Trading Behavior of Retail Investors in Derivatives Markets: Evidence from Mini Options*

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This Version: July 6, 2021

* Zhong acknowledges financial support from the David Whitcomb Center for Research in Financial Services at Rutgers Business School. We are grateful for comments from Vikas Agarwal, Charles Cao, Saeyoung Chang, Mi-Hsiu Chiang, Daniel Chi, Suengmook (Sam) Choi, Robin K. Chou, Grigori Erenburg, Bing Han, Cheng-Few Lee, Oded Palmon, Charles Trzcinka, Ronald Sverdlove, Yangru Wu, Liyan Yang, and conference participants at the 7th International Conference on Financial Risk and Corporate Finance Management (FRCFM), the 26th Annual Conference on Financial Economics and Accounting (CFEA), 2016 FMA Asia Pacific Conference, 2016 FMA Annual Meeting, and 2017 Research Day at Rutgers Business School, 2017 FMA European Conference, and 2017 Journal of Accounting Auditing and Finance Annual Conference. All remaining errors are ours.

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Abstract

Mini options are specially catered to retail investors with limited capital for trading options on extremely high-priced securities. The coexistence of both Mini and standard options for the same underlying security provides us a novel setting to investigate whether and how small retail investors use derivatives contracts differently compared to their counterparts. First, we find that the Mini option investors are more subject to constraints of limited attention. Specifically, Mini option investors trade more intensively near market opens, and their trading activities are more heavily influenced by attention-grabbing events and attention-distracting events. Second, we document that Mini option investors' trading is more likely to be driven by market sentiment than standard option investors. Third, the trading performance of Mini option investors is also worse than that of standard option investors, with less positive intraday returns and more negative overnight returns.

Keywords: options, retail investors, trading behavior, limited attention, sentiment

JEL classification: G10, G11, G12, G41

1. Introduction

The recent phenomenon of extremely high prices of some popular technology stocks has attracted a lot of media and investor attention. For example, the share price of Amazon has risen from less than 10 dollars per share to over 3,000 dollars per share in the last twenty years. However, the extremely high price levels of these securities mean that many small retail investors hold less than 100 shares of the underlying securities, which is the size of one standard option contract. In March 2013, a new type of options, the so-called "Mini options" with a deliverable of 10 shares of the underlying security, were specially created as an attempt to attract small retail investors with limited capital.[1] This creates a natural separation of the small retail investors from the rest of the investor community in the options markets.[2] After some initial success, most of the Mini options were eventually delisted by most options exchanges by the end of 2014. Although the creation of Mini options proves to be a failed experiment by the options exchanges, in this study, we take advantage of such a novel setting and use transaction-level data to examine the differences in trading behavior between Mini and standard option investors.

We begin our analysis by comparing the intraday trading patterns of Mini and standard option investors. We find that, compared to standard options, the trading of Mini options is more clustered near market opens and less clustered near market closes. This is consistent with the prediction that Mini option investors consist of mainly small individual investors with full-time jobs and thus have limited attention during normal working hours. As a result, they have less time to respond to the

[1] "Mini Options" are available for the five most popular but extremely high-priced securities, including Apple (AAPL), Amazon (AMZN), Google (GOOG), SPDR Gold Trust ETF (GLD), and SPDR S&P 500 ETF Trust (SPY). Although there are only five tickers, the daily standard option trading volume of these five tickers represents about a quarter of the total trading volume of the entire options market (with about 3800 underlying securities).

[2] Despite a lot of criticism, options exchanges maintained that the trading commissions for Mini options were based on the number of contracts traded instead of the number of underlying shares. Thus, for the same number of underlying shares, trading Mini options incurs ten times the trading commissions compared to trading standard options. In addition to commission, there is also evidence that other measures of transaction costs, such as quoted and effective bid-ask spreads, are also much higher for Mini options than for standard options (see Li, Zhao, and Zhong, 2019).

new information that arrives during the trading hours and thus trade less before the market closes compared to standard option investors. On the contrary, Mini option investors usually conduct their research in the evening and place orders before the market opens.

