The Impact of Off-market Trading on Liquidity: Evidence from Australian Options Market

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Abstract

This study investigates the impact of reducing the contract size threshold for off-market trading on transaction costs in the Australian Options Market. Small-to-medium trades incur lower transaction costs while large or small trades are unaffected by the recent structural change. After the recent structural change, market makers: (1) compete more aggressively for small-to-medium trades and (2) quote mid-size depths more often.

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1. Introduction

The impact of market structure on market quality is studied extensively in the microstructure literature. In particular, a great deal of attention is focused on the economics of off-market trading. There is an extensive literature on off-market trading in equity markets.[1] However, off-market trading in derivatives markets is yet to be investigated. This is largely due to unavailability of the data required for this line of research. The objective of this study is to bridge this gap in the literature by examining upstairs trading on the Australian Options Market (AOM). More specifically, this study investigates the impact of reducing the contract size threshold for off-market trading on the market quality of the AOM.

There are three sources of liquidity available on the AOM: (1) limit orders, (2) market quotes provided by market makers, and (3) unexpressed liquidity provided by off-market participants, which is unavailable on the centralised limit order book. The recent regime change initiated by the AOM allows more traders to access the third source of liquidity: liquidity unavailable on the centralised limit order book.

This structural transition provides a unique opportunity to investigate the effect of the contract size threshold reduction for off-market trading on the liquidity of the on-market, which distinguishes this study from earlier empirical work. Prior empirical studies examine how the off-market facilitates liquidity provision and its role in relation to on-market trading. Booth et al (2002), Bessembinder and Venkataraman (2004), Madhavan and Cheng (1997), and Smith et al. (2001) find that the off-market improves liquidity by reducing adverse selection costs. Bessembinder and Venkataraman (2004) and Booth et al. (2002) also find that the off-market improves

[1] See, for example, Madhavan and Chang (1997), Smith, Turnbull, and White (2001), Booth, Lin, Martikainen, and Tse (2002), and Bessembinder and Venkataraman (2004).

market quality by supplementing liquidity when on-market liquidity is not sufficient. Unlike these studies and earlier work, this study examines how the liquidity of the on-market is affected by a structural change that enables more traders to have access to liquidity provided by off-market participants.

Furthermore, unlike prior empirical work, this study focuses on the transaction costs for small order traders. Prior empirical studies primarily examine the role of off-market trading in liquidity provision to large order traders. For example, Bessembinder and Venkataraman (2004) provide evidence that off-market trading lowers transaction costs for large order traders since off-market broker-dealers can: (1) screen out informed traders and (2) tap into unexpressed liquidity. In contrast, by examining a particular event that involves off-market trading, this study is able to test for the relationship between off-market trading and transaction costs for small order traders.

This study also extends understanding of the economics of competition for order flow in the options market. Mayhew (2002) examines the role of inter-market competition on the Chicago Board Options Exchange (CBOE). Mayhew provides evidence that inter-market competition lowers bid-ask spreads. De Fontnouvelle et al. (2003) investigate how multiple listings of options affect bid-ask spreads using standard event study methodology. As in Mayhew (2002), De Fontnouvelle et al. conclude that market quality can be improved by inter-market competitive pressure in options markets. This study is distinguished from these earlier studies because the additional competitive pressure on liquidity provision caused by the event investigated in this paper is different. While earlier studies examine the impact of further competitive pressure on liquidity provision caused by multiple listing across

markets of similar characteristics, this study investigates how competition between two different specialised markets (on-market and off-market) impact on liquidity.

Differences between the microstructure of options markets examined in prior studies and the AOM also warrants an examination of the impact of competition on the liquidity of the AOM. The CBOE is a dealer market that incorporates the specialist market mechanism. Not every market marker has the same right on the CBOE. Only specialists (also known as Designated Primary Marketmaker (DPM)) represent limit orders. In contrast to the DPMs on the CBOE, market makers on the AOM do not represent limit orders, which implies that they may differ in their reactions to competitive pressure on liquidity provision. Therefore, findings from prior studies may not be generalised to the AOM without further investigation.

The remainder of this paper is structured as follows. Section 2 provides institutional details of the AOM and the recent rule change. Section 3 presents the sample and descriptive statistics. Section 4 outlines the research design and presents the results. Section 5 concludes.

