bid-ask spreads of only of only 11.7 bps. To gauge the economic significance of this estimate, we compare it to the average relative equity bid-ask spread for all companies with options 8.4 bps. This comparison suggests that companies with options experience an increase in relative bid-ask spread of approximately 139% when SEC Rule 201 is triggered.

[Insert Table XI here.]

Table XII presents the regression results for the relative equity price dispersion. Column (3) presents the most restrictive regression specification and suggests that a trigger event is associated with a significant increase in equity price dispersion. The results suggest that a trigger event is associated with a 7.0% increase in the relative equity price dispersion for companies without options. To gauge the economic significance of this estimate, we compare the estimate to the average relative equity price dispersion for all companies without options in our sample of 3.9%. This comparison suggests that companies without options experience a relative increase of approximately 179% when SEC Rule 201 is triggered.

Similar to before, the interaction term, $Trigger_{i,t} \times Options_{i,t}$, shows a negative and significant coefficient. The interpretation is that, relative to companies without options that experience a trigger event, companies with options that experience a trigger event have a lower increase in equity price dispersion of 4.7%. To gauge the economic significance of this estimate, we compare it to the average relative equity price dispersion for all companies with options 3.3%. This comparison suggests that companies with options experience a relative increase of approximately 142% when SEC Rule 201 is triggered.

[Insert Table XII here.]

Overall, the evidence presented in this section suggests that companies with and without options experience a deterioration in marked quality if they are subject to the SEC Rule 201 circuit breaker.

8. Conclusion

In this study we investigate the effect of Rule 201 on short selling activity and market quality in the equity market, and trading activity and market quality in the corresponding options market. Our analyses provide four primary results. First, we document a sharp decrease in equity short selling activity when Rule 201 is triggered for both companies with and without options. Second, we find, concurrently with the decrease in equity short interest, an increase in put options open interest for companies with options. Third, we find a significant increase in relative option bid-ask spreads for companies that experience a Rule 201 trigger. Fourth, we document an increase in relative equity bid-ask spreads and price dispersion for companies without options that experience a Rule 201 trigger. Further, we find that the increase in relative equity bid-ask spreads and price dispersion is reduced for companies with options.

Thus, this study provides important evidence on the inter-linkages between equity and option markets trading. The evidence supports the purpose of SEC Rule 201 to provide an effective halt on short selling once the rule is triggered. Further, the evidence supports that a Rule 201 trigger distorts market quality in both the equity and the options market. Importantly, we find that the increase in relative equity bid-ask spread and price dispersion is reduced for companies with options. The finding supports the conjecture that informed short sellers migrate from the equity market to the options market, which, in turn, decreases adverse selection risk for equity market makers for companies with options and, therefore, diminishes the adverse effect of SEC Rule 201 trigger on equity bid-ask spreads and price dispersion for these companies.

Overall, we contribute to the long-standing academic debate whether investors use options to circumvent equity shot-selling restrictions. In addition, our study contributes to the current policy debate about the disclosure of equity short positions by large market participants. In particular, we highlight the need of additional disclosure requirements related to large synthetic short sale positions through options.

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Appendix: Tables and Figures

Figures

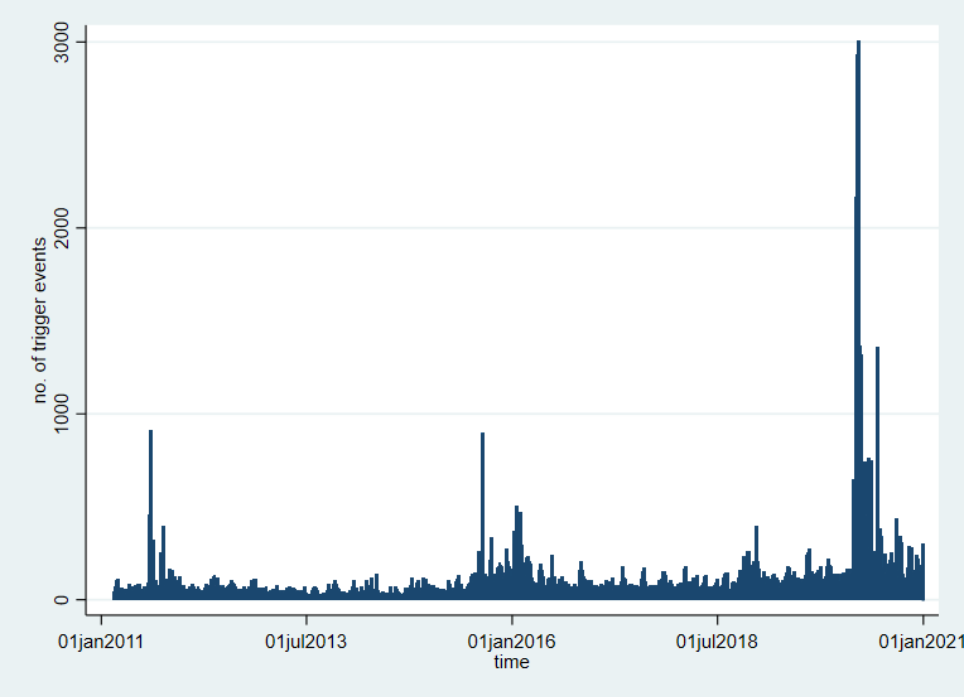

Figure 1. Number of Rule 201 short halts through time The figure above shows the daily total number of Rule 201 short halts on Nasdaq and NYSE through time. Data for NYSE trigger events starts on March 25, 2015.

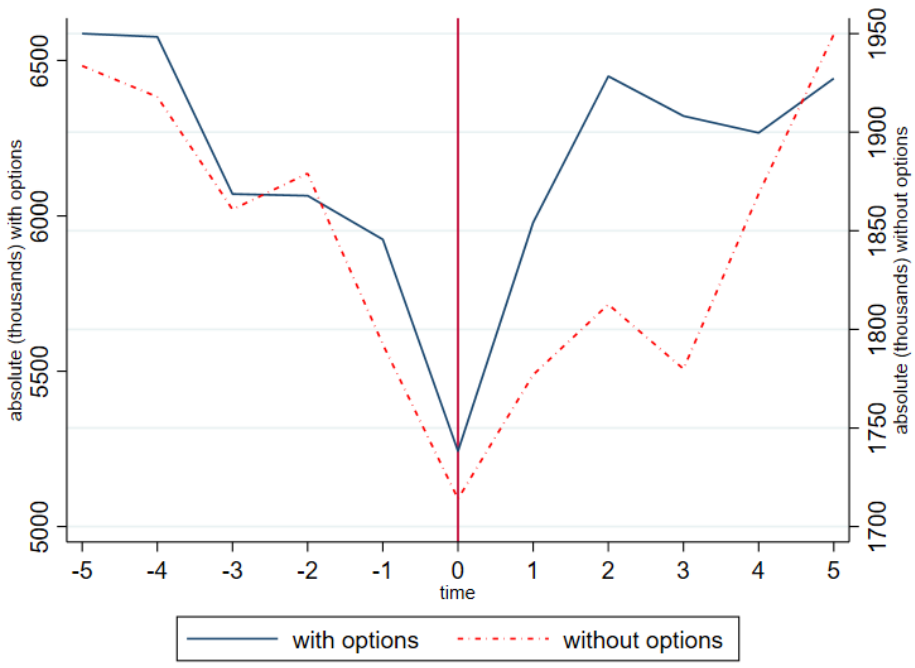

Figure 2. Short loan quantity around Rule 201 trigger event: The figure above shows the average short loan quantity, in thousand shares, for companies with options (lhs y-axis) and companies without options (rhs y-axis). We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