As the trading volume in Mini options is significantly higher near market opens, we further explore whether the intense trading in Mini options at market opens would lead to price pressure, as predicted by Garleanu, Pedersen, and Poteshman (2009). Price pressure effect exists if demand pressure increases the price of options. We find that the difference in demand pressure of Mini and standard options is positively and significantly related to the difference in option prices (or implied volatility) between Mini and standard options, supporting the existence of demand pressure effect on Mini option prices due to retail trading. More importantly, we find that price pressure is more prominent near market opens than other trading periods.

The more intense trading and higher price pressure at the market open of Mini options lead us to examine the intraday and overnight option return pattern documented by Muravyev and Ni (2020). Muravyev and Ni (2020) document that average returns on options are positive intraday but negative overnight. They attribute this intraday-overnight pattern to option prices failing to account for the fact that stock volatility is higher intraday than overnight. Consistent with Muravyev and Ni (2020), we find positive intraday returns and negative overnight returns for both Mini options and standard options. Comparison between Mini and standard options further shows that the intraday return of Mini options is significantly smaller than that of standard options, but the overnight returns are similar. One possible explanation is that the demand pressure of retail investors increases option prices at opens, which leads to lower intraday returns. Therefore, our results imply that limited attention is a potential driver of the intraday return spread between Mini options and standard options. They also lend support to the notion that Mini option traders, which are mainly retailer investors, earn less and suffer more compared with standard option traders.

Apart from market opens and closes, the effect of limited attention on Mini and standard options trading are also likely to exist around attention-grabbing events and attention-distracting

events. The attention-grabbing events we focus on are quarterly earnings announcements and the ranking of daily winners or losers in the stock market. Quarterly earnings announcements are scheduled in advance and attract a lot of investor attention (Liu and Peng, 2018). Newspapers, TV business channels, and business news websites rank stocks by daily returns and list the winners and losers, i.e., the top and bottom stocks, making them subject to spikes in attention (Kumar, Ruenzi, and Ungeheuer, 2019). To identify attention-distracting events, we use episodes of sensational news exogenous to the market and not related to the economy (Eisensee and Stromberg, 2007; Peress and Schmidt, 2020). Some examples of sensational news are the Boston Marathon bombing, Moore Oklahoma tornado, and MH17 plane crash. We predict that Mini option investors, mainly small retail investors, would trade more (less) heavily around attention-grabbing (attention-distracting) events than standard option investors. We find that, while the dollar trading volume of both Mini options and standard options increases the day after earnings are announced and after stocks being ranked as daily winners/losers, Mini option investors react more strongly than standard option investors. For example, the dollar trading volume of Mini call (put) options is 15.1% (15.6%) higher on the day after earnings announcements than normal times. In comparison, the dollar trading volume of standard call (put) options is 10.8% (11.2%) higher on the day after earnings announcements than normal times. For attention-distracting events, we find that the dollar trading volume of Mini call (put) options is 3.9% (4%) lower on distracting days than normal times. In comparison, the dollar trading volume of standard call (put) options is only 0.7% (0.3%) lower on distracting days than normal times. Therefore, Mini option investors' attention would be attracted (distracted) by attention-grabbing (attention-distracting) events and increase (reduce) their trading activities to a larger extent than standard option investors.