2. Institutional Background

The Australian Options Market (AOM) provides a trading platform that uses a centralised limit order book with designated market makers.[2] The Integrated Trading System (ITS), a screen based trading system, facilitates trading exchange traded options. The AOM offers options on a range of underlying assets such as equities, fixed income assets, and commodities. Of these instruments, equity options are most

[2] The Australian Options Market (AOM) is one of the trading platforms provided by the Australian Securities Exchange (ASX).

actively traded. These options are classified as call or put options.[3] Then, they are further classified according to a set of predetermined (by the AOM) exercise prices and expiry dates. The standard number of shares for one option contract is 1,000.

There are two sub-trading platforms on the AOM: (1) the centralised limit order book and (2) the off-market facility. On the centralised limit order book, liquidity is supplied by limit orders and designated market makers. Limit orders and market maker quotes are ranked on a price/time priority basis. Each market maker is charged with a particular set of option classes, and obliged to make a market in one of the following ways: (1) on a continuous basis only, (2) make a market in response to quote requests only, or (3) both on a continuous basis and in response to quote requests.

In contrast, the off-market allows more flexibility since the strict price/time priority rule does not apply to off-market transactions. To be eligible for off-market trading, the contract size for category 1 (category 2) option classes must be greater than or equal to $500,000 ($250,000) as of January 2, 2007.[4] It is a recent policy change that reflects traders' demands for more flexible large order execution. Note that before the change, the contract size threshold for category 1 (category 2) option classes was $1,000,000 ($500,000).

3. Data and Descriptive Statistics

The Reuters intra-day data used in the present study are provided by the Securities Industry Research Centre of Asia Pacific (SIRCA).[5] The original data

[3] Note that only American type options are available on equities.
[4] Option classes are classified into two groups (category 1 and category 2) in order of their liquidity at the discretion of the AOM. category 1 option classes are more liquid than category 2 option classes.
[5] The Reuters intra-day data are cross-checked with the data internally sourced from the AOM.

consist of trade level variables for the category 1 equity option classes from April 3, 2006 to September 28, 2007. This study selects 182 days prior (subsequent) to the introduction of the new rule as the pre-event period (the post-event period). The option classes that were listed continuously during the sample period are included, leading to 20 option classes. Each transaction is matched with its corresponding liquidity-related variables such as prevailing bid-ask spreads and depths.

Several filters are then applied. This study deletes 14 days surrounding the event since it may take time for traders to adapt to the new trading regime. Combination orders are excluded since it is difficult to track the corresponding prevailing bid and ask quotes.[6] In addition, Low Exercise Price Options (LEPOs) are deleted since they have futures-like characteristics. This study also removes long-term and near-expiration options, as in De Fontnouvelle et al. (2003).[7]

Table I reports summary statistics for the entire sample (both on-market and off-market trades) before filtering. The increase in the mean on-market trade premium is 20%. In contrast, the reduction in the mean off-market trade premium is 45%.[8] The mean off-market trade size, 819 contracts, in the pre-event period is 2.2 times as large as that, 2,605 contracts, in the post-event period. Similarly, the mean on-market daily number of trades remains constant while the mean off-market daily number of trades increases from 2 to 6 trades. The mean on-market trading volume increases by 37%, and the mean off-market trading volume increases from $31,819,307 to $149,218,189, an increase of 369%. Table I indicates that off-market trading becomes considerably

[6] Combination orders refer to the orders that: (1) comprise more than one option series, or (2) include underlying stocks. It is difficult to track their prevailing bid and ask quotes since they can be executed either as a whole or individually.

[7] In this study, long-term (near-expiration) options are defined as options with longer (shorter) than 365 (7) days to expiration.

[8] A huge discrepancy between the mean trade premiums for on-market and off-market trades is because a large portion of off-market trades are combinations and they are executed as a whole.

more active while on-market trading activity remains unchanged after the rule change.[9]

[Table I here]

4. Empirical Analysis and Results

To test for the impact of off-market trading on the liquidity of the market, this study uses percentage quoted spreads, percentage effective spreads and quoted depths as liquidity measures. The percentage quoted spread is defined as the difference between the prevailing ask price and bid price at the time of the transaction. The percentage effective spread is calculated as the twice the absolute value of the difference between the trade price and the prevailing mid-quote divided by the prevailing mid-quote.[10] The depth is defined as the sum of the prevailing ask depth and bid depth. Percentage quoted spreads proxy for the round-trip costs for liquidity demanders trading small orders that can be absorbed by the prevailing depth. However, since a set of market makers for each option class on the AOM is obliged to make a market in response to quote requests, the percentage effective spread is a more appropriate liquidity measure for large order traders.