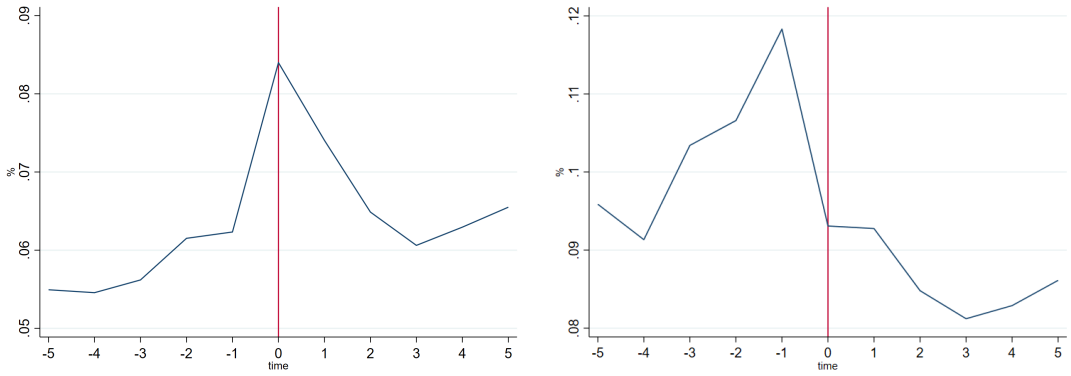

Figure 3. Delta-adjusted open interest as % of shares outstanding around Rule 201 trigger event: The figure above shows the average ratio of put options delta-adjusted open interest divided by shares outstanding (left panel) and the average ratio of call options delta-adjusted open interest divided by shares outstanding (right panel), in percentage, for companies with options. We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

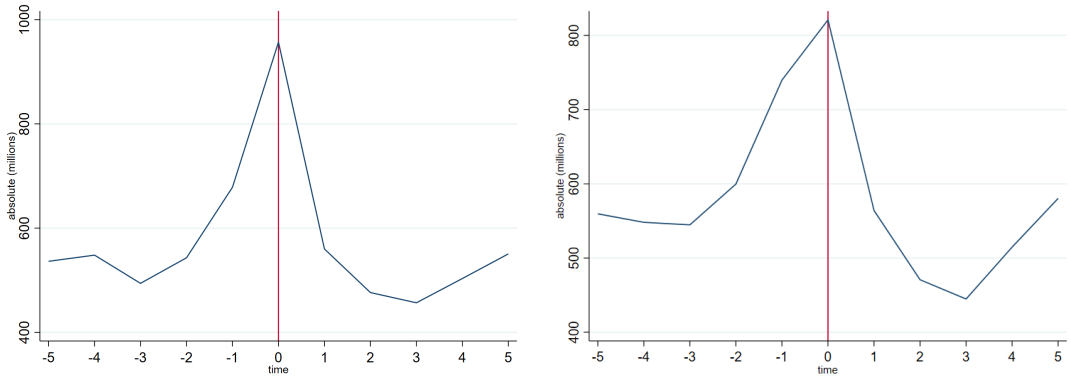

Figure 4. Option trading volume around Rule 201 trigger event: The figure above shows the average put option trading volume (left panel) and the average call option trading volume (right panel), in million shares, for companies with options. We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

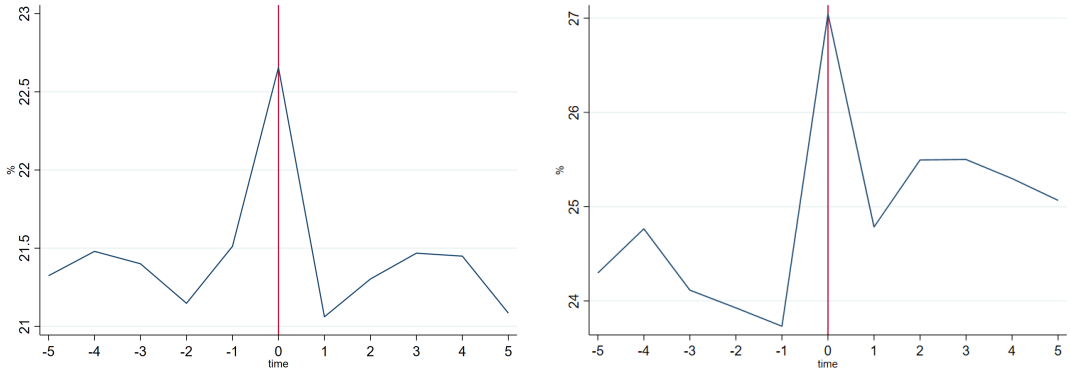

Figure 5. Relative option bid-ask spread around Rule 201 trigger event: The figure above shows the average relative put option bid-ask spread (left panel) and the average relative call option bid-ask spread (right panel), in percentage, for companies with options. We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

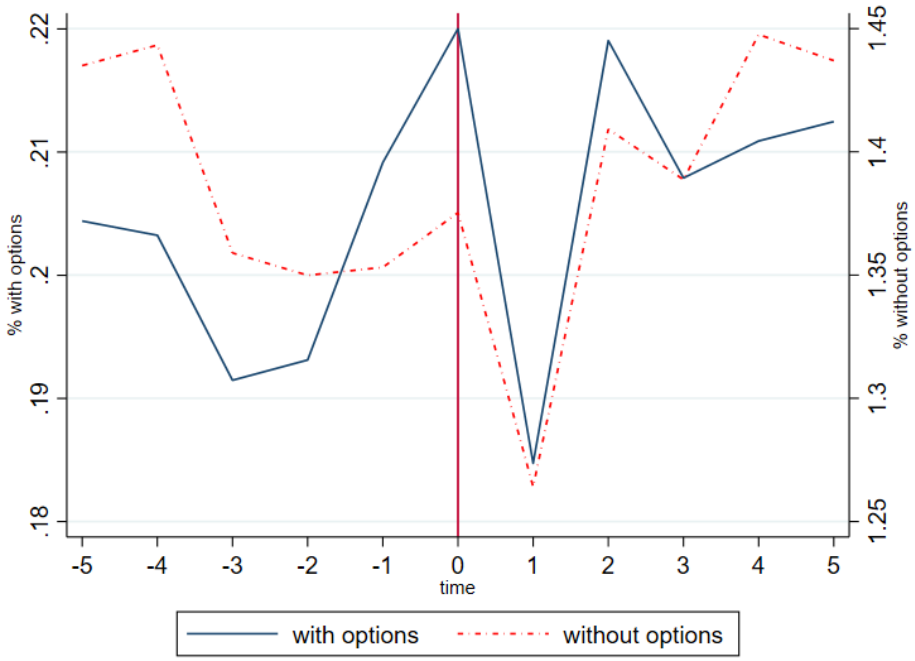

Figure 6. Relative equity bid-ask spread around Rule 201 trigger event: The figure above shows the average relative equity bid-ask spread, in percentage, for companies with options (lhs y-axis) and companies without options (rhs y-axis). We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