Previous studies investigate various economic consequences of investor sentiment (De Long et al., 1990; Baker and Wurgler, 2006; Yu and Yuan, 2011; Stambaugh, Yu, and Yuan, 2012). In our study, we explore how market sentiment affects retail investors and institutional investors differently. Specifically, since the C/P ratio (daily dollar trading volume of call options divided by

that of call and put options) is often seen as an indicator of investor sentiment (Bandopadhyaya and Jones, 2008; Houlihan and Creamer, 2019; Gang et al., 2020), we start our analysis by comparing the trading preference over call versus put options by comparing the C/P ratio of Mini options and standard options. We find that the C/P ratio of Mini options is significantly higher than the C/P ratio of corresponding standard options.[3] This indicates that, compared to standard option traders, Mini options investors are more likely to trade call options rather than to trade put options.[4]

To examine whether retail investors' trading is more likely to be driven by market sentiment, we relate the C/P ratio of Mini options and standard options to other sentiment measures. C/P ratio is calculated at the daily level, so we use the Daily News Sentiment Index from the official website of the Federal Reserve Bank of San Francisco as our measure of market sentiment. Daily News Sentiment Index is a high-frequency measure of economic sentiment based on lexical analysis of economics-related news articles (Shapiro, Sudhof, and Wilson, 2020).[5] We conjecture that the relation between the sentiment index and the C/P ratio would be stronger for Mini options. Consistent with our prediction, we find that market sentiment is more strongly related to the C/P ratio of Mini options than standard options. Overall, our findings suggest that, compared to standard options, the trading of Mini options is more likely to be driven by market sentiment.

Lastly, we compare the trading performance of Mini option investors and standard option investors. Specifically, we investigate the relation between order imbalance and future returns in Mini options. Order imbalance is measured as the daily dollar trading volume of buy trades divided

[3] Results are qualitatively similar if we calculate C/P ratio using trading volume in number of contracts.

[4] Moreover, the preference of calls over puts by Mini option investors is more pronounced among buys trades than among sell trades and is more prominent for options on the S&P500 index ETF than for options on individual stocks. This suggests that, rather than buying put options on index ETF to protect against market crashes, Mini options investors are more inclined to buy call options on index ETF to profit from market surges.

[5] The sentiment index is downloaded from the official website of Federal Reserve Bank of San Francisco: https://www.frbsf.org/economic-research/indicators-data/daily-news-sentiment-index/. Shapiro, Sudhof, and Wilson (2020) construct sentiment index for economics-related news articles from 16 major U.S. newspapers compiled by the news aggregator service LexisNexis. It aggregate the individual article scores into a daily time-series measure of news sentiment, relying on a statistical adjustment that accounts for changes over time in the composition of the sample across newspapers.

by the daily dollar trading volume of buy and sell trades. The predictability analysis shows that the order imbalance of Mini options is negatively and significantly related to option returns of the next trading day. However, we do not find similar patterns in standard options. Overall, our results suggest that Mini options trading is associated with lower next-day returns.

Our paper adds to the prior literature in several ways. First, we provide further evidence on how limited attention affects the trading behavior of retail investors. Prior literature has shown that rather than searching systematically, individual investors may consider only stocks that first catch their attention (e.g., stocks that are in the news or with large price moves).[6] For example, Barber and Odean (2008) find that individual investors execute proportionately more buy orders for more attention-grabbing stocks. Choy and Wei (2012) document that options trading around attention-grabbing events, such as earnings announcements, is mainly speculative and is mostly dominated by small retail investors.[7] The introduction of Mini options provides us a novel setting to examine how limited attention affects the trading behavior of retail investors and institutional investors differently. Using transaction-level data, we show that Mini option investors trade more intensively near market opens than standard option investors. The more intensive trading induced by limited attention further leads to larger price pressure at market opens and lower subsequent intraday returns in Mini options. In addition, most prior studies mainly focus on how attention-grabbing events affect the trading activities of individual investors. We also explore the effect of attention-distracting events on Mini options trading.

Secondly, our study also adds to the literature exploring the puzzle of intraday versus overnight return patterns. Lou, Polk, and Skouras (2019) document that stocks with higher

[6] Kumar, Ruenzi, and Ungeheuer (2019) find that retail investors' buying pressure surges when stocks are ranked as daily winners or daily losers. In the option market, Driessen, Lin and Hemert (2012) take the 52-week high or low as attention-attracting events, and find a strong and significant increase in option IV after breakthroughs.

