

# Migrate or Not? The Effects of Regulation SHO on Options Trading Activities

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## Abstract

In this study, we investigate the effects of stock short-sale constraints on options trading by exploiting two U.S. Securities and Exchange Commission (SEC) rule changes under Regulation SHO: Rule 203 (locate and close-out requirements) and Rule 202T (temporary removal of short-sale price tests). We find that stock short selling activities decrease (increase) significantly after Rule 203 (Rule 202T) implementation, supporting the validity of Rule 203 (Rule 202T) as an exogenous increase (decrease) in short-sale constraints. Options volume increases significantly after Rule 203 went into effect and the result is more pronounced among firms with lower levels of institutional ownership and smaller options bid-ask spreads. Therefore, the evidence from Rule 203 suggests that investors may use options as substitutes for stock short sales when short selling is less feasible or more costly due to the locate and delivery requirements. In contrast, we find no significant change in the options trading volume of pilot stocks during the pilot program of Rule 202T. Overall, our results indicate that the impact of short-sale constraints on options trading varies with the types of constraints affected.

**Keywords:** Short-sale constraints, Regulation SHO, short selling, options trading volume

**JEL classification:** G10, G12, G18, G23

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## 1. Introduction

Short-sale constraints include various costs and risks, such as the expense and difficulty of borrowing stocks, various legal and institutional restrictions, and the risks that the short positions will be involuntarily closed due to the recall of stock loans. A number of studies have tried to examine the relation between stock short-sale constraints and equity options trading focusing on either the *substitutability* or the *complementarity* between stock short selling and options trading.<sup>2</sup> However, short-sale constraints are difficult to measure (Lamont 2012), and many commonly used proxies for short-sale constraints (such as stock lending fees and institutional ownership) are largely endogenously determined. Therefore, the existing literature provides mixed empirical evidence on how stock short-sale constraints affect equity options trading.

In this paper, we examine the impact of short-sale constraints on options trading by exploiting exogenous shocks to short-sale constraints—Regulation SHO. Regulation SHO provides a regulatory framework, established by the U.S. Securities and Exchange Commission (SEC), governing short selling of securities in the U.S. equity market. The advantage of focusing on Regulation SHO is twofold: First, unlike other proxies for short-sale constraints that are endogenously determined (e.g., short interests or stock lending fees), Regulation SHO represents exogenous shocks to short-sale constraints. This enables us to provide direct evidence on the

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<sup>2</sup> The impact of short-sale constraints on options trading depends on whether and how investors (demand side) as well as options market makers (supply side) are affected by the constraints. On the one hand, the demand-side channel focuses on the *substitutability* between stock short-selling and options trading. When stock short selling becomes expensive, establishing bearish positions in the options markets (such as buying puts or selling calls) can be an alternative choice for investors, leading to an increase in the demand of options (Diamond and Verrecchia 1987; Easley, O'Hara, and Srinivas 1998; Johnson and So 2012; Lin and Lu 2015). On the other hand, the supply-side channel emphasizes the *complementarity* between stock short selling and options trading. When investors take bearish positions in the options markets, options market makers need to hedge their positions by short selling the underlying stocks. Consequently, an increase in the market makers' hedging costs due to tighter short-sale constraints would reduce the supply of options (Battalio and Schultz 2011; Grundy, Lim, and Verwijmeren 2012; Stratmann and Welborn 2013). Therefore, when the demand (supply) side dominates the supply (demand) side, high short-sale costs will lead to higher (lower) options trading volume.

*substitutability* or *complementarity* between equity short selling and options trading by examining both the change of stock short-sale activities and the variation in options trading volume given the exogenous increase or decrease of short-sale constraints. Second, the two rule changes under Regulation SHO provide an opportunity to investigate the impact of two different forms of short-sale constraints on options trading: locate and close-out requirements of Rule 203 and the short-sale price tests of Rule 202T.<sup>3</sup> This would help to clarify whether and how the effects of short-sale constraints on options trading vary with the types of short-sale constraints affected.

Rule 203 (locate and close-out requirements) went into effect on January 3, 2005. The rule addresses the potentially manipulative effects of naked short selling and extended “fail-to-deliver” of outstanding short positions. Naked short selling is selling short without borrowing the necessary securities to make delivery, thus potentially resulting in a fail-to-deliver of securities to the buyer.<sup>4</sup> Rule 203 of Regulation SHO creates a uniform rule requiring all broker-dealers to locate or borrow securities before executing short sales and to deliver upon or close-out short positions in which short sellers have prolonged fails-to-deliver. Rule 203 supplants existing overlapping self-regulatory organization (SRO) rules. (The requirements in Rule 203 differ from SRO rules in several important aspects. See the Appendix for a detailed comparison of locate and close-out requirements before and after Regulation SHO implementation.)

Rule 203 likely represents an increase in the costs of taking short positions in the stock markets because the would-be naked short sellers will have to bear search costs of locating and

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<sup>3</sup> Rule 203 and Rule 202T took effect at different time points, which provides us with two non-overlapping windows to investigate their effects separately.

<sup>4</sup> The fail-to-deliver typically occurs three business days after the naked short sale due to the “T+3” settlement used in the U.S. Boni (2006) finds that prior to Regulation SHO, a substantial fraction of issues (42% of listed stocks and 47% of unlisted stocks) had persistent fails-to-deliver of five days or more and these long-lived cases of “fail-to-deliver” were more likely to occur when stocks were expensive to borrow. This is consistent with the fact that equity and options market makers strategically fail to deliver shares that are expensive or impossible to borrow (Evans et al. 2009).

negotiating securities for lending, post margins, and pay lending fees to the lenders. In addition, as the demand for stock lending from the would-be naked short sellers drives up the stock lending fees, the short selling costs of covered short sellers are also likely to increase (Stratmann and Welborn 2013). If Rule 203 indeed represents an exogenous increase in short-sale costs, the short interests of optionable stocks are expected to decrease because some short sellers may leave the stock markets and take short positions in the options markets by buying put options or selling call options. However, if a stock has no exchange-traded options, the above result is expected to be less pronounced because short sellers have no alternative trading venue but to remain in the stock markets and bear higher short-sale costs (unless the short-sale costs are so high that the trading profits become negative). Consistent with our expectation, we find significant decreases in the short interests of stocks with exchange-traded options in the three months after the effective date of Rule 203, but no significant changes for stocks without exchange-traded options.

After verifying the validity of Rule 203 as an exogenous increase in short-sale costs, we examine the impact of Rule 203 on options trading volume under the demand-supply framework. As discussed above, Rule 203 increases the short-sale costs for stock investors. On the demand side, investors may migrate from the stock markets to the options markets to establish bearish positions, leading to an increased demand for options. On the supply side, as options market makers are exempted from locate and certain close-out requirements when they are involved in bona fide market making activities, we expect a slight decrease or even no change in the supply of options after Rule 203 took effect.<sup>5</sup> Taking both the demand- and supply-side channels into consideration, we predict that options volume increases after the implementation of Rule 203.

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<sup>5</sup> As initially adopted, Rule 203 included two major exceptions to the close-out requirement: the “grandfather” provision and the “options market maker” exception, both of which were subsequently eliminated after the end of our sample period.

Using data from October 2004 to March 2005 (6 months surrounding Rule 203 implementation), we find significant increases in the trading volumes of call and put options after the implementation of Rule 203. Specifically, we find a 13.2% (21.8%) increase in call (put) options volume after controlling for firm characteristics, market conditions, and industry fixed effects. This is consistent with the substitution relation between equity short selling and options trading. Furthermore, we document that the positive impact of Rule 203 on options trading volume is more pronounced among firms with lower institutional ownership and lower options bid-ask spreads. Institutional ownership is typically associated with the availability of shares that makes short selling feasible (e.g., Nagel, 2005). Therefore, our results suggest that short sellers are more likely to migrate to the options markets when short selling in the stock markets is less feasible (or more costly) and when the options transaction costs are lower.

The above results are in contrast with Grundy, Lim, and Verwijmeren (2012), which investigates the most binding form of short-sale constraints—the 2008 short-sale ban.<sup>6</sup> They find that options volume decreases significantly for banned stocks during the ban period (i.e., the decrease in supply of options by options market makers dominates the increase in demand of options by investors), supporting a complementary relation between equity short selling and options trading. One important driver for the complementary relation documented by Grundy, Lim, and Verwijmeren (2012) is the substantial increase in the options bid-ask spread, which reduces investors' incentives to trade options when short selling is prohibited. However, in the setting of

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<sup>6</sup> In September 2008, the SEC issued a short-sale ban prohibiting the short selling of U.S. financial stocks. With respect to banned stocks during the ban, investors could no longer take short positions. Options market makers could only sell short as part of bona fide market making and hedging activities.

Rule 203, we find no significant changes in the options bid-ask spreads. This explains and reconciles our findings.

Rule 202T is another important piece of Regulation SHO. It is a temporary rule that allows the SEC to establish a pilot program to examine the efficacy of short-sale price tests, including the tick test for exchange-listed stocks and the bid test for NASDAQ National Market stocks. The tick test mandates that a short sale can only occur at a price above the most recently traded price (plus tick) or at the most recently traded price if that price exceeds the last different price (zero-plus tick). The bid test requires a short sale to occur at a price one penny above the bid price if the bid is a downtick from the previous bid.<sup>7</sup> Under the pilot program, roughly 1,000 U.S. stocks—so-called pilot stocks—were exempted from short-sale price tests from May 2, 2005 to August 6, 2007.<sup>8</sup> The pilot stocks were drawn from the Russell 3000 Index, comprising every third stock ranked by volume. The remaining Russell 3000 Index securities were control stocks. Prior studies show that the exemption from short-sale price tests decreases the costs of short selling in the pilot stocks relative to the control stocks (see U.S. Securities and Exchange Commission 2007; Diether, Lee, and Werner 2009). We confirm this finding in our sample. Specifically, we document significant increases in the short-sale volumes of pilot stocks relative to that of control stock during the pilot program. In addition, the short trade frequency increases while the short trade size decreases, suggesting that short sellers engage more heavily in order-splitting.