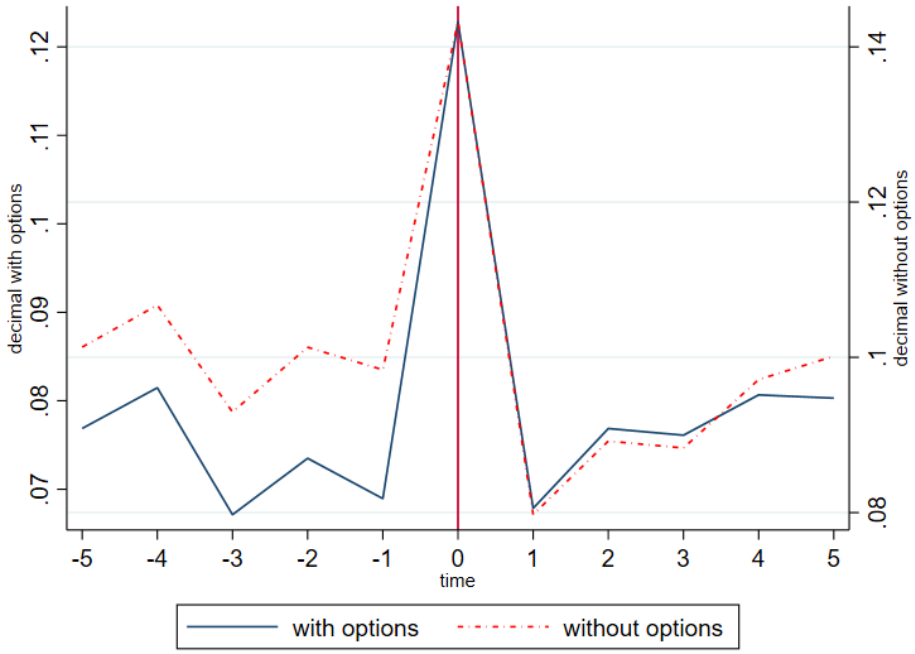

Figure 7. Equity price dispersion around Rule 201 trigger event: The figure above shows the equity price dispersion, in decimals, for companies with options (lhs y-axis) and companies without options (rhs y-axis). We depict +/- 5 trading days around the first day when a company triggered Rule 201 (denoted as time 0 in the graph). The sample consists of all stocks that triggered Rule 201 from Feb 28, 2011 through Dec 31, 2020.

Tables

Variable Descriptions This table describes the variables used in the analyses. The variables are grouped by their respective source and sorted alphabetically within these groups.

Variable	Description
Nasdaq/NYSE	
Trigger	An indicator that equals one on the day a company triggers Rule 201 and the following trading day; zero otherwise. The trigger events are sourced directly from Nasdaq and NYSE.
OptionMetrics	
Daily Total Option Volume (OVS)	Total trading volume of all options on the same stock.
Delta Open Interest (% Shares)	Total delta-adjusted open interest of a stock divided by the shares outstanding.
Implied Volatility Spread	The difference between the implied volatility of at-the-money put and call options with the same strike price and time to expiration.
Implied Volatility Skew	The difference between the implied volatility of out-of-the-money put and at-the-money call options. Averages are used if there are multiple options on a day.
Option	An indicator that equals one if the stock has options listed and tradable; zero otherwise.
Relative Option Spread	Lowest closing ask price across all exchanges minus the highest closing bid price across all exchanges divided the average of these two prices.
CRSP	
Illiquidity	Amihud illiquidity measure, defined as the ratio of the return to the dollar trading volume on any given day. Dollar trading volume is trading volume times price.
Equity Price Dispersion	Highest price minus the lowest price within a trading day divided by the average of these two prices.
Relative Equity Spread	Ask minus bid divided by the average of the two.
Trading Volume	Stock's trading volume in millions shares.
Size	Firm size measure by market capitalization - share price * numbers of shares outstanding.
IHS Markit	
Short Loan Quantity	Number of securities on loan with dividend trading and financing trades removed.

Table I
Sample Construction

This table presents the sample selection procedure and shows the number of firm-day observations, unique firms with options and unique firms without options remaining in the sample after each successive step of data manipulation. We start with all available OptionMetrics data for our sample period and adjust open interest as recording is lagged by one day in OptionMetrics. The data frequency is daily and the observation unit is option-day. Then we exclude observations with zero option open interest and observations for which the option ask price is lower than the bid price. Next we merge with CRSP via the WRDS linking table. We require that firms have a valid link between OptionMetrics and CRSP over the whole sample period, respectively. Next, we implement data filters common in the literature (see e.g., Grundy et al. (2012)): i) we require stocks to have data during the whole sample period - firms that changed listing venues or were involved in a merger or acquisition are excluded. ii) we exclude observations where the option price violates the no-arbitrage bound ($bid > \max[Ke^{-r_f T} - S, 0]$). iii) observations with zero option open interest or zero option trading volume are excluded. iv) both, bid and ask prices of options have to be larger than zero. Further, ask prices have to be higher than bid prices. v) observations with an option bid-ask spread larger than 50% are excluded. vi) options that expire in more than 365 days are excluded. vii) we exclude options with contract size different from 100 shares to ensure consistency. In a next step, we merge the shorthalt data obtained directly Nasdaq and NYSE. We drop observations for NYSE listed stocks recorded before March 25, 2015, since NYSE does not provide shorthalt data before that date. Furthermore , we merge lending market data obtained from IHS Markit. In a final step, we drop redundant observations and leave one observation on the firm-day level. Our sample runs from February 28, 2011 to December 31, 2020 for Nasdaq listed stocks, and from March 25, 2015 to December 2020 for NYSE listed stocks.