[7] Choy and Wei (2020) find that option investors (especially retail investors) buy more calls and puts written on attention-grabbing stocks, such as daily winners and losers, and this buying pressure leads to subsequent lower hedged returns.

overnight (intraday) returns over the last month have higher overnight (intraday) returns as well as lower intraday (overnight) returns in the subsequent month. This pattern is consistent with the notion that intraday returns are mainly driven by institutional investors who trade during the day, while overnight returns are driven by retail investors whose trades tend to execute near the open.[8] Regarding the options market, Muravyev and Ni (2020) find that average option returns are positive intraday but negative overnight. They attribute this intraday-overnight pattern to option prices failing to account for the fact that stock volatility is higher intraday than overnight. Relying on the setting of the Mini options market, our paper takes a further step to explore this pattern in terms of investor heterogeneity. We find that the positive intraday returns of Mini options are significantly smaller than those of standard options, which could be partially explained by the larger price pressure of Mini options at market opens.

Thirdly, we contribute to the investor sentiment literature by exploring retail investors' sentiment trading in the options market. Previous literature on investor sentiment can be divided into two categories. One stream investigates the economic consequence of investor sentiment. For example, De Long et al. (1990) theoretically argue that sentiment-driven noise traders with erroneous stochastic beliefs could drive stock price temporarily away from fundamental value. Baker and Wurgler(2006) find that investor sentiment has larger effects on securities whose valuations are highly subjective and difficult to arbitrage. Yu and Yuan (2011) show that sentiment directly influences the mean-variance tradeoff on the market portfolio. Stambaugh, Yu, and Yuan (2012) find that a broad set of anomalies are stronger following stronger sentiment. The other stream of sentiment literature focuses on how to measure investor sentiment. For example, previous research have explored the use of investor survey (Brown and Cliff 2005; Qiu and Welch 2004;

[8] In another related paper, Hendershott, Livdan, and Rösch (2020) explore the full cross-sectional relationship between the expected returns and beta. They find that stock returns are positively related to beta overnight, but negative related to intraday beta. In a recent paper, Bogousslavsky (2021) find that institutional constraints such as margin requirement and lending fees, could help explain the cross-sectional variation in the intraday-overnight return.

Lemmon and Portniaguina 2006), investor mood (Kamstra, Kramer, and Levi, 2003; Edmans, Garcia, and Norli, 2007), retail investor trades (Barber, Odean, and Zhu, 2008; Kumar and Lee, 2006; Edelen, Marcus, and Tehranian, 2010), mutual fund flows (Brown et al., 2002; Frazzini and Lamont, 2006); IPO first-day returns (Dorn 2009), option market metrics (Bandopadhyaya and Jones 2008; Houlihan and Creamer 2019), etc. Our study mainly contributes to the first stream of literature by exploring the effects of market sentiment on options market trading. In particular, we focus on the different effects of sentiment on Mini option investors and standard option investors and find that Mini option investors' trading is more likely to be driven by market sentiment.

Lastly, we also contribute to the literature on retail investors' trading performance. For example, Choy and Wei (2012) show that a higher level of retail trading participation in options is associated with lower returns. Lakonishok, Lee, Pearson, and Poteshman (2007) compare the options market activity of retail investors to that of firm proprietary traders and show that a significant fraction of options trading by discount customers is speculative in nature. Byun and Kim (2016) show that lottery-like options, to which retail investors display preference, are overpriced and earn lower future returns. Consistently, we also find that the trading performance of Mini option investors is worse than that of standard option investors.

The rest of our paper is organized as follows: Section 2 describes data and sample. Section 3 examines whether and how constraints of limited attention affect the trading activities of Mini option investors. Section 4 compares the C/P ratios and presents the sentiment-driven trading pattern of Mini option investors. Section 5 compares the trading performance of Mini option investors and standard option investors. Section 6 provides robustness checks of our main results. Section 7 concludes the paper.