This study uses standard event study methodology. For the empirical analysis, 182 days prior (subsequent) to the event date, 2 January, 2007, is defined as the pre (post)-event period. In Section 4.1, this study examines the effect of the recent

[9] The increase in both the mean on-market trading volume and the mean off-market trading volume suggests that on-market trading activity remains constant after the rule change.

[10] The percentage effective spread for a trade *i* can be defined as follows:

$$2\left|\text{Price}_i - \left(\frac{\text{Ask}_i + \text{Bid}_i}{2}\right)\right|$$

Price_i is the transaction price of trade *i*. Ask_i (Bid_i) are the prevailing ask (bid) quotes at the time of trade *i*.

structural regime change on the liquidity of the market based on trading volume and trade size, assuming that there is no other material confounding factor. Section 4-2 conducts regression analysis to isolate the marginal impact of the rule change on the liquidity of the market from option characteristics and market conditions.

4.1 Univariate Analysis

The study determines the statistical significance of univariate differences across the trading regimes using the t-test and the Wilcoxon rank sum test. The microstructure literature suggests that there are two major components of the bid-ask spread in dealer markets: (1) adverse selection cost and (2) inventory holding cost.[11] In particular, Ho and Macris (1984) find that the inventory holding cost is a significant determinant of the trading costs in the American Stock Exchange (AMEX) options market. It is documented that trading volume proxies for the inventory holding cost (for example, Stoll, 2000). Easley and O'Hara (1987) argue that the larger the trade size, the greater the adverse selection cost component of the bid-ask spread. To control for these variables, first, trades are categorised by trade size. Then, within each trade size group, trades are further categorised into four groups based on trading volume. This categorisation procedure enables this study to conduct a univariate analysis of the rule change on liquidity based on trade size and trading volume.

[11] See, for example, Kyle (1985) and Easley and O'Hara (1987) for the adverse selection cost theory. Examples of research linked to the inventory holding cost theory are Garman (1976), Stoll (1978), and Ho and Stoll (1981).

Table II reports the results of the univariate analysis based on trade size and trading volume.[12] This study finds that percentage quoted spreads decrease by 1.34%, which is statistically significant at the 1% level. The results are consistent across all trade size groups, but not uniform across trading volume categories. While there is a significant reduction for the most active option series, the change for the least active option series within each trade size group is not statistically significant. The result for the least active options within the largest trade size documents an increase of 0.69% although this change is statistically insignificant.

Evidence in Table II implies that the recent structural change is beneficial for small order traders who take liquidity visible on the centralised limit order book (both limit orders and market maker quotes). However, for liquidity demanders who use market maker quote requests, the changes in percentage quoted spreads will not be relevant since their trade prices often differ from the prevailing bid and ask quotes. In particular, the percentage quote spread is not useful to examine the impact of the rule change on the transaction costs for large market orders that require unexpressed liquidity. The percentage effective spread is a better measure for these types of liquidity demanders.

[Table II here]

Unlike the percentage quoted spread, the percentage effective spread measures the round-trip transaction cost for the orders that need unexpressed (on the centralised limit order book) liquidity since this measure incorporates the actual transaction price.

[12] Trading volume is measured on a class-by-class basis each day. The total trading volume for each option class is computed on each trading day. Then, option series are sorted in decreasing order of the total trading volume for each option class on each trading day. Trades are grouped into four trading volume categories according to their corresponding options' categories.

The results in Table II suggests that the impact of the rule change on the percentage effective spread is more complicated than that on the percentage quoted spread. For the entire sample, percentage effective spreads fall from 9.05% to 8.57%, a drop of 0.48%. However, the results on a category-by-category basis also show that this change is uniform across trade size and trading volume groups except for the largest trade size group. The mean percentage effective spread for the largest trade size group increases by 0.60%. The results of the t-test and the Wilcoxon rank sum test do not produce consistent results for the largest trade size group. The t-test results indicate that the mean percentage effective spread for the The Wilcoxon rank sum test results suggest that the change in the distribution of the percentage effective spread after the structural change is not significant. These inconsistent results across the two tests make inferences difficult without further examination.[13]

The results in Table II suggest that actual transaction costs for small-to-medium trades in high volume option series are significantly lower after the trading regime change. In addition, the reduction in the off-market threshold is also beneficial for traders with small-to-medium size trades in actively traded options that need liquidity invisible on the limit order book. The results also provide evidence that liquidity for low volume option series are unaffected by the change in market structure.