	Option-Day Obs.	Δ	Unique Firms w/ Options	Δ	Unique Firms w/o Options	Δ
OptionMetrics - CRSP	320,275,096		3,237		10,412	
Option Filters		-247,147,317		-68		0
	73,127,779		3,169		10,412	
Shorthalt Data		-13,680,235		-25		0
	59,447,544		3,144		10,412	
IHS Markit		-17,534,940		-802		-3,435
	41,912,604		2,342		6,977	
Firm level aggregation		-34,016,892		0		0
	Firm-Day Obs.					
Final full sample	**7,895,712**		2,342		6977	

Table II
Summary Statistics

The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and March 15, 2015 to December 31, 2020 for NYSE-listed stocks. Stocks that change listing venue, go private or are involved in a merger or an acquisition are excluded. We split our sample into stocks with options and stocks without options. We apply the following filters on the data: i) we drop observations that violate no-arbitrage bounds, i.e. **best bid** $> Ke^{-r_f T}$ or **best bid** $< \max[Ke^{-r_f T} - S, 0]$. We drop observations where either open interest or trading volume or bid or ask prices are zero or negative. We drop observations where ask prices are smaller than bid prices. We restrict our sample to include only options with a maturity of less than 365 calendar days. All option contracts in our sample are written on 100 shares. **Delta Open Interest / Shares Outstanding** is the total delta-adjusted open interest divided by shares outstanding for a stock on a day. (Implied Volatility Spread) is the difference between an ATM put-call option pair with the same strike price and time to expiration. **Equity Spread** is the ask price minus the bid price divided by the bid-ask midpoint for a stock on a day. **Equity Price Dispersion** is the highest ask price minus the lowest bid price divided by the high-low midpoint for a stock on a day. **OVS** is the total option trading volume for a stock on a day. **Relative Option Spread** is the average ask minus the average bid divided by the average bid-ask midpoint for a stock on a day. **Short Loan Quantity** is the number of securities on loan with dividend trading and financing trades removed for a stock on a day. **Stock Return** is the daily return on a stock. **Stock Trading Volume** is the daily trading volume for a stock. **VIX** is the daily closing value of the CBOE S&P 500 Volatility Index. **Size** is the market capitalization of the firm on a day. **Illiquidity** is the Amihud illiquidity measure, definded as the ratio of the return to the (dollar) trading volume for a stock on a day. All variables are winsorized at the 1% level in both tails of the distribution. See Table I for data sources.

	Full Sample			with Options			without Options		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
Delta Open Interest (% Shares) Puts	2,032,157	.183	.490	2,032,157	.183	.490	-	-	-
Delta Open Interest (% Shares) Calls	2,260,733	.295	.690	2,260,733	.295	.690	-	-	-
Equity Price Dispersion	8,230,842	.037	.034	2,482,298	.033	.026	5,748,544	.038	.036
Illiquidity	8,230,486	0	0	2,482,297	0	0	5,748,189	0	0
Implied Volatility Spread	21,810,430	-0.001	0.031	21,810,430	-0.001	0.031	-	-	-
Implied Volatility Skew	1,354,863	0.069	0.065	1,354,863	0.069	0.065	-	-	-
Open Interest (% Shares) Puts	2,032,256	.418	.686	2,032,256	.418	.686	-	-	-
Open Interest (% Shares) Calls	2,260,733	.566	.888	2,260,733	.566	.888	-	-	-
OVS Puts	2,032,157	1,993.519	11,855.65	2,032,157	1,993.519	11,855.65	-	-	-
OVS Calls	2,260,733	1674.672	5536.257	2,260,733	1674.672	5536.257	-	-	-
Put-Call-Parity Violations	21,810,430	0.254	0.435	21,810,430	0.254	0.435	-	-	-
Relative Equity Spread	8,230,823	.524	.951	2,482,298	.100	.173	5,748,525	.708	1.082
Relative Option Spread Puts	2,032,157	19.191	7.913	2,032,256	19.191	7.913	-	-	-
Relative Option Spread Calls	2,260,733	20.664	9.735	2,260,733	20.664	9.735	-	-	-
Short Loan Quantity	8,212,714	2,439,335	6,535,491	2,476,307	4,582,952	8,852,205	5,736,407	1,513,973	4,948,103
Short Loan Quantity (% Shares)	8,212,572	2.656	4.690	2,476,307	3.963	5.533	5,736,265	2.091	4.150
Size (Market Cap)	8,230,842	4,800,526	1.48e+07	2,482,298	1.24e+07	2.40e+07	5,748,544	1,524,143	5,345,298
Stock Return	8,230,507	0	.027	2,482,297	.001	.027	5,748,210	0	.028
Stock Trading Volume in Mio.	8,230,823	1.077	3.638	2,482,298	2.214	5.434	5,748,525	.586	2.325
Triggered	8,233,202	.03	.171	2,482,298	.021	.142	5,750,904	.034	.182
VIX	8,233,202	17.689	7.72	2,482,298	17.600	8.078	5,750,904	17.728	7.560

Table III
The effect of Rule 201 on short interest.

This table reports the results from the short interest regression estimation described in Section 4. The dependent variable in each OLS regression is the natural logarithm of the short loan quantity. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule 201 on a given day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution. The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
VARIABLES	Short Interest	Short Interest	Short Interest
Triggered	-0.404***	-0.831***	-0.780***
	(-11.590)	(-29.570)	(-27.642)
Options	0.823***	0.484***	0.551***
	(21.456)	(14.256)	(15.807)
Trigger×Options	-0.256***	0.164***	0.162***
	(-5.826)	(4.523)	(4.579)
Constant	13.895***	13.835***	13.830***
	(357.424)	(475.153)	(608.687)
Observations	8,211,999	8,194,159	8,194,159
Adjusted R^2	0.566	0.689	0.697
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table IV
The effect of Rule 201 on put and call option delta-adjusted open interest

Panels A and B in this table report the results for put and call options respectively from the delta-adjusted open interest scaled by shares outstanding regression estimation described in Section 5. The dependent variable in each OLS regression is the total delta adjusted open interest divided by shares outstanding. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	(1)	(2)	(3)
	Delta OI / shrout %	Delta OI / shrout %	Delta OI / shrout %
Triggered	0.125***	0.096***	0.114***
	(6.419)	(6.277)	(6.720)
Constant	0.193***	0.190***	0.180***
	(15.688)	(17.853)	(24.021)
Observations	2,032,255	2,032,157	2,032,157
Adjusted R^2	0.068	0.212	0.221
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: Call Options

	(1)	(2)	(3)
	Delta OI / shrout %	Delta OI / shrout %	Delta OI / shrout %
Triggered	0.097***	0.029	0.109***
	(2.759)	(0.968)	(4.097)
Constant	0.695***	0.684***	0.599***
	(24.299)	(29.322)	(35.176)
Observations	2,260,732	2,260,586	2,260,586
Adjusted R^2	0.137	0.318	0.340
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table V
The effect of Rule 201 on put and call option delta-adjusted open interest: Moneyness/Maturity splits.