2. Data and sample

2.1 Data and sample selection

Our main analysis is conducted using intraday option transaction data. We obtain trades and quotes on each option series from LiveVol. Each option series is uniquely identified by its underlying stock, option type (call or put), expiration date, and strike price. The LiveVol database contains information on all executed option transactions, including the NBBO quotes at the time of the trade, execution price, trade size (number of contracts), implied volatility, and option Greeks. We remove trades that were canceled or recorded outside regular trading hours. Next, we only retain all records that meet all the following conditions: (1) \$0 < bid < ask < 5×bid; (2) trade size > 0; (3) \$0.1 < trade price < 2×mid-quote; (4) 0.125< absolute value of option delta <0.875; (5) time-to-maturity>=10. Our sample covers both Mini and standard options. We also get daily stock return data from CRSP. As Mini options were launched on March 18, 2013, and gradually got delisted by the end of 2014, our sample period is from March 18, 2013, to December 31, 2014 (453 trading days).

2.2 Descriptive statistics of the Mini options market

Table 1 shows the total number of transactions and total dollar trading volume of Mini and standard options for the following five tickers: Apple (AAPL), Amazon (AMZN), Google (GOOG), SPDR Gold Trust ETF (GLD), and SPDR S&P 500 ETF Trust (SPY). It is worth noting that, although there are only five tickers, the daily standard options trading volume of these five tickers represents about a quarter of the total trading volume of the entire options market (with about 3800 underlying securities).

In terms of the number of transactions (Panel A), there are approximately 0.6 million Mini option transactions and about 26 million standard option transactions during our sample period from March 18, 2013, to December 31, 2014. For Mini option transactions, the majority of transactions take place in AAPL (57%), followed by GOOG (16%), AMZN (13%), SPY (9%), and

GLD (5%). However, for standard option transactions, the largest proportion goes to SPY (43%), followed by AAPL (37%), GLD (8%), AMZN (7%), and GOOG (5%). Overall, trading on Mini options of individual stocks (i.e., AAPL, AMZN, and GOOG) takes about 86% of total transactions in Mini options while trading on standard options of individual stocks and ETFs (i.e., SPY and GLD) each is about half of the total transactions in standard options.

With respect to dollar trading volume (Panel B), there are around 0.7 billion dollars trading in Mini options and about 187 billion dollars trading in standard options. Similar to the findings above, compared to standard option traders who place similar weight on options of individual stocks and ETFs, Mini option investors tend to concentrate their trading on options of individual stocks. The difference in their trading portfolio choices is consistent with our conjecture that the traders of Mini options are more likely to be small retail investors, while standard option investors are more likely to be institutions.

Panel C presents the dollar trading volume by moneyness. ATM options have absolute values of delta between 0.4 and 0.6. ITM options have absolute values of delta greater than 0.6. OTM options are those options with absolute values of delta smaller than 0.4. As shown, ATM options are most actively traded for both Mini and standard options. In addition, the trading volume of OTM options is higher than that of ITM options for both call and put Mini options, which implies a strong risk-seeking preference of Mini option traders. However, for standard put options, the trading volume of OTM options is smaller than the trading volume of ITM options, suggesting a relatively conservative risk-taking attitude of standard option traders.

< INSERT TABLE 1 HERE >

3. Limited attention

Due to the much higher transaction costs (such as commissions and effective bid-ask spread) of trading Mini options (Li, Zhao, and Zhong, 2019), Mini option investors are more likely to be small retail investors. Compared to institutional investors, they are more likely to be subject to

constraints of limited attention. For example, they tend to buy stocks that are attention-grabbing, such as stocks in the news, stocks experiencing high abnormal trading volume or extreme returns, and stocks of local companies (Barber and Odean, 2008; Engelberg and Parsons, 2011; Engelberg, Sasseville, and Williams, 2012). They are also more likely to be distracted from trading by sensational news (Peress and Schmidt, 2020). In this part, we examine how the trading behavior of Mini option investors is affected by limited attention.