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<sup>7</sup> Previous research shows that short sellers can receive better prices as a result of the short-sale price test (Albert, Smaby, and Robison 1997). However, the tick test and bid test restrict the ability of short sellers to demand liquidity even in rising markets. This results in execution delays and lower fill rates (Alexander and Peterson 1999).

<sup>8</sup> Subsequent to the pilot program of Rule 202T, on July 6, 2007, the SEC eliminated short-sale price tests for all exchange-listed stocks. The decision to eliminate all short-sale price tests prompted a huge backlash from managers and politicians. In response to this pressure, the SEC partially reversed course and restored a modified uptick rule (price tests are triggered when a security's price declines by 10% or more from the previous day's closing price) on February 24, 2010.

Next, we investigate the impact of removing short-sale price tests on options trading volume. From the demand side, investors might be attracted to the stock markets (from the options markets) to take short positions when the short-sale order is executed without price restrictions, leading to less demand for options of pilot stocks (relative to non-pilot stocks) during the pilot program. From the supply side, as options market makers are not subject to price restrictions before Rule 202T, we expect no significant change in the supply of options of pilot stocks. Therefore, we expect that the options trading volume of pilot firms (relative to that of non-pilot firms) would decrease during the pilot program. However, we find no evidence that removing short-sale price tests has a significant impact on the options volume. There is also no significant change in the options bid-ask spreads. Overall, although the exemption of short-sale price tests has significant impact on short selling activities in the stock markets, it has little influence on the options markets. Options investors do not migrate to the stock markets to take short positions after the removal of short-sale price restrictions. One possible explanation is that removing short-sale price tests enables stock short-sellers to trade more actively in the stock markets, as evidenced by more order splitting and more frequent trades for pilot stocks during the pilot program. However, these features may not be appealing enough for investors in the options markets, which offer many other advantages such as high leverage, to migrate to the stock markets.

This paper is related to the literature on the impact of short-sale regulations on options markets. Focusing on the most binding form of short-sale constraints, the 2008 short-sale ban of financial stocks, Grundy, Lim, and Verwijmeren (2012) find sizeable decreases in options trading volume and significant increases in options bid-ask spreads for banned stocks. Their results suggest a complementary relation between equity short selling and options trading when short sales are prohibited. Stratmann and Welborn (2013) study the elimination of the options market

maker exception to the Regulation SHO close-out requirement in September 2008, a follow-up amendment to the close-out requirement in Rule 203. They find that eliminating the exception leads to higher stock borrowing rates for optionable stocks as compared to non-optionable stocks, and lower options trading volume. We contribute to this literature by studying two distinct rules of Regulation SHO: Rule 203 and Rule 202T. Both rules significantly affect short selling activities, as evidenced in the validity tests. However, their impact on options trading differs from each other and also from prior studies of other short-sale regulations. Specifically, we find significant increases in options trading volume after the locate and close-out requirements of Rule 203 are in place, but no significant changes in options trading volume for stocks that are temporarily exempted from short-sale price tests. Taken together with prior literature, these findings highlight the fact that the impact of short-sale regulations on options markets varies with the types of short-sale constraints affected.

This study also contributes to the literature on Regulation SHO. Evans et al. (2009, p. 1975) describe Rule 203 (the locate and delivery requirements of Regulation SHO) as follows: “it has the potential to alter the cost of short exposure, so its impact is an important new empirical question.” However, prior research of Regulation SHO mainly focuses on the pilot program of Rule 202T (e.g., U.S. Securities and Exchange Commission 2007; Alexander and Peterson 2008; Diether, Lee, and Werner 2009), the effects of Rule 203 are largely ignored. To the best of our knowledge, we are the first to examine the effects of the initial adoption of Rule 203 on the equity options markets. We contribute to this literature by documenting that Rule 203 indeed induces increases in short-sale constraints and that it also has a significant impact on the options markets.

Lin and Lu (2015) also investigate the effects of short-sale constraints on options trading. We investigate exogenous shocks to short-sale constraints arising from Regulation SHO, while

Lin and Lu (2015) use stock lending fees as a proxy for short-sale costs. They find that stock lending fees are positively associated with put options trading volume in general and interpret their results as higher short-sale costs shifting investors from the stock lending markets to the options markets. Although stock lending fees are often used by researchers as a proxy for short-sale costs (e.g., Saffi and Sturgess 2011; Johnson and So 2012), it is endogenously determined and thus may affect the interpretation of results. For example, high stock lending fees may be driven by a high demand for stock loans. The demand for stock loans is usually high when investors have negative views for the future stock price. Investors with negative expectations may either short sell stocks or buy put options, leading to increases in both stock lending fees and put options trading volume. Therefore, a positive contemporaneous association between stock lending fees and put options volume may not necessarily reflect a shift from the stock lending markets to the options markets caused by high short-sale costs in the stock markets, but may merely be a reflection of investors' negative expectation of future stock price movements. By exploiting two short-sale rule changes that are exogenous, we provide direct evidence on how short-sale constraints affect options trading that is free from the endogenous concerns in prior studies.

The paper is organized as follows. In Section 1, we provide a brief introduction to short selling and discuss the details of Rule 203 and Rule 202T of Regulation SHO. In Section 2, we describe the data and sample. In Section 3, we test the validity of Rule 203 and Rule 202T as exogenous shocks to equity short-sale constraints. We examine the impact of Rule 203 and Rule 202T on options trading activities in Section 4. We provide additional analysis in Section 5 and conclude in Section 6.

## **2. Short selling and Regulation SHO**

### **2.1 Short selling**

According to the definition by the SEC, a short sale is the sale of a security that the seller does not own or any sale that is consummated by the delivery of a security borrowed by, or for the account of, the seller. In general, short selling is used to generate profit from an expected downward price movement, to provide liquidity in response to unanticipated demand, or to hedge the risk of a long position in the same security or in a related security. Short selling is an important fraction of the stock trading activity. For example, Diether, Lee, and Werner (2008) find that short sales represent 31% of share volume for NASDAQ-listed stocks and 24% of share volume for NYSE-listed stocks in 2005.

The procedures of covered short selling are as follows. In order to deliver the security to the purchaser, the short seller will borrow the security, typically from a broker-dealer or an institutional investor and then sell it in the open market. While the short position is open, the lender requires collateral. This collateral (usually the proceeds from the sale) earns interest payable to the borrower at less than a normal market rate (rebate rate). The spread between the normal market rate and the rebate rate is the “lending fee” that the lender earns and the borrower pays. When closing a position, the short seller buys back equivalent shares in the market and returns them to the stock lender. The collateral is then returned to the borrower plus interest earned at the rebate rate. There is no set time frame on how long a covered short position can be held, provided the lender does not recall the stock and the short seller can meet the margin requirements.

Naked short selling is selling short without first borrowing the necessary security or ensuring that the security can be borrowed to make delivery. In U.S. equity markets, sellers are required to deliver shares in return for payment by the third day following the transaction (“T+3”). Shares that are not delivered by T+3 are called fails-to-deliver. If the short seller fails to deliver the shares to the buyer three days after the naked short sale, the clearing corporation intermediating

the trade takes margin and marks it to market, thereby defending buyers against their sellers' nonperformance. In such cases, naked short selling, then failing to deliver is economically equivalent to borrowing shares at a zero-fee, zero-rebate equity loan plus the expected cost of being forced to buy back the stock and deliver it (a process called "buying-in"). As shown in Boni (2006) and Evans et al. (2009), the probability of buying-in is quite low. Therefore, if equity loans are expensive, unavailable or unreliable, as research shows they can be (e.g., D'Avolio 2002; Geczy, Musto, and Reed 2002; Jones and Lamont 2002; Lamont 2012), naked short selling and then failing to deliver is less costly than covered short selling. Evans et al. (2009) document that when borrowing costs are high, market makers sometimes choose not to borrow and naked short sell instead.

## **2.2 Regulation SHO**

Regulation SHO provides a new regulatory framework governing the short selling of securities in U.S. equity markets. The rules were passed on September 7, 2004 and became effective on January 3, 2005. Regulation SHO was adopted to update the regulation of short sales in light of numerous market developments since short-sale regulation was first adopted in 1938. Some of the goals of Regulation SHO include: (1) establishing uniform locate and delivery requirements to address problems associated with failures-to-deliver, including potentially abusive naked short selling (Rule 203); (2) temporarily suspending short-sale price tests in a group of securities to evaluate the overall effectiveness and necessity of such restrictions (Rule 202T); and (3) creating uniform order marking requirements for the sales of all equity securities. In this study, we focus on the impact of locate and delivery requirements and eliminating short-sale price tests on options trading activities.

### **2.2.1 Rule 203: Locate and delivery requirements**

Effective on January 3, 2005, Rule 203 imposes two key requirements: (1) the “locate” requirement prior to executing short sales; and (2) the “delivery” requirement for closing out short positions in “threshold securities” that are the subject of extended fails-to-deliver.<sup>9</sup> The locate requirement prohibits a broker-dealer from executing a short-sale order for its own account or the account of another person, unless the broker-dealer, or the person for whose account the short sale is executed (1) borrowed the security, or entered into an arrangement for the borrowing of the security or (2) had reasonable grounds to believe that they could borrow the security so that they would be capable of delivering the securities on the date delivery is due. The delivery (or close-out) requirement mandates any participant of a registered clearing agency (e.g., clearing brokers) to close-out any fail-to-deliver in “threshold securities”<sup>10</sup> by purchasing securities of like kind and quantity 10 days after the normal settlement date (i.e., 13 consecutive days after the transaction).

Short sales executed by market makers, including specialists and options market makers, are exempt from the locate requirement of Rule 203. There is a limited exemption from the close-out requirement for options market makers that hedge options positions (bona fide market making) established prior to the security’s achieving threshold status.<sup>11</sup> According to the SEC, the options market maker exception was created to address concerns regarding liquidity and the pricing of

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<sup>9</sup> Prior to the implementation of Regulation SHO, SROs had enacted several rules designed to prevent abusive naked short selling practices and fails-to-deliver. However, the SEC considered these rules as inadequate to prevent abusive short selling and extended fails-to-deliver.