Panels A and B in this table report the results for put and call options respectively from the delta-adjusted open interest scaled by shares outstanding regression estimation described in Section 5. The dependent variable in each OLS regression is the total delta adjusted open interest divided by shares outstanding. The sample is split into 1 of 10 maturity-moneyness buckets. Maturity buckets are defined as T1: short-term maturity options with time to expiration up to 90 days. T2 are long-term maturity options with time to expiration above 90 days. $Moneyness = \frac{Price}{Strike}$. Moneyness buckets are defined as at-the-money M1, if $moneyness >= 0.95 \& moneyness <= 1.05$. M2 is the first in-the-money bucket, defined as $moneyness >= median(ITM) \& moneyness < 0.95$ and M3 are deep ITM options: $moneyness < median(ITM)$. Out-of-the money options have their moneyness defined as M4: $moneyness > 1.05 \& moneyness <= median(OTM)$ and deep OTM as M5: $moneyness > median(OTM)$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	0.016***	0.003	0.029***	0.007***	0.081***	0.038***	0.014***	0.003*	0.026***	0.007***
	(3.483)	(1.566)	(8.703)	(4.398)	(8.040)	(5.647)	(8.350)	(1.866)	(7.033)	(2.892)
Constant	0.075***	0.026***	0.041***	0.024***	0.072***	0.049***	0.027***	0.023***	0.025***	0.014***
	(31.982)	(34.722)	(28.426)	(23.818)	(15.430)	(14.799)	(35.430)	(33.138)	(22.602)	(17.391)
Observations	1,510,791	958,628	501,936	467,222	409,017	368,696	1,021,856	1,012,503	850,441	758,622
Adjusted R^2	0.229	0.146	0.116	0.097	0.103	0.106	0.168	0.160	0.149	0.158
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Panel B: Call Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	0.004	0.007**	0.017***	0.011***	0.054***	0.035***	0.017***	0.010***	0.065***	0.045***
	(0.598)	(2.194)	(4.645)	(3.989)	(5.344)	(5.350)	(6.268)	(4.121)	(7.946)	(8.413)
Constant	0.117***	0.046***	0.060***	0.039***	0.081***	0.052***	0.042***	0.036***	0.056***	0.048***
	(32.602)	(39.229)	(36.311)	(31.401)	(21.687)	(18.848)	(33.030)	(36.157)	(20.747)	(21.522)
Observations	1,667,157	1,232,530	723,803	716,133	633,147	593,231	990,622	1,184,602	781,284	860,270
Adjusted R^2	0.255	0.164	0.152	0.137	0.129	0.136	0.152	0.149	0.129	0.158
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table VI
The effect of Rule 201 on aggregate put and call option volume

Panels A and B in this table report the results for put and call options respectively from the option volume regression estimation described in Section 5. The dependent variable in each OLS regression is the aggregate option volume per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	(1)	(2)	(3)
	Aggregate Option Volume	Aggregate Option Volume	Aggregate Option Volume
Triggered	542.897***	415.072***	492.918***
	(6.505)	(5.436)	(5.844)
Constant	418.074***	359.962***	348.611***
	(7.417)	(6.870)	(8.579)
Observations	2,032,255	2,032,157	2,032,157
Adjusted R^2	0.422	0.500	0.504
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: Call Options

	(1)	(2)	(3)
	Aggregate Option Volume	Aggregate Option Volume	Aggregate Option Volume
Triggered	977.442***	668.622***	1,053.123***
	(4.295)	(3.186)	(5.053)
Constant	694.283***	667.155***	641.538***
	(4.898)	(5.047)	(6.204)
Observations	2,260,732	2,260,586	2,260,586
Adjusted R^2	0.397	0.489	0.498
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table VII
The effect of Rule 201 on aggregate put and call option volume: Moneyness/Maturity splits.

This table reports the results from the option volume regression estimation described in Section 5. The dependent variable in each OLS regression is the aggregate option volume per stock on any given day. The sample is split into 1 of 10 maturity-moneyness buckets. Maturity buckets are defined as T1: short-term maturity options with time to expiration up to 90 days. T2 are long-term maturity options with time to expiration above 90 days. $Moneyness = \frac{Price}{Strike}$. Moneyness buckets are defined as at-the-money M1, if $moneyness >= 0.95$ & $moneyness <= 1.05$. M2 is the first in-the-money bucket, defined as $moneyness >= median(ITM)$ & $moneyness < 0.95$ and M3 are deep ITM options: $moneyness < median(ITM)$. Out-of-the money options have their moneyness defined as M4: $moneyness > 1.05$ & $moneyness <= median(OTM)$ and deep OTM as M5: $moneyness > median(OTM)$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	454.106***	53.763**	138.854***	23.663**	142.182***	29.217***	363.230***	68.598**	313.825***	25.651***
	(2.614)	(2.041)	(4.847)	(2.292)	(5.210)	(3.943)	(6.403)	(2.521)	(6.826)	(5.245)
Constant	265.092***	34.808***	8.302	20.739***	14.918	33.525***	116.966***	51.474***	119.571***	42.449***
	(5.457)	(5.358)	(0.957)	(7.648)	(1.532)	(10.372)	(6.077)	(5.879)	(7.202)	(24.131)
Observations	1,617,025	976,702	506,801	471,391	412,338	371,400	1,223,968	1,093,490	1,081,353	867,803
Adjusted R^2	0.491	0.261	0.126	0.086	0.075	0.060	0.369	0.259	0.265	0.268
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Panel B: Call Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	684.889**	95.473**	165.539***	46.845***	121.105***	16.040***	334.779***	109.938***	446.450***	136.936***
	(2.371)	(2.462)	(5.990)	(4.057)	(5.925)	(9.766)	(3.348)	(2.584)	(4.921)	(5.053)
Constant	337.266***	47.859***	9.324	16.781***	18.636**	17.966***	87.474***	55.650***	99.243***	67.007***
	(4.670)	(4.903)	(0.883)	(4.015)	(2.173)	(29.993)	(3.134)	(5.642)	(2.871)	(6.208)
Observations	1,667,157	1,232,530	723,803	716,133	633,147	593,231	990,622	1,184,602	781,284	860,270
Adjusted R^2	0.507	0.308	0.236	0.112	0.094	0.236	0.337	0.267	0.250	0.212
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table VIII
The effect of Rule 201 on relative put and call option bid-ask spreads.