3.1 Trading at market open and close

In this sub-section, we explore the intraday trading behavior of Mini and standard option investors by examining the intraday proportional trading volume. Each day, the trading hours (from 9:30 to 16:00) are divided into 5-minute intervals (e.g., 9:30-9:35, 9:35-9:40). For each 5-minute interval of a trading day, we calculate the dollar trading volume of all Mini or standard options of a ticker and then divide it by the total daily trading volume of Mini or corresponding standard options of that ticker to get the intraday proportional trading volume.

We first plot intraday figures of the proportional trading volume of Mini and corresponding standard options. As shown in Figure 1, the solid red (dotted blue) line stands for Mini (standard) options. Panel A and Panel B show the figures for call options and put options, respectively. We find an L-shape for Mini options and a U-shape for standard options. The Mini options trading volume in the first 5-minute of the trading hours (i.e., 9:30-9:35) accounts for 7%-8% of the total trading volume of the day. In contrast, the standard options trading volume in the first 5-minute is only about 3.5% of the total trading volume of the day. Then the proportional trading volume of Mini options and standard options gradually decreases to a stable level at about 1%. In the last 5-minutes of the trading hours, trading activities rise to approximately 2%. The rise is more pronounced for standard options than for Mini options, especially among call options.

<INSERT FIGURE 1 HERE>

Next, we use a regression framework to formally test the differences in the intraday trading pattern of Mini options and standard options at market opens and closes. Based on the patterns observed in Figure 1, we test whether Mini option investors are more (less) likely to trade at the start (end) of a trading day than standard option investors. The results are shown in Table 2. The dependent variable is the proportional trading volume. *First5* is a dummy variable, which is equal to 1 if trading activities occur in the first five minutes of the trading hours (i.e., 9:30-9:35), and 0 otherwise. *Last5* is an indicator variable for the last five minutes of the trading hours, i.e., 15:55-16:00. *Mini* is the indicator variable for Mini options.

Consistent with Figure 1, Columns 1 and 2 (Columns 4 and 5) show that both Mini and standard call (put) options trading are more active in the first and last five minutes of the trading hours than other times. We then test the differences in the proportional trading volume of Mini and standard call (put) options during the first and last five minutes by adding the interaction between *Mini* and *First5* (i.e., *Mini*First5*) or *Last5* (i.e., *Mini*last5*). As shown in Columns 3 and 6, the interaction between *Mini* and *First5* (*Mini*First5)* is significantly positive, while the interaction between *Mini* and *Last5* (*Mini*Last5*) is significantly negative.[9] Therefore, compared to standard option trades, Mini option trades are more (less) likely to be executed near market opens (closes). This result is consistent with the hypothesis that Mini option investors are mainly individual investors with full-time jobs who have limited attention during working hours. As a result, Mini option investors usually place orders before the market opens or in the previous evening after they catch up on the news after work.

<INSERT TABLE 2 HERE>

[9] The regression coefficients (in columns 3 and 6) for calls and puts are not significantly different based on z-statistics.

3.2 Price pressure at market opens

As the trading volume in Mini options is significantly higher near market opens, we further explore whether the intense trading in Mini options at the open leads to price pressure, as predicted by Garleanu, Pedersen, and Poteshman (2009). Price pressure effect exists if demand pressure increases the price of options. Demand pressure is defined as the total dollar trading volume of buy trades minus the total dollar trading volume of sell trades and then divided by the total dollar trading volume of buy and sell trades in each 5-minute interval. An option transaction is classified as buyer-initiated if it is executed above the mid-quote and as seller-initiated if it is below the mid-quote. Next, we calculate the volume-weighted average option price (or implied volatility) for each interval. Mini options are matched with standard options based on the underlying security, option type (call or put), expiration date, and strike price. To capture the price pressure effect, we run the following regression: The dependent variable is the difference in price (or implied volatility) between Mini options and their matched standard options. The independent variable is the difference in demand pressure between Mini options and standard options (i.e., *Demand Pressure Diff*). To measure the additional price pressure effect at market opens, we include *Market Open Dummy* and its interaction with *Demand Pressure Diff*. Specifically, *Market Open Dummy* is equal to one if the trading time is within the first 30-minute interval (9:30:00-9:59:59); otherwise, it is equal to 0.