<sup>10</sup> Rule 203(c)(6) defines “threshold securities” as the securities of publicly traded and reporting issuers in which: (1) for five consecutive settlement days have aggregate fails-to-deliver at a registered clearing agency of 10,000 shares or more; (2) the volume of fails in a security is equal to at least one-half of one percent of the reported total shares outstanding in the security; and (3) the security is included on a SRO list identifying securities that exceed specified fail levels.

<sup>11</sup> Bona fide market making does not include activity that is related to speculative selling strategies or investment purposes of the broker-dealer and is disproportionate to the usual market making patterns or practices of the broker-dealer in that security. In addition, where a market maker posts continually at or near the best offer, but does not also post at or near the best bid, the market maker’s activities would not generally qualify as bona fide market making for purposes of the exception. Further, bona fide market making does not include transactions whereby a market maker enters into an arrangement with another broker-dealer or customer in an attempt to use the market maker’s exception for the purpose of avoiding compliance with Rule 203 by the other broker-dealer or customer.

options. When options market makers sell put options or buy call options, they are in a long position. They can hedge their long options position by selling short the underlying equity. The exception allows options market makers to hedge the risk of long options positions for the duration of an option contract if they are unable to borrow, which allows them to delay short-sale close-out until options expiration if necessary.

### **2.2.2 Rule 202T: Eliminating short-sale price tests**

Short-sale price tests were initially introduced to the U.S. equity markets in the 1930s to avoid bear raids by short sellers in declining markets. The NYSE adopted an uptick rule in 1935, which was replaced in 1938 by a stricter SEC rule, Rule 10a-1, also known as the “tick test.” The rule mandates that a short sale can only occur at a price above the most recently traded price (plus tick) or at the most recently traded price if that price exceeds the last different price (zero-plus tick). In 1994, the National Association of Securities Dealers (NASD) also adopted its own price test (“bid test”) under Rule 3350. Rule 3350 requires a short sale to occur at a price one penny above the bid price if the bid is a downtick from the previous bid.

Rule 202T of Regulation SHO is a temporary rule that allows the SEC to establish, through separate orders, a pilot program to examine the efficacy of price restrictions. On May 2, 2005, roughly 1,000 U.S. stocks—so-called pilot stocks—began to trade without short-sale price tests (tick test for the NYSE and bid price test for NASDAQ). These stocks were selected by the SEC to represent a broad cross-section of the U.S. equity market. The pilot stocks were drawn from the Russell 3000 Index, comprising every third stock ranked by volume. The remaining Russell 3000 Index securities were control stocks. The experiment was designed by the SEC to investigate whether Rule 10a-1, NYSE’s Uptick rule, and NASDAQ’s bid price test affect market quality, and

to develop uniform price tests if such rules were deemed necessary going forward. The temporary suspension was originally set to expire on April 28, 2006, but was extended to August 6, 2007.

Most evidence indicates that the price tests work to constrain short selling. For example, Angel (1997) and Alexander and Peterson (1999) show that Rule 10a-1 impedes short selling by delaying order execution and lowering fill rates, even in rising markets. McCormick and Reilly (1996) find that Rule 3350 curtails short selling for NASDAQ NMS stocks during declining markets. Diether, Lee, and Werner (2009) show that pilot stocks listed on both the NYSE and NASDAQ experienced a significant increase in short selling activities during the pilot program. These stocks had more frequent short-sale trades and a greater short-sales-to-share volume ratio during the pilot program. Moreover, NYSE-listed pilot stocks experienced a higher level of order splitting (i.e., short-sale trades with smaller trade size), suggesting that short sellers applied more active trading strategies.

In summary, previous research shows that short sellers can receive better prices as a result of the tick test and that the tick test does not impede profit opportunities. However, the tick test and bid test restrict the ability of short sellers to demand liquidity even in rising markets.

### **3. Data and sample**

#### **3.1 Data**

The options data are from OptionMetrics, which provides end of day bid and ask quotes, open interest, volume, implied volatilities, and options Greeks for all put and call options listed in the U.S. options markets. OptionMetrics calculates the underlying implied volatilities of individual options based on binomial trees that account for early exercise of individual stock options and the dividends expected to be paid over the lives of the options. To alleviate the influence of illiquid

options, we require the following criteria (Grundy, Lim, and Verwijmeren 2012): (1) the open interest is positive; (2) the time to expiration is between 7 and 365 calendar days; (3) the options relative bid-ask spread is no greater than 0.5; and (4) the option's best closing ask is no less than the best closing bid.

The stock trading data are from the Center for Research in Security Prices (CRSP). The general accounting data and monthly short interests data are provided by Compustat. We also download intraday data from all SROs that report short sales for NYSE- and NASDAQ-listed securities and compute the daily number of shares sold short (both in absolute terms and as a fraction of stock trading volume), short trade size, and number of short trades each day.

## **3.2 Sample and descriptive statistics**

### **3.2.1 Rule 203 sample**

Rule 203 became effective on Jan 3, 2005. The Rule 203 sample covers the period from October 1, 2004 through March 31, 2005, including 125 trading days around the effective date. The sample consists of stocks in the 2004 Russell 3000 Index with listed options. After merging with necessary option-, stock-, and firm-related data, the resulting sample contains 1,040 firms.

Panel A of Table 1 reports the firm characteristics. There are 127,411 firm-day observations. The mean firm size (market capitalization) is \$9.06 billion. The mean daily stock trading volume is 1.68 million shares. The mean institutional ownership is 75%. Panel B reports the options characteristics. There are 1,435,480 (1,284,064) call (put) option-day observations. The mean and standard deviation of call (put) options relative bid-ask spreads are 0.115 and 0.110 (0.136 and 0.121). The mean implied volatility of call (put) options is 0.351 (0.363). The mean time-to-maturity of call (put) options is 129 calendar days. The daily trading volume per option is

highly skewed, with mean of 92 (63) and median of 0 (0) for call (put) options. The daily aggregated options volume at the stock level is on average 1,044 for call options and 645 for put options.

[Insert Table 1 Here]

### **3.2.2 Rule 202T sample**

The pilot program took place from May 2, 2005 to August 6, 2007. Consistent with the Rule 203 sample, we choose the six months surrounding the effective date as the sample period (i.e., February 1, 2005 through July 31, 2005). The initial sample includes all pilot stocks as defined by the Securities Exchange Act Release No. 50104 (July 28, 2004), 69 FR 48032 (August 6, 2004). The remaining Russell 3000 securities are included as control stocks. To eliminate the potential confounding influence of index inclusion or exclusion, we require that sample stocks be members of the Russell 3000 Index after the June 2004 reconstitution and remain as members after the June 2005 reconstitution. After merging the option-, stock-, and firm-related data, the sample contains 1,049 firms, with 362 pilot firms and 687 control firms.

Panel A of Table 2 reports the firm characteristics for both pilot stocks and control stocks. There are 44,424 pilot firm-day observations and 84,325 control firm-day observations. The two groups exhibit similar mean and median values for firm size, stock price, book-to-market ratio, daily stock trading volume, stock return volatility, stock return skew, and institutional ownership. Panel B shows the options characteristics. We find that pilot and control firms are quite comparable in terms of the options relative bid-ask spread, implied volatility, time-to-maturity, and options volume. Panels A and B provide support for the contention that Regulation SHO's pilot program is a well-controlled experiment that is suitable for examining the effects of short-sale constraints.

[Insert Table 2 Here]

#### **4. The validity of Regulation SHO as exogenous shocks to short-sale constraints**

Before investigating the impact of Rule 203 and Rule 202T on the options markets, we first examine whether these rules affect short-sale constraints by testing the change of short interests or short-sale volume before and after the implementation of the rules. In Section 4.1, we examine the validity of Rule 203 as an exogenous increase in short-sale constraints. In Section 4.2, we examine the validity of Rule 202T as an exogenous decrease in short-sale constraints.

##### **4.1 Does short selling decrease after Rule 203?**

To examine the validity of Rule 203 as an exogenous increase to short-sale constraints, we test the change of relative short interests before and after the effective date of Rule 203 (January 3, 2005).<sup>12</sup> If the locate and close-out requirements increase short-sale constraints, there would be a decrease in short interests after the implementation of Rule 203. In addition, the decrease in short interests is expected to be larger for stocks with exchange-traded options (optionable stocks) than those without exchange-traded options (non-optionable stocks). The rationale is that the would-be naked short sellers of stocks with exchange-traded options could stay in the stock markets and conduct covered short selling, or move to the options markets, or do not trade at all. In contrast, the naked short sellers of stocks without exchange-traded options could only either stay in the stock markets or quit trading.

Table 3 shows the impact of Rule 203 on the relative short interests of optionable and non-optionable stocks in the 2004 Russell 3000 Index. The dependent variable is the short interest scaled by shares outstanding (in percentage). The control variables include firm size, book-to-market ratio, stock bid-ask spread, stock turnover, last month stock return, stock return volatility,

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<sup>12</sup> Short interest data are on a monthly basis. Daily short-sale volume data are not available before year 2005.

stock return skew, institutional ownership, and the 12 Fama-French industry fixed effects. The standard errors are two-way clustered by firm and month. Column (1) shows how short interests change after Rule 203 for stocks with exchange-traded options. We find a negative and significant coefficient on variable Rule 203, suggesting a significant decrease in short interests under the locate and delivery requirements. This result supports the argument that the locate and delivery requirements of Rule 203 indeed increase short-sale costs, resulting in a reduction in short selling activities.