This table reports the results from the relative option spreads regression estimation described in Section 6. The dependent variable in each OLS regression is the average relative option bid-ask spread per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	(1)	(2)	(3)
	Put Option Bid-Ask Spread	Put Option Bid-Ask Spread	Put Option Bid-Ask Spread
Triggered	2.774***	2.400***	2.190***
	(12.991)	(12.162)	(15.314)
Constant	17.736***	17.853***	20.087***
	(101.484)	(118.802)	(257.072)
Observations	2,032,255	2,032,157	2,032,157
Adjusted R^2	0.178	0.253	0.301
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: Call Options

	(1)	(2)	(3)
	Call Option Bid-Ask Spread	Call Option Bid-Ask Spread	Call Option Bid-Ask Spread
Triggered	4.316***	3.596***	3.608***
	(19.108)	(17.724)	(22.199)
Constant	17.776***	17.786***	21.536***
	(89.476)	(105.315)	(212.477)
Observations	2,260,732	2,260,586	2,260,586
Adjusted R^2	0.209	0.290	0.319
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table IX
The effect of Rule 201 on implied volatility spread

This table reports the results from a variation of the relative option spreads regression estimation described in Section 6. The dependent variable in each OLS regression is the spread in the volatility of the options following Figlewski and Webb (1993). We select at-the-money put-call option pairs with the same strike price and time to expiration on the same stock. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
VARIABLES	IV Spread	IV Spread	IV Spread
Trigger	0.012***	0.011***	0.006***
	(83.959)	(80.012)	(53.947)
Constant	0.000***	0.000***	-0.000**
	(7.118)	(8.872)	(-2.372)
Observations	21,810,430	21,810,406	21,810,406
Adjusted R-squared	0.011	0.039	0.151
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table X
The effect of Rule 201 on implied volatility skew

This table reports the results from a variation of the relative option spreads regression estimation described in Section 6. The dependent variable in each OLS regression is the implied volatility skew of the options following Chen et al. (2020). The skew is defined as the difference between the average implied volatility of out-of-the-money put and at-the-money call options. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
VARIABLES	IV Skew	IV Skew	IV Skew
Triggered	0.032***	0.027***	0.025***
	(9.528)	(8.113)	(12.413)
Constant	0.035***	0.035***	0.067***
	(19.723)	(19.955)	(104.063)
Observations	1,354,863	1,354,852	1,354,852
Adjusted R-squared	0.079	0.117	0.169
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table XI
The effect of Rule 201 on equity spreads.

This table reports the results from the option volume regression estimation described in Section 7. The dependent variable in each OLS regression is the relative equity spread per stock on any given day, defined as $\frac{Ask-Bid}{(Ask+Bid)/2} * 100$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
VARIABLES	Equity Bid - Ask Spread	Equity Bid - Ask Spread	Equity Bid - Ask Spread
Triggered	0.905***	0.764***	0.774***
	(35.735)	(33.104)	(35.208)
Options	-0.088***	-0.144***	-0.134***
	(-9.726)	(-13.620)	(-11.948)
Trigger×Options	-0.653***	-0.557***	-0.523***
	(-25.208)	(-21.612)	(-21.449)
Constant	-0.085***	-0.095***	0.076***
	(-6.175)	(-7.248)	(8.201)
Observations	8,230,467	8,212,574	8,212,574
Adjusted R^2	0.313	0.394	0.401
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table XII
The effect of Rule 201 on equity price dispersion

This table reports the results from the option volume regression estimation described in Section 7. The dependent variable in each OLS regression is the relative equity price dispersion per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in column (2) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. All variables are winsorized at the 1% level. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
VARIABLES	Equity Price Dispersion	Equity Price Dispersion	Equity Price Dispersion
Triggered	0.080***	0.072***	0.070***
	(103.185)	(93.677)	(112.910)
Options	-0.008***	-0.008***	-0.010***
	(-17.422)	(-20.000)	(-22.438)
Trigger×Options	-0.017***	-0.012***	-0.013***
	(-11.957)	(-8.859)	(-11.719)
Constant	0.027***	0.026***	0.044***
	(37.744)	(37.533)	(134.146)
Observations	8,230,486	8,212,593	8,212,593
Adjusted R^2	0.297	0.403	0.422
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Internet Appendix

Are shorts restricted when options are an option? Evidence from SEC Rule 201

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(*Not for Publication*)

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A.1. Robustness: Nasdaq and NYSE sample splits

Table A1
The effect of Rule 201 on short interest: Nasdaq and NYSE split

Panels A and B of this table report the results from the short interest regression estimation described in Section 4 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the natural logarithm of the short loan quantity. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule 201 on a given day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution. The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Short Interest	Short Interest	Short Interest
Triggered	-0.972***	-0.950***	-0.929***
	(-30.457)	(-33.032)	(-32.273)
Options	0.515***	0.571***	0.620***
	(11.213)	(11.237)	(12.094)
Trigger×Options	0.085*	0.063	0.094**
	(1.958)	(1.547)	(2.373)
Constant	14.332***	14.184***	14.244***
	(334.123)	(342.550)	(423.288)
Observations	4,230,171	4,220,902	4,220,902
Adjusted R^2	0.615	0.650	0.661
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Short Interest	Short Interest	Short Interest
Triggered	0.169**	-0.489***	-0.393***
	(2.473)	(-9.643)	(-8.113)
Options	1.004***	0.421***	0.480***
	(18.206)	(9.138)	(9.775)
Trigger×Options	-0.670***	0.079	0.037
	(-7.063)	(1.270)	(0.607)
Constant	13.650***	13.410***	13.354***
	(248.329)	(363.542)	(444.163)
Observations	3,981,828	3,973,257	3,973,257
Adjusted R^2	0.569	0.738	0.742
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A2
The effect of Rule 201 on put option delta-adjusted open interest: Nasdaq and NYSE split

Panels A and B of this table report the results from the delta-adjusted open interest scaled by shares outstanding regression estimation described in Section 5 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the total delta adjusted open interest divided by shares outstanding. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Delta OI / shrout %	Delta OI / shrout %	Delta OI / shrout %
Triggered	0.114***	0.066***	0.087***
	(3.490)	(2.620)	(3.300)
Constant	0.230***	0.239***	0.244***
	(10.141)	(11.516)	(13.653)
Observations	905,968	905,967	905,967
Adjusted R^2	0.079	0.215	0.225
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Delta OI / shrout %	Delta OI / shrout %	Delta OI / shrout %
Triggered	0.110***	0.089***	0.100***
	(5.899)	(5.613)	(5.438)
Constant	0.194***	0.189***	0.165***
	(10.374)	(13.487)	(15.576)
Observations	1,126,287	1,126,189	1,126,189
Adjusted R^2	0.082	0.252	0.256
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A3
The effect of Rule 201 on aggregate put option volume: Nasdaq and NYSE split

Panels A and B of this table report the results from the option volume regression estimation described in Section 5 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the aggregate option volume per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Aggregate Option Volume	Aggregate Option Volume	Aggregate Option Volume
Triggered	428.813***	269.597***	293.083***
	(6.420)	(4.355)	(4.215)
Constant	392.001***	396.793***	385.231***
	(5.364)	(5.579)	(6.842)
Observations	905,968	905,967	905,967
Adjusted R^2	0.495	0.561	0.565
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Aggregate Option Volume	Aggregate Option Volume	Aggregate Option Volume
Triggered	687.485***	513.050***	667.454***
	(4.718)	(3.972)	(4.561)
Constant	401.414***	326.969***	283.287***
	(5.159)	(4.626)	(5.150)
Observations	1,126,287	1,126,189	1,126,189
Adjusted R^2	0.402	0.496	0.500
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A4
The effect of Rule 201 on relative put option bid-ask spreads: Nasdaq and NYSE split