Table III presents the results of the univariate analysis of quoted depth, denominated in contracts, based on trade size and trading volume. The results reveal that the mean quoted depth falls from 65 to 58 contracts, which is statistically significant at the 1% level. However, the results are not consistent across trade size groups. The most notable result is that the mean quoted depth for smallest trade size group remains unchanged after the event. Table III also reports changes in median

[13] See Section 4.2 for fur examination.

quoted depths. The median quoted depth for the entire sample remains unchanged after the structural change. However, the statistical significance of the result of the Wilcoxon rank sum test suggests that the shape of the distribution of the quoted depth is influenced by the event. The median quoted depth results are not uniform across sub-groups, and it is more complicated than the mean quoted depth results, making inferences difficult. Nevertheless, it is revealed that most sub-categories experience increases in median quoted depths.

The results for quoted depths provide evidence that market makers' quote setting strategies are influenced by the recent structural change. For the entire sample, the decline in the mean and the increase in the median indicate that the distribution of the quoted depth becomes less positively-skewed after the event.[14] The shift in the distribution of the quoted depth suggests that market makers quote mid-size depths more often compared to large or small depths located in the tails of the distribution after the event. The reduction in the minimum trade size for off-market trading offers more traders exposure to unexpressed off-market liquidity. However, not all types of traders will find this additional option advantageous. It is demonstrated that off-market broker-dealers can screen out informed traders, leading to enhanced liquidity for large liquidity-motivated traders (Bessembinder and Venkataraman, 2004). Thus, rational informed traders will not choose to trade with off-market broker-dealers. The implication is that increased off-market trading may lead to a smaller percentage of liquidity-motivated traders on the limit order book, resulting in an increased expected adverse selection cost for market makers. Therefore, the market makers' propensity for mid-size depths could reflect their motivation to mitigate adverse selection costs.

[14] The skewness of the quoted depth decreases from 8.29 to 7.33.

[Table III here]

To correctly interpret the results (in Table III) regarding liquidity, it is required to examine the extent to which quoted depths represent total liquidity available to liquidity demanders since liquidity demanders can request market maker quotes. However, this study is unable to do so due to unavailability of the required data. Nevertheless, it is evident that quoted depths on the limit order book is far from the total liquidity. Aspris et al. (2006) documents that there is a sizeable number of market markers with no obligation to provide liquidity continuously. Furthermore, market makers providing liquidity continuously may not disclose their actual trading interests on the limit order book for various reasons. Market makers only need to quote a certain level of depth depending on circumstances. The minimum depth for the option series that belong to category 1 (category 2) is 10 (5) contracts.[15] Full disclosure of their actual trading interests may also adversely affect market makers since displayed firm quotes can be picked off by informed traders. Therefore, this study argues that quoted depth on the limit order book of the AOM is not a reliable measure of liquidity.

4.2 Multivariate Analysis

The underlying assumption of the above univariate analysis is that the recent structural change is the only material determinant of bid-ask spreads, which means that the tests are not materially affected by other unspecified factors. However, prior studies demonstrate that there are a number of other factors that affect option bid-ask

[15] See ASX Market Procedure 23.3.2 for more detailed information.

spreads (for example, Mayhew, 2002, and De Fontnouvelle et al., 2003). Therefore, to control for other possible confounding factors, this section conducts regression analysis. Ordinary Least Squares (OLS) is used to estimate the parameters of the linear regression specified as follows:

$$\begin{aligned} Liquidity_i = {} & \beta_0 + \beta_1 Event_i + \beta_2 TradeSize_i + \beta_3 Type_i + \beta_4 ITM_i + \beta_5 ATM_i \\ & + \beta_6 TimetoMaturity_i + \beta_7 Volume_i + \beta_8 IV_i + \beta_9 UnderSpread_i \\ & + \beta_{10} TradeSize_i * Event_i + \beta_{11} Vol * Event_i + \varepsilon_i \end{aligned}$$

where $Liduidity_i$ proxies for liquidity. Two measures are used in this study: (1) the percentage quoted spread and (2) the percentage effective spread. $Event_i$ is a dummy variable that takes one if trade *i* takes place in the pre-event period and zero otherwise. $TradeSize_i$ is the number of option contracts for trade *i*. $Type_i$ is a dummy variable with value of one if trade *i* is for call options and zero for put options. ITM_i (ATM_i) is a dummy variable that equals one if the option for trade *i* is in-the-money (at-the-money) and zero otherwise. A call (put) option is defined to be in-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is greater than 1.02. A call (put) option is defined be at-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is between 0.98 and 1.02. $TimetoMaturity_i$ is the number of days between the transaction date for trade *i* and its expiry date. $Volume_i$ is the log of the total trading volume of the option series to which trade *i* belongs. IV_i is the annualised implied volatility of the stock that underlies the options trade *i*. $UnderSpread_i$ is the prevailing percentage quoted spread for the underlying stock at the time of transaction *i*. $TradeSize_i * Event_i$ ($Vol_i * Event_i$) is the interaction term between $TradeSize_i$ ($Volume_i$) and $Event_i$.