[Insert Table 3 Here]

We further examine two possible explanations for the decrease in short interests for optionable stocks: (1) the would-be naked short sellers quit the market and do not trade at all when facing higher short-sale costs, or (2) the would-be naked short sellers migrate to the options markets to take bearish positions. To help differentiate these two explanations, we test how short interests of non-optionable stocks change after Rule 203. A significant decrease in the short interests of non-optionable stocks would lend support to the first explanation, while no significant change for non-optionable stocks would lend support the second explanation. The results in column (2) of Table 3 show an insignificant coefficient on Rule 203, indicating no significant change in short interests of non-optionable stocks after Rule 203 goes into effect. This supports the second explanation.

Taking together, the results of short interests for both optionable and non-optionable stocks not only provide confirmation of Rule 203 being an exogenous increase to short-sale constraints but also offer preliminary evidence for the substitution relation between stock short selling and options trading.

## 4.2 Does short selling increase after Rule 202T?

To examine the validity of Rule 202T as an exogenous decrease to the short-sale constraints of pilot stocks, we test the change in the short-sale activity of pilot stocks (relative to control stocks) before and during the pilot program. If the removal of the short-sale price tests relaxes short-sale constraints, then there will be an increase in the short-sale volume of pilot stocks (relative to the control stocks) after the effective date of the pilot program (May 2, 2005).

We first compare the short selling activities of pilot and control stocks before and during the pilot program. Panel A of Table 4 shows the mean and median of the daily short-sale volume, short-sale volume as a fraction of stock trading volume, and short trade size for pilot and control stocks during the three months before and the three months after the start of the pilot program. For pilot stocks, the mean and median of the number of shares sold are similar before and during the pilot program. However, there is a slight decrease in the number of shares sold short of control firms. As to the relative short-sales (short-sale volume divided by stock trading volume), there is a slight increase in both the mean and median values for pilot stocks, but not for control stocks. In addition, there is a 15% decrease in the short trade size for pilot stocks and only a 4% decrease for control stocks. Therefore, the results indicate that after removing short-sale price tests, short-sale volume increases and short sellers engage more heavily in order splitting.

[Insert Table 4 Here]

Next, we test the statistical significance of the change in short-sale volume. The regression results are in Panel B of Table 4. The dependent variable is the number of shares sold short (in thousands). The variable of interest is *PilotStock\*Post*, which is the interaction between the pilot stock dummy and the Post dummy. As shown in column (1), without adding any control variables, the coefficient of *PilotStock\*Post* is positive and significant ( $t$ -statistic = 6.96). This suggests that

the short-sale volume of pilot stocks increases significantly (relative to control stocks) after the removal of the short-sale price tests. As to the economic magnitude, the relative increase in the short-sale volume of pilot stocks is about 4.4% of the mean short-sale volume during the three months before the pilot program. We add control variables to the regression to test whether the results still hold. The control variables include firm size, market-to-book ratio, stock bid-ask spread, stock trading volume, last month stock return, stock return volatility, stock return skew, and institutional ownership. As shown in column (2), the coefficient of *PilotStock\*Post* is still positive and significant ( $t$ -statistic = 2.31). After controlling for firm- and stock-related characteristics, the relative increase in the short-sale volume of pilot stocks is about 7.2% of the mean short-sale volume during the three months before the pilot program. Overall, the significant increase in the short-sale volume of pilot stocks supports the use of the pilot program as an exogenous decrease to the costs of selling short in pilot firms.

## **5. How does Regulation SHO affect options trading volume?**

### **5.1 The impact of Rule 203 on the options trading volume**

#### **5.1.1 Multivariate analysis**

Rule 203 of Regulation SHO requires all broker-dealers to locate or borrow securities before executing short sales and to deliver upon and close-out short positions in which short sellers have prolonged fails-to-deliver. Consequently, naked short selling is expected to decrease under Rule 203. If the would-be naked short sellers continue to take short positions in the stock markets, they incur the costs of locating and negotiating securities for lending, posting margins, and paying lending fees to the lender. They also face the risk of a short squeeze due to an involuntary closure of the stock loan (the short seller is unable to find an alternative supply of stocks in the event the

loan is closed). Given the exogenous increase in short-sale costs due to the locate and close-out requirements, some would-be naked short sellers may migrate to the options markets to take short positions by either buying put options or selling call options. Our first hypothesis is that there will be an increase in the options trading volume after the implementation of Rule 203. To test this hypothesis, we perform the following pooled OLS regression:

$$\begin{aligned}
 OptionVolume = & \beta_0 + \beta_1 Rule203 + \beta_2 Ln(Size) + \beta_3 BM\_Ratio + \beta_4 Stock\_Bid - ask\_Spread \\
 & + \beta_5 Stock\_Volume + \beta_6 Last\_Month\_Stock\_Return + \beta_7 Stock\_Return\_Volatility \\
 & + \beta_8 Stock\_Return\_Skew + \beta_9 Institutional\_Ownership + \beta_{10} VIX \\
 & + \beta_{11} S \& P500\_Index\_Return + \beta_{12} Stock\_Return + IndustryFixedEffects + \varepsilon.
 \end{aligned} \tag{1}$$

In Equation (1), we regress the daily aggregated options volume (*Option Volume*) on the dummy variable for Rule 203 (*Rule203*). The control variables include a series of firm-level characteristics and market-level conditions: the natural logarithm of firm size at the end of the last calendar month (*Ln(Size)*), the book-to-market ratio at the end of the last calendar year (*BM Ratio*), the stock bid-ask spread (*Stock Bid-ask Spread*), defined as the closing ask less the closing bid and divided by the midpoint, the daily stock trading volume (*Stock Volume*), the cumulative stock return over the previous month (*Last Month Stock Return*), stock return volatility in the previous month (*Stock Return Volatility*), the skewness of daily stock returns in the previous month (*Stock Return Skew*), the institutional ownership ratio (*Institutional Ownership*), which is defined as institutional holdings divided by the total number of shares outstanding at the last quarter end, the market uncertainty proxied by the VIX (*VIX*), the market return measured by the return on the S&P 500 Index (*S&P 500 Index Return*), and the daily stock return (*Stock Return*). The 12 Fama-French industry fixed effects are also included. The estimated standard errors are two-way clustered by firm and date.

We expect a significant and positive coefficient on Rule 203 in the options volume regression. Such a finding would suggest that an increase in short-sale costs after Rule 203 is accompanied by an increase in options volume, supporting the substitution relationship between short sales and options trading.

Table 5 presents the estimated coefficients for the options volume regressions (at the stock level). The dependent variable is the daily aggregated options volume (in thousands). The results for calls and puts are reported separately. For call options, the coefficient of Rule 203 is significantly positive (coefficient = 0.131,  $t$ -statistic = 2.09). This indicates that the daily call options volume on average increased by 131 or 13.2% after Rule 203.<sup>13</sup> For put options, the coefficient of Rule 203 is also significantly positive (coefficient = 0.128,  $t$ -statistic = 3.10). This indicates that the daily put options volume on average increased by 128 or 21.8%.<sup>14</sup> Overall, we find that as short-sale costs increase after Rule 203, investors shift their demand from the stock markets to the options markets. In addition, the larger proportionate increase in put options volume relative to call options volume implies that buying put options is preferred to selling call options as a substitute for shorting stocks.

[Insert Table 5 Here]

### **5.1.2 Multivariate analysis partitioned by institutional ownership**

In this section, we investigate whether the positive effect of Rule 203 on options volume is related to the level of institutional ownership of the firm. Institutional ownership is typically associated with the availability of shares that makes short selling feasible. When institutional

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<sup>13</sup> 131/998 is 13.2%, where 998 is the mean value of daily call options volume in the three-month period before the implementation of Rule 203.

<sup>14</sup> 128/588 is 21.8%, where 588 is the mean value of daily put options volume in the three-month period before the implementation of Rule 203.

ownership is low, stock loan supply tends to be sparse and stock lending is more expensive (e.g., Chen, Hong, and Stein, 2002; Nagel, 2005; Hirshleifer, Teoh, and Yu, 2011). This will affect the positive effect of Rule 203 on options volume in two possible ways (that are not exclusive to each other). First, the scarcity and expensiveness of a stock loan in firms with low institutional ownership will lead to a higher level of naked short selling before the locate and delivery requirements are in place.<sup>15</sup> Rule 203, which intends to curb naked short selling, is expected to have a more pronounced effect on firms with a higher level of naked short selling before the rule went into effect. Thus, we expect the positive impact of Rule 203 on options volume to be higher among firms with lower institutional ownership. Second, the decision of would-be naked short sellers to migrate to the options markets depends on the incremental costs related to covered short selling (such as searching costs, stock lending fees, etc.). For stocks that are easy to borrow, the increase in options trading volume will be smaller because the incremental costs associated with covered short selling are small and short sellers are more likely to remain in the stock markets and do covered short selling. Stated differently, the positive impact of Rule 203 on options trading volume is expected to be greater for firms with lower institutional ownership since the incremental costs associated with covered short selling are larger, which may drive investors to the options markets.

To test this conjecture, we partition the sample into two subsamples based on whether a firm's institutional ownership is above or below the sample median. Institutional ownership data are retrieved from Thomson's CDA/Spectrum database (form 13F) and aggregated on the firm

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<sup>15</sup> Boni (2006) documents that the likelihood of persistent fails-to-deliver (a proxy for naked short selling) decreases with institutional ownership.

level. We define institutional ownership as the shares held by all institutions divided by the total shares outstanding at the end of the quarter from CRSP monthly files.

Table 6 reports the results from re-estimating Equation (1) using these two subsamples. The results for the call and put options are displayed separately. Consistent with our conjecture, the impact of Rule 203 on options trading volume is more pronounced among firms with low levels of institutional ownership. Columns (2) and (4) show that there is no significant effect among firms with above median levels of institutional ownership. The results hold for both call and put options, but are stronger for put options. Among firms with lower levels of institutional ownership, the magnitude of the effect is about 36% (74%) higher than that reported in Table 5 for the overall call (put) options sample.