Panels A and B of this table report the results from the relative option spreads regression estimation described in Section 6 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the average relative option bid-ask spread per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Average Option Spread	Average Option Spread	Average Option Spread
Triggered	3.496***	2.825***	2.291***
	(15.165)	(14.709)	(14.381)
Constant	17.998***	17.904***	19.795***
	(67.518)	(85.885)	(160.776)
Observations	905,968	905,967	905,967
Adjusted R^2	0.175	0.258	0.321
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Average Option Spread	Average Option Spread	Average Option Spread
Triggered	2.001***	1.878***	1.897***
	(7.381)	(7.229)	(9.450)
Constant	17.575***	17.839***	20.248***
	(90.986)	(106.351)	(210.902)
Observations	1,126,287	1,126,189	1,126,189
Adjusted R^2	0.183	0.263	0.299
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A5
The effect of Rule 201 on equity spreads: Nasdaq and NYSE split

Panels A and B of this table report the results from the option volume regression estimation described in Section 7 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the relative equity spread per stock on any given day, defined as $\frac{Ask-Bid}{(Ask+Bid)/2} * 100$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Equity Bid - Ask Spread	Equity Bid - Ask Spread	Equity Bid - Ask Spread
Triggered	0.926***	0.852***	0.857***
	(34.696)	(34.445)	(35.483)
Options	-0.143***	-0.182***	-0.170***
	(-9.897)	(-10.338)	(-9.503)
Trigger×Options	-0.610***	-0.568***	-0.535***
	(-19.404)	(-18.903)	(-19.355)
Constant	-0.166***	-0.172***	0.077***
	(-8.015)	(-8.465)	(5.347)
Observations	4,240,283	4,230,970	4,230,970
Adjusted R^2	0.350	0.396	0.406
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Equity Bid - Ask Spread	Equity Bid - Ask Spread	Equity Bid - Ask Spread
Triggered	0.593***	0.403***	0.407***
	(18.453)	(16.413)	(17.814)
Options	-0.071***	-0.120***	-0.123***
	(-8.060)	(-10.649)	(-10.144)
Trigger×Options	-0.414***	-0.270***	-0.249***
	(-14.549)	(-10.261)	(-9.971)
Constant	0.036***	-0.005	0.090***
	(2.972)	(-0.414)	(9.988)
Observations	3,990,184	3,981,604	3,981,604
Adjusted R^2	0.217	0.378	0.382
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A6
The effect of Rule 201 on equity price dispersion: Nasdaq and NYSE split

Panels A and B of this table report the results from the option volume regression estimation described in Section 7 for the Nasdaq and NYSE sample respectively. The dependent variable in each OLS regression is the relative equity price dispersion per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in column (2) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. All variables are winsorized at the 1% level. Our sample consists of firms traded on the respective exchanges with and without listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Nasdaq sample

	(1)	(2)	(3)
	Equity Price Dispersion	Equity Price Dispersion	Equity Price Dispersion
Triggered	0.076***	0.073***	0.071***
	(119.554)	(116.422)	(128.943)
Options	-0.014***	-0.012***	-0.012***
	(-20.688)	(-16.954)	(-18.433)
Trigger×Options	-0.012***	-0.011***	-0.012***
	(-10.495)	(-10.182)	(-12.031)
Constant	0.037***	0.035***	0.052***
	(41.675)	(42.625)	(97.454)
Observations	4,240,292	4,230,979	4,230,979
Adjusted R^2	0.327	0.374	0.392
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Panel B: NYSE sample

	(1)	(2)	(3)
	Equity Price Dispersion	Equity Price Dispersion	Equity Price Dispersion
Triggered	0.078***	0.068***	0.064***
	(42.489)	(37.739)	(47.284)
Options	-0.004***	-0.006***	-0.007***
	(-6.573)	(-11.815)	(-13.918)
Trigger×Options	-0.017***	-0.010***	-0.010***
	(-7.305)	(-5.016)	(-5.176)
Constant	0.021***	0.018***	0.036***
	(24.559)	(22.972)	(98.045)
Observations	3,990,194	3,981,614	3,981,614
Adjusted R^2	0.281	0.428	0.455
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

A.2. Robustness: The effect of Rule 201 on put and call option open interest

Table A7
The effect of Rule 201 on put and call option open interest

Panels A and B in this table report the results for put and call options respectively from the open interest scaled by shares outstanding regression estimation described in Section 5. The dependent variable in each OLS regression is the total open interest divided by shares outstanding. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options			
	(1)	(2)	(3)
	Open Interest (%)	Open Interest (%)	Open Interest (%)
Triggered	0.136***	0.099***	0.122***
	(6.068)	(5.345)	(6.053)
Constant	0.451***	0.437***	0.392***
	(21.758)	(26.330)	(29.929)
Observations	2,032,255	2,032,157	2,032,157
Adjusted R^2	0.136	0.326	0.334
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES
Panel B: Call Options			
	(1)	(2)	(3)
	Open Interest (%)	Open Interest (%)	Open Interest (%)
Triggered	0.097***	0.029	0.109***
	(2.759)	(0.968)	(4.097)
Constant	0.695***	0.684***	0.599***
	(24.299)	(29.322)	(35.176)
Observations	2,260,732	2,260,586	2,260,586
Adjusted R^2	0.137	0.318	0.340
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A8
The effect of Rule 201 on put and call option open interest: Moneyness/Maturity splits.

Panels A and B in this table report the results for put and call options respectively from the open interest scaled by shares outstanding regression estimation described in Section 5. The dependent variable in each OLS regression is the total open interest divided by shares outstanding. The sample is split into 1 of 10 maturity-moneyness buckets. Maturity buckets are defined as T1: short-term maturity options with time to expiration up to 90 days. T2 are long-term maturity options with time to expiration above 90 days. $Moneyness = \frac{Price}{Strike}$. Moneyness buckets are defined as at-the-money M1, if $moneyness >= 0.95$ & $moneyness <= 1.05$. M2 is the first in-the-money bucket, defined as $moneyness >= median(ITM)$ & $moneyness < 0.95$ and M3 are deep ITM options: $moneyness < median(ITM)$. Out-of-the money options have their moneyness defined as M4: $moneyness > 1.05$ & $moneyness <= median(OTM)$ and deep OTM as M5: $moneyness > median(OTM)$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	0.041***	0.012**	0.049***	0.017***	0.178***	0.066***	0.043***	0.011*	0.156***	0.047*
	(3.988)	(2.532)	(7.960)	(5.167)	(3.784)	(5.986)	(5.847)	(1.842)	(4.144)	(1.685)
Constant	0.165***	0.058***	0.063***	0.044***	0.100***	0.077***	0.118***	0.081***	0.194***	0.107***
	(26.343)	(30.380)	(27.494)	(23.201)	(10.886)	(15.841)	(27.181)	(29.586)	(15.312)	(10.345)
Observations	1,510,786	958,623	501,932	467,220	409,012	368,690	1,021,851	1,012,494	850,435	758,613
Adjusted R^2	0.235	0.145	0.116	0.103	0.083	0.114	0.196	0.166	0.137	0.134
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Panel B: Call Options