The coefficient of $Event_i$ measures the marginal impact of the reduction in the minimum threshold for off-market trading on: (1) the percentage quoted spread and

(2) the percentage effective spread. $TradeSize_i$ captures trade-specific characteristics. Easley and O'Hara (1987) argue that informed traders are more likely to submit large orders, indicating that trade size has information content. Option series characteristics are controlled for by: (1) $Type_i$, (2) ITM_i, (3) ATM_i, and (4) $TimetoMaturity_i$. Prior studies find that trading volume and implied volatility are important variables that affect option bid-ask spreads (for example, Mayhew, 2002, and De Fontnouvelle et al. 2003) Trading volume proxies for market activity level that directly influences trading costs. It is demonstrated that trading volume is negatively associated with option spreads (Mayhew, 2002). Implied volatility measures uncertainty regarding the underlying stock returns. The adverse selection literature argues that market makers are more likely to increase bid-ask spreads when the market is more uncertain (Kyle, 1985). Most market makers on the AOM hedge their exposures using other options, underlying stocks, or index futures contracts according to the AOM.[16] If the stock market is used for hedging, dealers will face higher market making costs when the underlying spreads are larger. Market makers may increase bid-ask spreads to compensate themselves for additional costs. Thus, $UnderSpread_i$ is expected to be positively related to $Liduidity_i$. Prior studies find that off-market broker-dealers can screen out informed traders, resulting in lower transaction costs for large order traders. Hence, more liquidity-motivated traders may use the off-market facility after the recent regime change, leading to a smaller portion of uninformed traders on the limit order book. In this environment, market makers might be more reactive to variables related to information asymmetry such as trade size. $TradeSize_i$* $Event_i$ is used to control for this possible effect. The literature suggests that trading volume has

[16] See http://www.asx.com.au/products/options/trading_information/RoleOptionMarketMakers.html for more detailed information.

information content.[17] If the proportion of informed traders is larger after the rule change, market makers might react to changes in trading volume differently to mitigate increased adverse selection costs. Vol_i* $Event_i$ is included to capture this possible effect.

Table IV reports the regression results. The results are uniform across the two regressions except for Vol_i* $Event_i$. The coefficients of $Event_i$ in both regressions are negative and statistically significant at the 1% level as in the univariate analysis, implying that the two liquidity measures decrease substantially after the recent regime change. All control variables included in the regressions are statistically significant at the 1% level except for Vol_i* $Event_i$. Percentage bid-ask spreads for call options are smaller then put options. In terms of moneyness, Percentage spreads for in-the-money options are the lowest. Time-to-maturity is negatively associated with percentage bid-ask spreads. Percentage bid-ask spreads increase with trade size. The association between trading volume and percentage bid-ask spreads is negative. Percentage bid-ask spreads are negatively related to implied volatility. The underlying percentage quoted spreads and percentage option spreads are positively related. The coefficients of $TradeSize_i$* $Event_i$ are positive and statistically significant at the 1% level, indicating that the impact of trade size on percentage spreads is stronger after the event. The coefficient of Vol_i* $Event_i$ for percentage effective spreads is significantly positive at the 1% level while that for percentage quoted spreads is statistically indistinguishable from zero. It implies that the volume effect changes only for percentage effective spreads after the regime change.

[Table IV here]

[17] See, for example, Wang (1994) and Blume, Easley, and O'Hara (1994).

The results in Table IV clearly demonstrate that percentage spreads fall after the structural change for the entire sample. However, the results of the univariate analysis show that the impact of the rule change on percentage effective spreads is not homogeneous across trade size groups. The significance of the coefficients for $TradeSize_i$* $Event_i$ also suggests that the results may not be uniform across trade size sub-groups. To examine whether the impact of the rule change on percentage effective spreads, is consistent across trade size groups, regression analysis is conducted for each trade size group. The results of this analysis are presented in Table V. $TradeSize_i$ and $TradeSize$ *$Event_i$ are excluded from the regression specifications for this analysis since their effects are controlled for by grouping based on trade size. The results in Table V demonstrate that trade size group 3 is the only sub-group in which the impact of the regime change on percentage effective spreads is negatively significant after controlling for other influential factors.[18] Thus, it can be concluded that the results of the univariate analysis for trade size group 1 are influenced by other unspecified factors.