[Insert Table 6 Here]

### **5.1.3 Multivariate analysis partitioned by options transaction costs**

As widely documented in the literature, the transaction costs (e.g., bid-ask spread) in options markets are much higher than those in stock markets. For example, Govindaraj, Li, and Zhao (2015) show that the relative bid-ask spread of liquid at-the-money options is on average as high as 20%. In contrast, the average relative bid-ask spread of the underlying stocks is only 0.6%. As options transaction costs directly reduce the profit of trading options, it will also affect whether investors will trade in stock markets or options markets (e.g., Easley, O'Hara, and Srinivas 1998; Chakravarty, Gulen, and Mayhew 2004). The larger the bid-ask spread in the options markets, the less likely that investors will choose to trade in the options markets. Consequently, we expect the positive impact of Rule 203 on options trading volume to be more pronounced for firms with low options bid-ask spreads.

To test this conjecture, we partition the sample of into two subsamples based on whether a firm's daily equal-weighted options bid-ask spread is above or below the sample median. For each option contract, the bid-ask spread is calculated as the end-of-day ask price minus the bid price then divided by the mid-point. It is then aggregated at the stock-day level by taking the equal-weighted average across all call (put) options with the same underlying stock.

Table 7 reports the results from re-estimating Equation (1) using these two subsamples. The results for the call and put options are displayed separately. Consistent with our conjecture, the impact of Rule 203 on options trading volume is more pronounced among firms with lower options bid-ask spreads. Columns (2) and (4) show that there is no significant effect among firms with an above median value of the options bid-ask spread. The results hold for both call and put options, but are much stronger for put options. Among firms with lower options bid-ask spreads, the magnitude of the effect is about 19% (108%) higher than that reported in Table 5 for the overall call (put) options sample.

[Insert Table 7 Here]

## **5.2 The impact of Rule 202T on the options trading volume**

Under the pilot program of Rule 202T, pilot stocks are traded without short-sale price tests. The increase in the short-sale volume of pilot stocks provides evidence that removing price tests reduces short-sale constraints. In this subsection, we investigate whether investors would migrate from options markets to stock markets when they are faced with lower short-sale constraints due to the removal of price tests. To test this, we perform the following pooled OLS regression:

$$\begin{aligned}
OptionVolume = & \beta_0 + \beta_1 PilotStock * Post + \beta_2 PilotStock + \beta_3 Post + \beta_4 Ln(Size) + \beta_5 BM\_Ratio \\
& + \beta_6 Stock\_Bid - ask\_Spread + \beta_7 Stock\_Volume + \beta_8 Last\_Month\_Stock\_Return \\
& + \beta_9 Stock\_Return\_Volatility + \beta_{10} Stock\_Return\_Skew + \beta_{11} Institutional\_Ownership \\
& + \beta_{12} VIX + \beta_{13} S \& P500\_Index\_Return + \beta_{14} Stock\_Return + IndustryFixedEffects + \varepsilon.
\end{aligned} \tag{2}$$

In Equation (2), the dependent variable is the options volume aggregated over all classes of options for each underlying stock on a daily basis (*Option Volume*). *PilotStock* is an indicator variable that is equal to 1 for pilot firms and 0 for control firms. *Post* is an indicator variable that is equal to 1 for the three months immediately after the effective date of the pilot program and 0 for the three months before the effective date. The variable of interest is *PilotStock\*Post*, which is the interaction between *PilotStock* and *Post*. A negative and significant coefficient on *PilotStock\*Post* indicates that the removal of price tests drives investors from the options markets to the stock markets. The control variables are the same as those in Equation (1). The coefficients are estimated using daily stock-level data. The estimated standard errors are two-way clustered by firm and date.

Table 8 presents the estimated coefficients for Equation (2). The dependent variable is the daily aggregated options volume (in thousands). The results for calls and puts are reported separately. Without adding any control variables, the coefficient of *PilotStock\*Post* is negative but insignificant for both call and put options, as shown in columns (1) and (3). After controlling for firm characteristics, market conditions, and the 12 Fama-French industry fixed effects, the coefficients on *PilotStock\*Post* are still negative and insignificant, as shown in columns (2) and (4). Overall, the options volume results provide no statistical evidence that decreases in short-sale constraints as a result of the removal of price tests would drive investors away from the options markets and to the equity markets to trade. One possible explanation is that removing short-sale

price tests enables stock short-sellers to trade more actively in the stock markets, as indicated by more order splitting and more frequent trades for pilot stocks during the pilot program. However, these changes may not be appealing enough for investors in the options markets, which offer many other advantages such as high leverage over the stock markets, to switch.

[Insert Table 8 Here]

Overall, when short-sale constraints become tight as a result of the locate and delivery requirements, stock investors would substitute stock short selling with options trading. However, when short-sale constraints are relaxed due to the removal of price tests, options investors do not substitute the bearish option positions with stock short sales. These results indicate that the substitutability is not symmetric or the effects of increasing and relaxing short-sale constraints on options volume are not symmetric.

## **6. Additional Analysis**

### **6.1 The impact of Rule 203 on the bid-ask spreads of options**

During the 2008 short-sale ban, there is evidence of substantial increases in the options bid-ask spreads resulting from the higher hedging costs of options market makers (e.g., Battalio and Schultz 2011; Grundy, Lim, and Verwijmeren 2012). The significant increase in the options bid-ask spreads further discourages options volume and leads to a complementary relation between short sales and options trading.

In this section, we examine whether there is a significant change in options bid-ask spreads after the implementation of Rule 203. As options market makers are exempted from the locate and certain close-out requirements when doing bona fide market making, the hedging costs of market makers will not change significantly. Consequently, we expect no significant change in the options

bid-ask spreads after the implementation of Rule 203. To test this conjecture, we perform the following pooled OLS regression at the option-day level:

$$\begin{aligned}
Basp = & \beta_0 + \beta_1 Rule203 + \beta_2 Dummy \times Moneyness + \beta_3 [Dummy \times Moneyness]^2 \\
& + \beta_4 (1 - Dummy) \times Moneyness + \beta_5 [(1 - Dummy) \times Moneyness]^2 + \beta_6 (Maturity)^{-1} \\
& + \beta_7 Ln(Size) + \beta_8 BM\_Ratio + \beta_9 Stock\_Bid - ask\_Spread + \beta_{10} Stock\_Volume \\
& + \beta_{11} Last\_Month\_Stock\_Return + \beta_{12} Stock\_Return\_Volatility \\
& + \beta_{13} Stock\_Return\_Skew + \beta_{14} Institutional\_Ownership + \beta_{15} VIX \\
& + \beta_{16} S \& P500\_Index\_Return + \beta_{17} Stock\_Return + IndustryFixedEffects + \varepsilon.
\end{aligned} \tag{3}$$

In Equation (3), the options relative bid-ask spread (*Basp*) is regressed on the dummy variable for Rule 203 (*Rule203*). The options relative bid-ask spread is the closing ask price minus the closing bid price divided by the midpoint. Following Grundy, Lim, and Verwijmeren (2012), we control for various option-level characteristics. *Dummy* is a dummy variable that equals 1 if the options strike price is no greater than the underlying stock price and 0 otherwise. *Moneyness* is  $Ln(StockPrice / StrikePrice) / (IV_{ATM} * \sqrt{Maturity})$ , where *StockPrice* is stock price, *StrikePrice* is strike price,  $IV_{ATM}$  is the implied volatility of the at-the-money options on the same stock with an identical observation date, strike price, and expiration date, and *Maturity* is the number of days to the option's expiration date. This variable describes how much an option contract is in or out of the money. In addition, we control for the same firm-level and market-level explanatory variables that we use in Equation (1). In both regressions, the 12 Fama-French industry fixed effects are also included. The estimated standard errors are two-way clustered by firm and date.

Table 9 presents the estimated coefficients for the options relative bid-ask spread regressions (at the option level). The results for call and put options are reported separately. In contrast to the significant increase in options bid-ask spreads during the 2008 short-sale ban, we

find no significant change in relative bid-ask spreads after Rule 203 went into effect for both call and put options. This reconciles our finding that short sales and options trading are substitutes in the setting of Rule 203, with studies that show complements in the setting of the 2008 short-sale ban.

[Insert Table 9 Here]

## 6.2 The impact of Rule 202T on options bid-ask spreads

In this section, we examine whether there is a significant change in the options bid-ask spreads of pilot stocks (relative to control stocks) during the pilot program. To test this, we perform the following pooled OLS regression:

$$\begin{aligned}
 Basp = & \beta_0 + \beta_1 PilotStock * Post + \beta_2 PilotStock + \beta_3 Post + \beta_4 Dummy \times Moneyness \\
 & + \beta_5 [Dummy \times Moneyness]^2 + \beta_6 (1 - Dummy) \times Moneyness \\
 & + \beta_7 [(1 - Dummy) \times Moneyness]^2 + \beta_8 (Maturity)^{-1} + \beta_9 Ln(Size) \\
 & + \beta_{10} BM\_Ratio + \beta_{11} Stock\_Bid\_ask\_Spread + \beta_{12} Stock\_Volume \\
 & + \beta_{13} Last\_Month\_Stock\_Return + \beta_{14} Stock\_Return\_Volatility \\
 & + \beta_{15} Stock\_Return\_Skew + \beta_{16} Institutional\_Ownership + \beta_{17} VIX \\
 & + \beta_{18} S \& P500\_Index\_Return + \beta_{19} Stock\_Return + IndustryFixedEffects + \varepsilon.
 \end{aligned} \tag{4}$$

In Equation (4), the dependent variable is the options relative bid-ask spread (*Basp*), defined as the closing ask price minus the closing bid price divided by the midpoint. The variable of interest is *PilotStock\*Post*. A negative coefficient on *PilotStock\*Post* suggests that market makers decrease the options bid-ask spreads after the lifting of short-sale price restrictions. The control variables are the same as those in Equation (3). The coefficients are estimated using daily option-level data. The estimated standard errors are two-way clustered by firm and date.