<INSERT TABLE 3 HERE>

The regression results are presented in Table 3. As shown by the coefficient of *Demand Pressure Diff*, the difference in demand pressure between two options markets is positively and significantly related to the option price (implied volatility) difference, suggesting the existence of price pressure effects on Mini option prices due to retail tradings. Taking column 2 as an example, the coefficient of the interaction term is 0.0007 with a significance level of 1%. Economically, this result suggests that one standard deviation increase in demand pressure differences leads to 0.05% larger difference of implied volatility between the paird standard and Mini options, and this value

is equal to 14.39% of the sample mean value. In addition, the positive coefficient of interaction between *Demand Pressure Diff* and *Market Open Dummy* implies that, compared to standard options, Mini options experience larger demand-pressure during open intervals, which induces a larger price deviation of Mini options from the corresponding standard options.

3.3 Intraday versus overnight returns

If intense trading at market opens leads to higher price pressure, then how would option returns be affected? In this sub-section, we examine the effect of limited attention on intraday and overnight returns of Mini options and standard options. Muravyev and Ni (2020) document that average returns on options are positive intraday but negative overnight, based on the standard options data from January 2004 to April 2013. They attribute this intraday-overnight pattern to option prices failing to account for the fact that stock volatility is higher intraday than overnight. Since most trading activities in Mini options likely stem from retail traders, we examine if the intraday and overnight patterns are stronger/weaker in Mini options than in standard options.

Following Muravyev and Ni (2020), we construct delta hedged return for intraday and overnight period as:

$$Ret_t = \frac{C_t - C_{t-1} - Delta_{t-1}(S_t - S_{t-1})}{C_{t-1}}$$

C is the option price. *Delta* is the option delta, and *S* is the stock price. The intraday return is from open to close, and the overnight return is from close to the next day's open. We apply the same data filters as Muravyev and Ni (2020). Specifically, we exclude option contracts for which option prices violating no-arbitrage bounds, the bid price is greater than or equal to the ask price, the bid price is not available or is below 50 cents, the quoted bid-ask spread is over 70% of the midpoint, or three dollars or if option delta cannot be computed. In order to compare the intraday/overnight pattern of the two options markets, we match every Mini option contract with its corresponding standard option contract on the same day to compare their intraday and overnight returns.

The empirical results are presented in Table 4. Panel A reports the results for the full sample. As we can see, both standard options and Mini options of the five tickers show a generally significant pattern of positive intraday returns and negative overnight returns. However, the positive intraday return pattern is significantly weaker in Mini options than in standard options, and the negative overnight return pattern is similar in Mini options and standard options. Specifically, the intraday returns of Mini options are significantly less positive compared to standard options in four out of the five stocks/ETFs, and the overnight returns of Mini options are significantly more negative than that of standard options in one of the five stocks/ETFs. Similar patterns are presented in Panel B for call and put options separately. Therefore, our results suggest that the more crowded trading induced by Mini option investors' limited attention could also lead to larger price pressure at market opens and lower subsequent intraday returns.

<INSERT TABLE 4 HERE>

3.4 Trading around attention-grabbing events

In this sub-section, we examine how attention-grabbing events affect daily trading patterns of Mini options and standard options. The attention-grabbing events we focus on are quarterly earnings announcements and daily winners/losers. The earnings announcement is one of the most significant information events for a firm. It is scheduled in advance and attracts a lot of investor attention (Liu and Peng, 2018). Stocks are ranked prominently in the media, leading to investor attention spikes (Kumar, Ruenzi, and Ungeheuer, 2019).