	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	-0.003	0.006	0.027***	0.016***	0.075***	0.043***	0.024***	0.009	0.218***	0.099***
	(-0.229)	(1.167)	(5.341)	(3.987)	(5.764)	(5.433)	(2.781)	(1.422)	(6.089)	(5.305)
Constant	0.240***	0.085***	0.081***	0.057***	0.100***	0.065***	0.148***	0.094***	0.267***	0.178***
	(31.128)	(40.211)	(35.867)	(31.337)	(21.712)	(19.579)	(32.614)	(40.186)	(21.640)	(21.468)
Observations	1,667,157	1,232,530	723,803	716,133	633,147	593,231	990,622	1,184,602	781,284	860,270
Adjusted R^2	0.264	0.166	0.149	0.137	0.125	0.137	0.171	0.154	0.158	0.163
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

A.3. Robustness: The effect of Rule 201 on put and call option implied volatility

Table A9
The effect of Rule 201 on put and call option implied volatility

Panels A and B in this table report the results for put and call options respectively from a variation of the open interest scaled by shares outstanding regression estimation described in Section 6. The dependent variable in each OLS regression is the average implied volatility per stock on any given day. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Panel A: Put Options			
	(1)	(2)	(3)
VARIABLES	Implied Volatility	Implied Volatility	Implied Volatility
Triggered	0.254***	0.202***	0.229***
	(17.100)	(15.909)	(26.538)
Constant	0.269***	0.260***	0.473***
	(36.098)	(42.407)	(130.053)
Observations	2,232,011	2,231,846	2,231,846
Adjusted R^2	0.294	0.481	0.524
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES
Panel B: Call Options			
	(1)	(2)	(3)
VARIABLES	Implied Volatility	Implied Volatility	Implied Volatility
Triggered	0.222***	0.170***	0.202***
	(15.497)	(13.947)	(25.527)
Constant	0.263***	0.255***	0.440***
	(37.368)	(45.001)	(124.533)
Observations	2,260,199	2,260,053	2,260,053
Adjusted R^2	0.272	0.493	0.534
Industry Fixed Effects	NO	YES	YES
Time Fixed Effects	NO	NO	YES
Controls	YES	YES	YES

Table A10
The effect of Rule 201 on put option implied volatility: Moneyness/Maturity splits.

This table reports the results from a variation of the open interest scaled by shares outstanding regression estimation described in Section 5. The dependent variable in each OLS regression is the average implied volatility per stock on any given day. The sample is split into 1 of 10 maturity-moneyness buckets. Maturity buckets are defined as T1: short-term maturity options with time to expiration up to 90 days. T2 are long-term maturity options with time to expiration above 90 days. $Moneyness = \frac{Price}{Strike}$. Moneyness buckets are defined as at-the-money M1, if $moneyness >= 0.95$ & $moneyness <= 1.05$. M2 is the first in-the-money bucket, defined as $moneyness >= median(ITM)$ & $moneyness < 0.95$ and M3 are deep ITM options: $moneyness < median(ITM)$. Out-of-the money options have their moneyness defined as M4: $moneyness > 1.05$ & $moneyness <= median(OTM)$ and deep OTM as M5: $moneyness > median(OTM)$. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added in columns (2) and (3) to account for unobservable industry fixed characteristics. Column (3) also adds time-fixed effects. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	M1/T1	M1/T2	M2/T1	M2/T2	M3/T1	M3/T2	M4/T1	M4/T2	M5/T1	M5/T2
Triggered	0.188***	0.146***	0.195***	0.156***	0.284***	0.230***	0.187***	0.150***	0.276***	0.214***
	(21.866)	(18.369)	(15.823)	(15.526)	(20.879)	(18.939)	(19.318)	(19.570)	(21.390)	(19.161)
Constant	0.387***	0.356***	0.435***	0.382***	0.596***	0.518***	0.426***	0.387***	0.554***	0.504***
	(107.902)	(101.952)	(91.137)	(90.220)	(77.172)	(73.030)	(117.696)	(113.410)	(117.677)	(107.771)
Observations	1,614,459	975,809	502,891	469,536	401,814	363,971	1,222,177	1,092,465	1,078,517	865,742
Adjusted R-squared	0.527	0.507	0.441	0.479	0.402	0.454	0.517	0.512	0.484	0.476
Industry Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

A.4. Robustness: The effect of Rule 201 on Put-Call Parity

Table A11
The effect of Rule 201 on Put-Call Parity

This table reports the results of the effect of Rule 201 on the pricing relation between stocks and options. Following Chen et al. (2020), table A11 presents an estimation of a probit model examining the effects of a trigger event on the probability of put-call parity violations.The dependent variable is a dummy variable called *Violation* equal to 1 if following equation is not satisfied: $P_{j,t} + S_{i,t} \leq C_{j,t} + K_j + PV_{i,t}(DIV)$. $P_{j,t}$ and $C_{j,t}$ are closing midpoint prices for at-the-money puts and calls in the option pair j with the same strike price and time to expiration. $S_{i,t}$ is the underlying stock price, K_j is the exercise price of the option pair, and $PV_{i,t}(DIV)$ is the present value of the sum of dividends in a given year before the expiration date. Triggered is a dummy variable equal to 1 if a stock triggered the circuit breaker of Rule201 on a given day and the following day, and 0 otherwise. Control variables include i) trade volume as the natural logarithm of the daily trading volume of the stock in millions, ii) stock return as the daily return on the stock, iii) the closing value of the CBOE Volatility Index, iv) the market capitalization of the firm, and v) Amihud's illiquidity measure (see Amihud (2002)). Industry fixed effects are added to account for unobservable industry fixed characteristics. To control for the effect of outliers in the estimations the variables are winsorized at the 1% level in both tails of the distribution.The sample period is February 28, 2011 to December 31, 2020 for Nasdaq-listed stocks and, due to data availability, from March 25, 2015 to December 31, 2020 for NYSE-listed stocks. Our sample consists of firms traded on the respective exchanges with listed options. We report t-statistics in parentheses that are based on standard errors clustered by firm and year (see Petersen (2009)). ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)
VARIABLES	Put/Call Violation
Trigger	0.269***
	(5.650)
Constant	-0.665***
	(-116.320)
Observations	21,810,362
Pseudo R-squared	0.017
Industry Fixed Effects	YES
Controls	YES