Table 10 presents the estimated coefficients for the options relative bid-ask spreads regressions. The results for call (put) options are reported in the first (last) two columns. Without adding any control variables, the coefficient of *PilotStock\*Post* is positive but insignificant for both call and put options, as shown in columns (1) and (3). After controlling for options characteristics, firms characteristics, market conditions, and the 12 Fama-French industry fixed effects, the coefficients on *PilotStock\*Post* are still positive but insignificant (as shown in columns (2) and (4)). Thus, we find no evidence that pilot firms experience significant changes in options bid-ask spreads during the first three months of the pilot program (relative to control firms).

[Insert Table 10 Here]

## 7. Conclusion

In this study, we investigate the effects of stock short-sale constraints on options trading by exploiting two SEC rules under Regulation SHO: Rule 203 and Rule 202T. Consistent with the conjecture that Rule 203 tightens short-sale constraints, we find significant decreases in the short interests of optionable stocks after Rule 203 went into effect on January 3, 2005. The trading volume of call and put options increased significantly after the implementation of Rule 203. This result is more pronounced among firms with lower levels of institutional ownership and smaller options bid-ask spreads. Overall, the evidence from Rule 203 suggests that investors use options as substitutes for stock short sales when short selling is less feasible or more costly due to locate and delivery requirements. We also find a significant increase in the short-sale volume of pilot stocks relative to that of control stocks, supporting the validity of Rule 202T as an exogenous decrease in short-sale constraints of pilot stocks. Although the exemption of short-sale price tests relaxes short-sale constraints, we find no significant change in the options trading volume of pilot

stocks (relative to control stocks) during the pilot program of Rule 202T from May 2, 2005 to August 6, 2007. Overall, the evidence from Rule 202T suggests that shorting stocks without price restrictions may not be appealing enough for option investors to move to the stock markets to take bearish positions.

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**Appendix: Comparison of locate and close-out requirements before and after Rule 203**

	<b>Before Rule 203</b>	<b>After Rule 203</b>
<b>Locate requirement</b>	<p>Prior to short selling, there must be arrangements or acceptable assurances that the stock can be borrowed and delivered on the settlement date.</p> <p>Exempt: Equity market makers Options market makers Hedgers Arbitragers</p>	<p>Prior to short selling, there must be arrangements or acceptable assurances that the stock can be borrowed and delivered on the settlement date.</p> <p>Exempt: Equity market makers Options market makers (but only in connection with bona fide market making activities)</p>
<b>Close-out requirement</b>	<p>For NASDAQ stocks with fails of at least 0.5% of shares outstanding and 10,000 shares, positions that have failed for at least 10 days must be closed out.</p> <p>Exempt: Equity market makers Options market makers Hedgers Arbitragers</p>	<p>For stocks issued by Section 12 and Section 15(d) filers (i.e., stocks listed on NYSE, AMEX, NASDAQ; OTCBB stocks; and stocks of Pink Sheet filers) with total fails of at least 0.5% of shares outstanding and 10,000 shares for five consecutive days (i.e., “threshold” stocks), positions that have failed for at least 10 days must be closed out.</p> <p>Exempt: Pre-existing fail positions; New short sales that are options market makers’ hedges for preexisting option positions.</p>
<b>Others</b>	<p>NASD rules prohibit further short selling by those with fails-to-deliver of that security for at least 60 days.</p>	<p>Those with fails of at least 10 days in the above “threshold” stocks cannot make further short sales until the fail position is closed out unless the stock has been already borrowed (or arranged to borrow).</p>

**Table 1: Summary statistics of Rule 203 sample**

This table reports the summary statistics of the Rule 203 sample. The sample contains 1,040 firms and covers the period from October 1, 2004 to March 31, 2005. Panel A displays firm characteristics at the firm-day level. Panel B shows characteristics for call and put options at the option contract-day level. *Size* is the market value of equity, expressed in billion dollars. *Stock Price* is the end-of-day stock price. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Volume* is the daily stock trading volume, expressed in millions. *Stock Return Volatility* is the standard deviation of daily returns in the previous month multiplied by square root of 252/30 (annualized). *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. *Relative Bid-ask Spread* is defined as the closing options ask price minus the closing bid price then divided by the midpoint. *Implied Volatility* is the volatility implied from the options price. *Time-to-Maturity* is the number of days to expiration. *Trading Volume per Option* is the daily options volume for each option contract. *Trading Volume per Stock* is the daily aggregated options volume for the same underlying stock.

## Panel A: Firm characteristics

Variable	<i>N</i>	Mean	SD	5th	25th	Median	75th	95th
Size (in billions \$)	127,411	9.06	27.08	0.28	0.82	2.11	6.32	32.21
Stock Price	127,411	33.59	20.28	6.85	17.9	30.59	44.75	71.2
BM Ratio	127,411	0.40	0.26	0.09	0.23	0.36	0.54	0.83
Stock Volume (in millions)	127,411	1.68	5.49	0.08	0.24	0.54	1.34	5.55
Stock Return Volatility	127,411	0.33	0.15	0.16	0.22	0.30	0.42	0.62
Stock Return Skew	127,411	0.14	1.01	-1.43	-0.36	0.12	0.61	1.84
Institutional Ownership	127,411	0.75	0.20	0.38	0.63	0.78	0.89	1.00

## Panel B: Options characteristics

	Call Options				Put Options			
	<i>N</i>	Mean	Median	SD	<i>N</i>	Mean	Median	SD
Relative Bid-ask Spread	1,435,480	0.115	0.074	0.110	1,284,064	0.136	0.092	0.121
Implied Volatility	1,435,480	0.351	0.323	0.153	1,284,064	0.363	0.329	0.166
Time-to-Maturity	1,435,480	129	116	87	1,284,064	131	117	88
Trading Volume per Option	1,435,480	92	0	767	1,284,064	63	0	469
Trading Volume per Stock	126,637	1,044	41	5,027	124,571	645	11	2,860

**Table 2: Summary statistics of the Rule 202T sample**

This table reports the summary statistics of Rule 202T sample. The sample contains 1,049 firms (362 pilot firms and 687 control firms) and covers the period from February 1, 2005 to July 31, 2005. Panel A displays firm characteristics at the firm-day level. Panel B shows characteristics for call and put options at the option contract-day level. *Size* is the market value of equity, expressed in billion dollars. *Stock Price* is the end-of-day stock price. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Volume* is the daily stock trading volume, expressed in millions. *Stock Return Volatility* is the standard deviation of daily returns in the previous month multiplied by square root of 252/30 (annualized). *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. *Relative Bid-ask Spread* is defined as the closing options ask price minus the closing bid price and then divided by the midpoint. *Implied Volatility* is the volatility implied from the options price. *Time-to-Maturity* is the number of days to expiration. *Trading Volume Per Option* is the daily options volume for each option contract. *Trading Volume per Stock* is the daily aggregated options volume for the same underlying stock.

## Panel A: Firm characteristics

Variable	<i>N</i>	Mean	SD	5th	25th	Median	75th	95th
Pilot Firms								
Size (in billions \$)	44,424	9.01	23.91	0.26	0.81	2.06	6.84	42.07
Stock Price	44,424	32.93	20.32	6.52	17.5	29.69	44.13	71.92
BM Ratio	44,424	0.40	0.25	0.10	0.23	0.37	0.55	0.86
Stock Volume (in millions)	44,424	1.69	5.09	0.09	0.26	0.56	1.33	5.82
Stock Return Volatility	44,424	0.34	0.14	0.16	0.22	0.31	0.42	0.59
Stock Return Skew	44,424	0.17	0.99	-1.35	-0.3	0.16	0.64	1.8
Institutional Ownership	44,424	0.75	0.22	0.34	0.62	0.78	0.90	1.00
Control Firms								
Size (in billions \$)	84,325	9.30	28.8	0.28	0.88	2.23	6.27	32.13
Stock Price	84,325	34.59	20.81	6.30	18.62	31.97	46.36	73.53
BM Ratio	84,325	0.41	0.28	0.09	0.24	0.36	0.55	0.87
Stock Volume (in millions)	84,325	1.65	4.87	0.09	0.25	0.56	1.38	5.47
Stock Return Volatility	84,325	0.32	0.14	0.16	0.21	0.29	0.39	0.6
Stock Return Skew	84,325	0.18	0.99	-1.35	-0.31	0.15	0.64	1.86
Institutional Ownership	84,325	0.77	0.2	0.41	0.66	0.80	0.91	1.00

Panel B: Options characteristics

	Call Options				Put Options			
	<i>N</i>	Mean	Median	SD	<i>N</i>	Mean	Median	SD
Pilot Firms								
Relative Bid-ask Spread	529,702	0.118	0.075	0.112	483,460	0.133	0.088	0.120
Implied Volatility	529,702	0.343	0.318	0.141	483,460	0.36	0.327	0.166
Time-to-Maturity	529,702	145	141	89	483,460	144	138	90
Trading Volume per Option	529,702	91	0	883	483,460	64	0	453
Trading Volume per Stock	43,933	1,098	43	5,002	43,521	710	13	2,884
Control Firms								
Relative Bid-ask Spread	986,897	0.116	0.074	0.112	889,972	0.137	0.092	0.121
Implied Volatility	986,897	0.327	0.302	0.133	889,972	0.34	0.309	0.153
Time-to-Maturity	986,897	143	137	88	889,972	144	138	89
Trading Volume per Option	986,897	85	0	675	889,972	61	0	478
Trading Volume per Stock	83,466	1,009	43	4,555	82,333	661	15	3,051

**Table 3: How does Rule 203 influence short selling activities?**

In this table, we show the impact of Rule 203 on the short interests of 2004 Russell 3000 firms with and without exchange-traded options. The samples period is from October 1, 2004 to March 31, 2005. Regressions are performed at the firm-month level. The dependent variable is the short interest as of the midmonth reporting date scaled by shares outstanding, expressed in percentage. *Rule203* is a dummy variable that is equal to 1 if the observation date is between January 1, 2005 and March 31, 2005, and equal to 0 if the observation date is between October 1, 2004 and December 31, 2004. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is defined as the closing ask less the closing bid and divided by the midpoint (expressed in percentage), averaged over the prior month. *Stock Turnover* is the daily stock volume divided by shares outstanding (expressed in percentage), averaged over the prior month. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month (expressed in percentage). *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and month. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level, respectively.