[Table V]

5. Conclusion

This study investigates this study investigates the impact of reducing the contract size threshold for off-market trading on the market quality of the AOM. More specifically, this study examines: (1) the impact of the recent regime change on

[18] In trade size group 3, trade size is between 3 and 7 option contracts.

transaction costs and (2) how market makers alter their quote setting strategies in response to this rule change. The results demonstrate that the reduction in the minimum threshold for off-market trading lowers percentage effective spreads for small-medium size trades. In addition, the distribution of the quoted depth is affected by the recent rule change. The distribution is less positively skewed in the post-event period.

The percentage effective spread results indicate that small-to-medium trades incur lower transaction costs while large or small trades are unaffected by the recent structural change. The quoted depth results show market makers' propensity for mid-size depths. In the post-event period, market makers: (1) compete more aggressively for small-to-medium trades and (2) quote mid-size depths more often. The microstructure literature implies that a more flexible off-market trading may lead to a smaller proportion of liquidity-motivated traders on the limit order book. Thus, changes in market makers' strategies could be attributed to the increased adverse selection costs in the post-event period. Direct examination on changes in market makers' behaviours in response to the structural change is left as an area for future research. In conclusion, transaction costs for most liquidity demanders on-market remains unchanged. However, small-to-medium traders incur substantially lower trading costs in the post-period.

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Table I

Sample Summary Statistics

This table reports summary statistics for the entire sample (both on-market and off-market trades) before filtering. The original data consist of trade level variables for the category 1 equity option classes from April 3, 2006 to September 28, 2007. This study selects 182 days prior (subsequent) to the introduction of the new rule as the pre-event period (the post-event period). The option classes that were listed continuously during the sample period are included, leading to 20 option classes. Each transaction is matched with its corresponding liquidity-related variables such as prevailing bid-ask spreads and depths. The *Off-market* refers to any trades classified as Special Crossing (SP). The *On-market* refers to any non-SP trades. The *Trade Premium* is the mean of the premiums The *Trade Size* is the mean of the trade sizes (contracts). The *Daily Number of Trades* is the mean of the daily number of trades (contracts). The *Daily Volume* is the mean of the daily trading volume ($ in millions).

	Period	Trade Types		
		Total	On-market	Off-market
Trade Premium	Pre	0.82	0.81	17.91
($)	Post	0.98	0.96	9.79
	Change	0.16	0.15	-8.12
Trade size	Pre	15	14	819
(contracts)	Post	18	13	2,605
	Change	3	-1	1,786
Daily Number of	Pre	3,438	3,435	2
Trades	Post	3,552	3,546	6
(contracts)	Change	114	111	4
Daily Volume	Pre	56	30	32
($ millions)	Post	189	41	149
	Change	133	11	117

Table II

Percentage Quoted and Effective Spreads Surrounding the Current Market Rule Change in the Minimum Thresholds for Off-market Trading

This table reports the results of the univariate analysis for percentage quoted and effective spreads based on trade size and trading volume. In trade size group 1, trade size is greater than 12 option contracts. In trade size group 2, trade size is between 7 and 12 option contracts. In trade size group 3, trade size is between 3 and 6 options contracts. In trade size group 4, trade size is less than 3 option contracts. Trading volume is measured on a class-by-class basis each day. The total trading volume for each option class is computed on each trading day. Then, option series are sorted in decreasing order of the total trading volume for each option class on each trading day. Trades are grouped into four trading volume categories according to their corresponding options' categories. The percentage quoted spread is defined as the difference between the prevailing ask price and bid price at the time of the transaction. The percentage effective spread is calculated as the twice the absolute value of the difference between the trade price and the prevailing mid-quote divided by the prevailing mid-quote. The t-test and the Wilcoxon rank sum test are used to determine the statistical significance of univariate differences across the trading regimes.