	Optionable Stocks	Non-optionable Stocks
	(1)	(2)
Rule203	-0.200** (-2.18)	0.048 (0.23)
Ln(Size)	-1.266*** (-7.27)	-0.658*** (-3.11)
BM Ratio	-1.347*** (-2.93)	-1.968*** (-4.98)
Stock Bid-ask Spread	0.035 (0.11)	-0.027 (-0.24)
Stock Turnover	3.924*** (6.71)	3.238*** (5.94)
Last Month Stock Return	3.592*** (4.71)	1.610* (1.91)
Stock Return Volatility	-0.681 (-1.20)	-0.310 (-0.96)
Stock Return Skew	0.028 (0.29)	-0.033 (-0.41)
Institutional Ownership	8.242*** (6.25)	4.744*** (6.05)
Intercept	40.791*** (2.87)	12.902*** (2.94)
Industry FE	Yes	Yes
$R^2$	0.25	0.55
$N$	10,336	4,806

**Table 4: How does Rule 202T influence short selling activities?**

In this table, we show the impact of Rule 202T on short selling activities in the stock markets. Panel A shows the summary statistics for short selling activities before (from February 1, 2005 to April 30, 2005) and during (from May 1, 2005 to July 31, 2005) the pilot program at the firm-day level. *Shares Sold Short* is the daily short-sale volume, expressed in thousands. *Relative Short Sales* is the daily short-sale volume divided by the daily stock trading volume, expressed in percentage. *Trade Size* is the number of shares sold short in each trade. Panel B reports pooled OLS regression results at the firm-day level. The sample contains 1,049 firms and covers the period from February 1, 2005 to July 31, 2005. The dependent variable is the daily short-sale volume, expressed in thousands. *Pilot Stock* is a dummy variable, equals one if a firm's stock is designated as pilot stock in the Regulation SHO's pilot program and zero otherwise. *Post* is a dummy variable, which is equal to 1 if the observation date is between May 1, 2005 and July 31, 2005, and equal to 0 if the observation date is between February 1, 2005 and April 30, 2005.  $\ln(\text{Size})$  is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is defined as the closing ask less the closing bid and divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level, respectively.

Panel A: Short selling activities before and during the pilot program

	Pilot stocks				Control Stocks			
	Before		During		Before		During	
	Mea n	Media n	Mea n	Media n	Mea n	Media n	Mea n	Media n
Shares Sold Short (1,000 shares)	288.1	104.8	285.5	104.9	286.5	106.5	270.6	97.0
Relative Short Sales (%)	19.5	18.0	20.9	19.4	19.8	18.2	19.5	18.1
Trade Size (shares)	452.1	366.8	452.1	307	452.3	365.8	439.4	346.6
<i>N</i>	22,140		22,619		42,211		42,998	

Panel B: Regression analysis

	(1)	(2)
Pilot Stock* Post	12.55*** (6.96)	20.87** (2.31)
Pilot Stock	9.19 (0.22)	-6.78 (-0.77)
Post	-16.06** (-2.50)	-7.46 (-1.57)
Ln(Size)		13.95 (1.44)
BM Ratio		8.06 (0.41)
Stock Bid-ask Spread		-29.53*** (-2.68)
Stock Volume		145.85*** (20.75)
Last Month Stock Return		239.51*** (9.27)
Stock Return Volatility		123.65** (2.51)
Stock Return Skew		-14.46*** (-5.92)
Institutional Ownership		51.53*** (3.05)
Intercept	182.76*** (7.10)	-343.09 (-1.51)
Industry FE	Yes	Yes
R <sup>2</sup>	0.03	0.89
N	129,968	129,968

**Table 5: How does Rule 203 influence options volume?**

In this table, we show the impact of Rule 203 on the options volume. The sample contains 1,040 firms and covers the period from October 1, 2004 to March 31, 2005. Pooled OLS regressions are performed at the firm-day level and results are reported for call and put options separately. The dependent variable is the daily aggregated options volume (in thousands). *Rule203* is a dummy variable that is equal to 1 if the observation date is between January 1, 2005 and March 31, 2005 and equal to 0 if the observation date is between October 1, 2004 and December 31, 2004. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is the closing ask less the closing bid divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 Index. *Stock Return* is the daily stock return. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level.

	Call Options	Put Options
Rule203	0.132** (2.09)	0.128*** (3.10)
Ln(Size)	0.596*** (5.57)	0.460*** (6.69)
BM Ratio	0.192 (0.87)	0.183 (1.22)
Stock Bid-ask Spread	-0.172 (-1.49)	-0.100 (-1.33)
Stock Volume	0.505*** (7.30)	0.255*** (5.45)
Last Month Stock Return	1.224** (2.10)	0.065 (0.18)
Stock Return Volatility	4.448*** (4.44)	3.143*** (4.58)
Stock Return Skew	-0.040 (-1.30)	-0.027 (-1.34)
Institutional Ownership	-0.247 (-1.15)	-0.053 (-0.34)
VIX	0.016 (0.81)	0.029*** (2.61)
SP 500 Index Return	-0.360 (-0.12)	1.897 (1.12)
Stock Return	5.870*** (4.65)	-2.590*** (-3.69)
Intercept	-14.253*** (-5.45)	-11.238*** (-6.62)
Industry FE	Yes	Yes
R <sup>2</sup>	0.39	0.36
N	126,637	124,571

**Table 6: The change of options volume after Rule 203, partitioned by institutional ownership**

In this table, we show the impact of Rule 203 on options trading volume for subsamples of firms with institutional ownership above or equal to the sample (High) or below (Low) the sample median. The subsamples contain 1,040 firms and cover the period from October 1, 2004 to March 31, 2005. Pooled OLS regressions are performed at the firm-day level and results are reported for call and put options separately. The dependent variable is the daily aggregated options volume (in thousands). *Rule203* is a dummy variable, which is equal to 1 if the observation date is between January 1, 2005 and March 31, 2005, and equal to 0 if the observation date is between October 1, 2004 and December 31, 2004. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is defined as the closing ask less the closing bid and divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional ownership* is defined as institutional holdings divided by the total number of outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 Index. *Stock Return* is the daily stock return. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level.

	Call Options		Put Options	
	Institutional Ownership		Institutional Ownership	
	Low (1)	High (2)	Low (3)	High (4)
Rule203	0.179* (1.68)	0.074 (1.52)	0.223*** (2.91)	0.021 (1.02)
Ln(Size)	0.813*** (5.69)	0.070 (1.43)	0.586*** (6.36)	0.127*** (2.63)
BM Ratio	0.174 (0.46)	-0.035 (-0.23)	0.188 (0.69)	0.063 (0.76)
Stock Bid-ask Spread	-0.285 (-1.27)	-0.041 (-0.84)	-0.155 (-1.06)	-0.039 (-1.18)
Stock Volume	0.481*** (6.99)	0.742*** (12.91)	0.239*** (5.17)	0.430*** (8.39)
Last Month Stock	1.749* (1.74)	0.750** (2.37)	0.196 (0.30)	0.094 (0.47)
Stock Return Volatility	6.165*** (3.58)	1.267*** (2.91)	4.052*** (3.39)	1.161*** (3.18)
Stock Return Skew	-0.061 (-1.08)	-0.011 (-0.58)	-0.057 (-1.55)	0.006 (0.64)
Institutional Ownership	0.173 (0.30)	0.041 (0.16)	0.133 (0.34)	0.396* (1.77)
VIX	0.010 (0.30)	0.005 (0.57)	0.035** (2.02)	0.014** (2.10)
SP 500 Index Return	0.508 (0.11)	-3.329 (-1.39)	1.447 (0.53)	0.327 (0.23)
Stock Return	7.789*** (3.53)	5.019*** (4.46)	-3.042*** (-3.37)	-0.915 (-1.09)
Intercept	-19.562*** (-5.33)	-2.241* (-1.80)	-14.442*** (-6.01)	-3.736*** (-3.07)
Industry FE	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.40	0.38	0.37	0.34
N	63,558	63,079	62,372	62,199

**Table 7: The change of options volume after Rule 203, partitioned by options bid-ask spreads**

In this table, we show the impact of Rule 203 on options trading volume for subsamples of firms with daily equal-weighted options bid-ask spread above or equal to the sample median (High) or below the sample median (Low). The subsamples contain 1,040 firms and cover the period from October 1, 2004 to March 31, 2005. Pooled OLS regressions are performed at the firm-day level and results are reported for call and put options separately. The dependent variable is the daily aggregated options volume (in thousands). *Rule203* is a dummy variable, which is equal to 1 if the observation date is between Jan 1, 2005 and March 31, 2005, and equal to 0 if the observation date is between October 1, 2004 and December 31, 2004. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is defined as the closing ask less the closing bid and divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skewness* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of shares outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 index. *Stock Return* is the daily stock return. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level.