Option series groups	Percentage Quoted Spread (in %)			Percentage Effective Spread (in %)		
	Mean			Mean		
	Pre	Post	Change	Pre	Post	Change
Entire sample	10.25%	8.91%	-1.34%**	9.05%	8 .57%	-0.48%**
Trade size group 1 (Largest)	11.99%	11.51%	-0.48%**	10.38%	10.99%	0.60%**
Volume group 1 (Most active)	11.53%	11.12%	-0.41%**	9.86%	10.58%	0.70%**
Volume group 2	12.93%	12.24%	-0.69%**	11.40%	11.80%	0.40%
Volume group 3	13.47%	13.00%	-0.47%	12.12%	12.55%	0.40%
Volume group 4 (Least active)	14.08%	14.77%	0.69%	13.35%	14.14%	0.80%
Trade size group 2	11.02%	9.53%	-1.49%**	9.77%	9.22%	-0.56%**
Volume group 1 (Most active)	10.42%	8.48%	-1.95%**	9.06%	8.22%	-0.84%**
Volume group 2	11.01%	9.69%	-1.31%**	9.78%	9.35%	-0.43%*
Volume group 3	12.19%	11.45%	-0.74%**	11.15%	11.08%	-0.07%
Volume group 4	12.62%	12.31%	-0.31%	11.68%	11.75%	0.07%
Trade size group 3	9.20%	7.86%	-1.34%**	8.19%	7.57%	-0.62%**
Volume group 1 (Most active)	8.95%	7.50%	-1.45%**	7.80%	7.22%	-0.58%**
Volume group 2	9.30%	7.96%	-1.34%**	8.21%	7.68%	-0.53%**
Volume group 3	9.55%	7.88%	-1.67%**	8.62%	7.59%	-1.03%**
Volume group 4	9.30%	8.60%	-0.70%**	8.63%	8.22%	-0.41%
Trade size group 4 (Smallest)	7.31%	6.38%	-0.93%**	6.65%	6.18%	-0.47%**
Volume group 1 (Most active)	7.56%	6.40%	-1.16%**	6.83%	6.26%	-0.57%**
Volume group 2	7.54%	6.49%	-1.05%**	6.76%	6.27%	-0.49%**
Volume group 3	7.36%	6.13%	-1.22%**	6.73%	5.87%	-0.86%**
Volume group 4 (Least active)	6.72%	6.41%	-0.32%	6.28%	6.18%	-0.01%

Table III

Quoted Depths Surrounding the Current Market Rule Change in the Minimum Thresholds for Off-market Trading

This table reports the results of the univariate analysis for quoted depths based on trade size and trading volume. In trade size group 1, trade size is greater than 12 option contracts. In trade size group 2, trade size is between 7 and 12 option contracts. In trade size group 3, trade size is between 3 and 6 options contracts. In trade size group 4, trade size is less than 3 option contracts. Trading volume is measured on a class-by-class basis each day. The total trading volume for each option class is computed on each trading day. Then, option series are sorted in decreasing order of the total trading volume for each option class on each trading day. Trades are grouped into four trading volume categories according to their corresponding options' categories. The depth is defined as the sum of the prevailing ask depth and bid depth. The t-test and the Wilcoxon rank sum test are used to determine the statistical significance of univariate differences across the trading regimes.

Option series groups	Quoted Depth (contracts)					
	Mean			Median		
	Pre	Post	Change	Pre	Post	Change
Entire sample	65	58	-7**	35	35	0**
Trade Size group 1 (Largest)	109	106	-3**	60	65	5**
Volume group 1 (Most active)	116	113	-3**	60	69	9**
Volume group 2	92	87	-5	52	52	0
Volume group 3	102	102	0	55	60	5**
Volume group 4 (Least active)	128	133	5	76	95	9*
Trade size group 2	54	50	-4**	32	33	1
Volume group 1 (Most active)	57	54	-3**	35	37	2**
Volume group 2	48	43	-5**	30	30	0**
Volume group 3	46	42	-4**	30	30	0
Volume group 4 (Least active)	82	79	-3	38	47	9
Trade size group 3	41	39	-2**	25	26	1**
Volume group 1 (Most active)	45	46	1	29	31	2**
Volume group 2	38	35	-3**	25	25	0**
Volume group 3	37	32	-5**	23	23	0
Volume group 4 (Least group)	41	38	-3	23	23	0*
Trade size group 4 (Smallest)	33	33	0	21	23	2**
Volume group 1 (Most active)	40	41	1	26	30	4**
Volume group 2	31	31	0	22	23	1**
Volume group 3	30	27	-3**	20	21	1**
Volume group 4	28	26	-2**	20	20	0