	Call Options		Put Options	
	Options Bid-ask Spread		Options Bid-ask Spread	
	Low (1)	High (2)	Low (3)	High (4)
Rule203	0.157* (1.72)	0.037 (1.44)	0.266*** (3.40)	0.009 (0.96)
Ln(Size)	0.878*** (5.95)	0.112* (1.67)	0.668*** (7.39)	0.125*** (4.53)
BM Ratio	-0.044 (-0.13)	0.083 (0.97)	0.202 (0.75)	0.060* (1.67)
Stock Bid-ask Spread	-0.230 (-1.09)	-0.097* (-1.95)	-0.226 (-1.44)	0.012 (1.60)
Stock Volume	0.537*** (7.47)	0.279*** (3.15)	0.258*** (5.61)	0.086** (2.56)
Last Month Stock Return	2.391** (2.20)	-0.408 (-1.38)	0.360 (0.54)	0.151 (1.38)
Stock Return Volatility	7.787*** (5.06)	1.401** (2.37)	5.144*** (4.75)	0.539*** (4.16)
Stock Return Skew	-0.043 (-0.82)	-0.011 (-0.80)	-0.046 (-1.32)	-0.004 (-0.76)
Institutional Ownership	-0.522 (-1.31)	0.020 (0.27)	-0.091 (-0.31)	0.015 (0.41)
VIX	0.037 (1.01)	-0.002 (-0.26)	0.059*** (2.80)	0.004 (1.13)
SP 500 Index Return	0.518 (0.10)	-0.864 (-0.53)	3.625 (1.10)	-0.446 (-0.66)
Stock Return	10.866*** (5.12)	1.053 (1.33)	-4.422*** (-3.46)	0.405* (1.66)
Intercept	-21.564*** (-5.72)	-2.888* (-1.88)	-16.844*** (-7.21)	-2.906*** (-4.67)
R <sup>2</sup>	0.41	0.29	0.37	0.14
Industry FE	Yes	Yes	Yes	Yes
N	63,290	63,347	62,079	62,492

### **Table 8: How does Rule 202T influence options volume?**

In this table, we show the impact of Rule 202T on the options volume. The sample contains 1,049 firms (362 pilot firms and 687 control firms) and covers the period from February 1, 2005 to July 31, 2005. Pooled OLS results are performed at the firm-day level and results are reported for call and put options separately. The dependent variable is the daily aggregated options volume (in thousands). *Pilot Stock* is a dummy variable that equals one if a firm's stock is designated as pilot stock in the Regulation SHO's pilot program and zero otherwise. *Post* is a dummy variable that is equal to 1 if the observation date is between May 1, 2005 and July 31, 2005, and equal to 0 if the observation date is between February 1, 2005 and April 30, 2005. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is the closing ask less the closing bid divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of shares outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 index. *Stock Return* is the daily stock return. Industry FE refers to controls for 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level, respectively.

	Call Options		Put Options	
	(1)	(2)	(3)	(4)
Pilot Stock* Post	-0.077 (-1.27)	-0.025 (-0.40)	-0.079 (-1.55)	-0.050 (-1.01)
Pilot Stock	0.136 (0.60)	0.021 (0.15)	0.089 (0.61)	0.021 (0.22)
Post	-0.060 (-1.20)	-0.036 (-0.77)	-0.051 (-1.15)	-0.007 (-0.17)
Ln(Size)		0.555*** (5.31)		0.467*** (6.36)
BM Ratio		0.282 (1.42)		0.297 (2.12)**
Stock Bid-ask Spread		-0.175* (-1.67)		-0.134* (-1.87)
Stock Volume		0.531*** (7.43)		0.282*** (5.31)
Last Month Stock Return		0.654* (1.74)		-0.184 (-0.66)
Stock Return Volatility		4.127*** (5.66)		3.169*** (5.69)
Stock Return Skew		-0.026 (-0.74)		-0.032 (-1.12)
Institutional Ownership		-0.127 (-0.69)		-0.120 (-0.80)
VIX		-0.007 (-0.50)		0.004 (0.39)
S&P 500 Index Return		-5.814** (-2.27)		-1.932 (-1.14)
Stock Return		5.926*** (5.26)		-1.400** (-2.08)
Intercept	0.625*** (3.68)	-13.067*** (-5.17)	0.491*** (3.97)	-10.936*** (-6.21)
Industry FE	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.02	0.41	0.01	0.34
N	127,399	127,399	125,854	125,854

### **Table 9: How does Rule 203 influence options bid-ask spreads?**

In this table, we show the impact of Rule 203 on options bid-ask spreads. The sample contains 1,040 firms and covers the period from October 1, 2004 to March 31, 2005. Pooled OLS regressions are performed at the option contract-day level and results are reported for call and put options separately. The dependent variable is the options relative bid-ask spread (*Basp*), defined as the closing ask price minus the closing bid price divided by the midpoint. *Rule203* is a dummy variable that is equal to 1 if the observation date is between January 1, 2005 and March 31, 2005, and equal to 0 if the observation date is between October 1, 2004 and December 31, 2004. *Dummy* is a dummy variable that equals 1 if the options strike price is no greater than the underlying stock price and 0 otherwise. *Moneyness* describes how much an option contract is in or out of the money and is defined in Section 6.1. *Maturity* is the number of days to the option's expiration date. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is defined as the closing ask less the closing bid and divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of shares outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 Index. *Stock Return* is the daily stock return. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level, respectively.

	Call options	Put options
	(1)	(2)
Rule203	0.001 (1.54)	0.001 (1.09)
Dummy*Moneyiness	-0.352*** (-13.79)	3.179*** (48.39)
(Dummy*Moneyiness) <sup>2</sup>	0.291*** (3.83)	-5.537*** (-10.95)
(1-Dummy)*Moneyiness	-3.403*** (-17.49)	0.660*** (18.63)
[(1-Dummy)*Moneyiness] <sup>2</sup>	1.743 (0.54)	1.206*** (8.28)
1 / Maturity	1.161*** (29.66)	1.293*** (28.49)
Ln(Size)	-0.030*** (-28.27)	-0.033*** (-28.25)
BM Ratio	0.031*** (5.63)	0.024*** (3.99)
Stock Bid-ask Spread	0.023*** (9.09)	0.022*** (8.16)
Stock Volume	0.001*** (7.26)	0.001*** (9.19)
Last Month Stock Return	-0.032*** (-5.06)	-0.036*** (-4.81)
Stock Return Volatility	-0.178*** (-13.68)	-0.188*** (-14.62)
Stock Return Skew	0.001 (1.46)	0.001** (2.33)
Institutional Ownership	-0.056*** (-8.44)	-0.065*** (-9.08)
VIX	0.001*** (4.08)	0.001* (1.74)
S&P 500 Index Return	0.048 (1.20)	0.063 (1.29)
Stock Return	0.006 (0.59)	0.035*** (2.60)
Intercept	0.793*** (27.90)	0.880*** (27.95)
Industry FE	Yes	Yes
R <sup>2</sup>	0.63	0.63
N	1,435,480	1,284,064

### **Table 10: How does Rule 202T influence options bid-ask spreads?**

In this table, we show the impact of Rule 202T on options bid-ask spreads. The sample contains 1,049 firms (362 pilot firms and 687 control firms) and covers the period from February 1, 2005 to July 31, 2005. Pooled OLS results are performed at the option contract-day level and results are reported for call and put options separately. The dependent variable is the options relative bid-ask spread (*Basp*), defined as the closing ask price minus the closing bid price divided by the midpoint. *Pilot Stock* is a dummy variable that equals one if a firm's stock is designated as pilot stock in the Regulation SHO's pilot program and zero otherwise. *Post* is a dummy variable that is equal to 1 if the observation date is between May 1, 2005 and July 31, 2005, and equal to 0 if the observation date is between February 1, 2005 and April 30, 2005. *Dummy* is a dummy variable that equals 1 if the options strike price is no greater than the underlying stock price and 0 otherwise. *Moneyness* describes how much an option contract is in or out of the money and is defined in Section 6.1. *Maturity* is the number of days to the option's expiration date. *Ln(Size)* is the natural logarithm of firm size at the end of the last calendar month. *BM Ratio* is the book-to-market ratio at the end of the last calendar year. *Stock Bid-ask Spread* is the closing ask less the closing bid divided by the midpoint, expressed in percentage. *Stock Volume* is the daily stock trading volume, expressed in millions. *Last Month Stock Return* is the cumulative stock return over the last month. *Stock Return Volatility* is calculated using the daily return in the previous month. *Stock Return Skew* is the skewness of daily stock returns over the previous month. *Institutional Ownership* is defined as institutional holdings divided by the total number of shares outstanding at the last quarter end. *VIX* is the daily VIX index value. *S&P 500 Index Return* is the daily return of the S&P 500 index. *Stock Return* is the daily stock return. Industry FE refers to controls for the 12 Fama-French industry fixed effects. Estimated standard errors are two-way clustered by firm and date. \*\*\*, \*\*, and \* indicate that the estimated coefficient is significant at the 1%, 5%, or 10% level, respectively.

	Call Options		Put Options	
	(1)	(2)	(3)	(4)
Pilot Stock* Post	0.002 (1.45)	0.001 (0.68)	0.001 (0.79)	0.001 (0.68)
Pilot Stock	0.001 (0.30)	-0.002 (-0.90)	-0.004 (-1.31)	-0.001 (-0.36)
Post	-0.001 (-0.76)	0.002*** (2.75)	0.006*** (4.36)	0.004*** (4.35)
Dummy*Moneyiness		-0.276*** (-6.85)		3.048*** (46.73)
(Dummy*Moneyiness) <sup>2</sup>		0.059*** (5.61)		-4.741*** (-9.12)
(1-Dummy)*Moneyiness		-3.085*** (-20.83)		0.754*** (22.13)
[(1-Dummy)*Moneyiness] <sup>2</sup>		6.991*** (3.15)		1.456*** (12.00)
1 / Maturity		1.187*** (29.22)		1.326*** (29.08)
Ln(Size)		-0.033*** (-27.26)		-0.035*** (-28.99)
BM Ratio		0.026*** (4.71)		0.018*** (3.03)
Stock Bid-ask Spread		0.023*** (10.67)		0.022*** (8.56)
Stock Volume		0.001*** (6.42)		0.002*** (8.53)
Last Month Stock Return		-0.014* (-1.90)		-0.022** (-2.48)
Stock Return Volatility		-0.190*** (-12.73)		-0.203*** (-13.10)
Stock Return Skew		0.002*** (2.74)		0.003*** (3.98)
Institutional Ownership		-0.057*** (-8.38)		-0.058*** (-7.50)
VIX		0.000 (0.45)		-0.001*** (-2.89)
S&P 500 Index Return		-0.091*** (-3.08)		-0.134*** (-3.61)
Stock Return		-0.005 (-0.38)		0.039*** (2.76)
Intercept	0.114*** (18.84)	0.877*** (27.68)	0.130 (27.30)***	0.951*** (28.34)
Industry FE	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.01	0.63	0.01	0.63
N	1,516,599	1,516,599	1,373,432	1,373,432