Table IV

Regression Analysis of Percentage Quoted and Effective Spreads

This table reports the regression results for percentage quoted and effective spreads. $Liduidity_i$ proxies for liquidity. Two measures are used in this study: (1) the percentage quoted spread and (2) the percentage effective spread. $Event_i$ is a dummy variable that takes one if trade *i* takes place in the pre-event period and zero otherwise. $TradeSize_i$ is the number of option contracts for trade *i*. $Type_i$ is a dummy variable with value of one if trade *i* is for call options and zero for put options. ITM_i (ATM_i) is a dummy variable that equals one if the option for trade *i* is in-the-money (at-the-money) and zero otherwise. A call (put) option is defined to be in-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is greater than 1.02. A call (put) option is defined be at-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is between 0.98 and 1.02. $TimetoMaturity_i$ is the number of days between the transaction date for trade *i* and its expiry date. $Volume_i$ is the log of the total trading volume of the option series to which trade *i* belongs. IV_i is the annualised implied volatility of the stock that underlies the options trade *i*. $UnderSpread_i$ is the prevailing percentage quoted spread for the underlying stock at the time of transaction *i*. $TradeSize_i * Event_i$ ($Vol_i * Event_i$) is the interaction term between $TradeSize_i$ ($Volume_i$) and $Event_i$.

Explanatory Variables	Percentage Quoted Spreads	Percentage Effective Spreads
Intercept	0.1431**	0.1345**
Event	-0.0057**	-0.0056**
Type	-0.0141**	-0.0106**
ITM	-0.0893**	-0.0832**
ATM	-0.0661**	-0.0610**
TimetoMaturity	-0.0002**	-0.0002**
TradeSize	0.0002**	0.0001**
Volume	-0.0060**	-0.0071**
IV	0.0794**	0.0746**
UnderSpread	10.9359**	10.6545**
TradeSize*Event	0.0003**	0.0003**
Volume*Event	-0.0024**	-0.0005
Adj R-squared	0.1030	0.0961

** (*) indicates statistical significance at the 1% (5%) level.

Table V

Regression Analysis of Percentage Effective Spreads by Trade Size

This table reports the regression results for percentage effective spreads by trade size. In trade size group 1, trade size is greater than 12 option contracts. In trade size group 2, trade size is between 7 and 12 option contracts. In trade size group 3, trade size is between 3 and 6 options contracts. In trade size group 4, trade size is less than 3 option contracts. $Event_i$ is a dummy variable that takes one if trade *i* takes place in the pre-event period and zero otherwise. $TradeSize_i$ is the number of option contracts for trade *i*. $Type_i$ is a dummy variable with value of one if trade *i* is for call options and zero for put options. ITM_i (ATM_i) is a dummy variable that equals one if the option for trade *i* is in-the-money (at-the-money) and zero otherwise. A call (put) option is defined to be in-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is greater than 1.02. A call (put) option is defined be at-the-money if the ratio of its underlying price to its exercise price (the ratio of its exercise price to its underlying price) is between 0.98 and 1.02. $TimetoMaturity_i$ is the number of days between the transaction date for trade *i* and its expiry date. $Volume_i$ is the log of the total trading volume of the option series to which trade *i* belongs. IV_i is the annualised implied volatility of the stock that underlies the options trade *i*. $UnderSpread_i$ is the prevailing percentage quoted spread for the underlying stock at the time of transaction *i*. $TradeSize_i$* $Event_i$ (Vol_i* $Event_i$) is the interaction term between $TradeSize_i$ ($Volume_i$) and $Event_i$.

Explanatory Variables	Percentage Effective Spread			
	Trade Size Group 1	Trade Size Group 2	Trade Size Group 3	Trade Size Group 4
Intercept	0.1947**	0.1622**	0.1268**	0.0938**
Event	-0.0007	0.0024	-0.0061**	-0.0001
Type	-0.0170**	-0.0064**	-0.0065**	-0.0046**
ITM	-0.0990**	-0.0934**	-0.0740**	-0.0582**
ATM	-0.0741**	-0.0654**	-0.0523**	-0.0406**
TimetoMaturity	-0.0002**	-0.0002**	-0.0002**	-0.0001**
Volume	-0.0141**	-0.0139**	-0.0082**	-0.0027**
IV	0.0338**	0.1423**	0.0883**	0.0396**
UnderSpread	14.7803**	7.6584**	6.7392**	9.4766**
Volume*Event	0.0007	-0.0022**	0.0003	-0.0010*
Adj-R-squared	0.0891	0.1062	0.0926	0.0812

** (*) indicates statistical significance at the 1% (5%) level.