We predict that Mini option investors, mainly small retail investors, would react to attention-grabbing events by trading more heavily around these events than during normal times. Compared to standard option investors who are less subject to constraints of limited attention and devote attention to material information no matter whether it is attention-grabbing or not, Mini option investors may devote too much attention to these events. Therefore, we also predict that Mini option investors would trade more heavily around these events than standard option investors.

3.4.1 Earnings announcements

During our sample period from March 18, 2013, to December 31, 2014, each of the three individual stocks had seven earnings announcements. As all of the earnings announcements are after-hour, event day is the next trading day after the earnings announcement. We perform an event study analysis of options trading volume around earnings announcements. Trading volume is defined as the logarithm of daily dollar volume. It is calculated at ticker level each day for Mini options and standard options. We define normal trading volume as the average trading volume in a 100-day window that is centered on the event day.[10] Abnormal trading volume is the trading volume on event day minus normal trading volume and then divided by normal trading volume. We test for the significance of abnormal trading volume using parametric t-test as well as nonparametric rank test.

As shown in Panel A of Table 5, dollar trading volume (log($volume)) of Mini call (put) options is 15.1% (15.6%) higher on the day after earnings announcements than normal times (Column 1). In comparison, the dollar trading volume of standard call (put) options is 10.8% (11.2%) higher on the day after earnings announcement than normal times (Column 2). The difference in abnormal trading volume between Mini options and standard options is statistically significant (Column 3). Overall, Mini option investors' attention is attracted by earnings announcements, and their trading activities are more heavily influenced by such an event than standard option investors.

<INSERT TABLE 5 HERE>

[10] Results are unchanged if the window includes only the pre-event period.

3.4.2 Extreme returns (daily winners or daily losers)

One of the most salient events for a stock is being a daily winner or loser. These stocks are ranked prominently in the media, leading to investor attention spikes. Following Kumar, Ruenzi, and Ungeheuer (2019), we define daily winners/losers as stocks with daily returns ranked as top 80 or bottom 80 in the CRSP universe (including all common shares traded on the NYSE, the AMEX, NASDAQ, and Arca). Event day is the next trading day after a stock is ranked as daily winner or loser. In our sample period from March 8, 2013, to December 31, 2014, there are 16 event days, including seven winner days and nine loser days.

Using the same methodology as described in section 3.4.1, we perform an event study analysis of dollar trading volume when the underlying stock is ranked as daily winners or daily losers. As shown in Panel B of Table 5, the dollar trading volume (log($volume)) of Mini call (put) options is 17.1% (15.9%) higher on the day after the underlying stocks experience extreme returns than normal times (Column 1). In comparison, the dollar trading volume of standard call (put) options is 9.8% (11.5%) higher on the day after the underlying stocks are ranked as daily winners or losers than normal times (Column 2). The difference in abnormal trading volume between Mini options and standard options is statistically significant (Column 3). Overall, Mini option investors' attention is attracted by extreme returns, and their trading activities are more heavily influenced by such an event than standard option investors.

3.5 Trading around distracting events

In this sub-section, we examine how events that divert, rather than attract, investors' attention would affect trading activities in Mini options and standard options. Peress and Schmidt (2020) show that on days with sensational news events that are exogenous to the economy, trading activities decrease, particularly among small stocks owned predominantly by retail investors. As Mini options are predominantly traded by retail investors, we examine how distraction events affect the trading activities of Mini options.

To get a sample of distraction events, we follow Eisensee and Stromberg (2007) and Peress and Schmidt (2020) and use a variable called "news pressure". This variable measures the median number of minutes that U.S. news broadcasts spend on the first three news segments. Each year, we sort days into news pressure deciles and identify days belonging to the highest decile. We then read the headlines of the news segments in the highest decile and retain only those days for which sensational news events are plausibly exogenous to the economy.[11] This procedure yields a list of 56 event days. Examples of distracting events include the Boston Marathon bombing, Moore Oklahoma tornado, and MH17 plane crash.

We predict that Mini option investors, mainly small retail investors, would react to attention-distracting events by trading less heavily around these events than during normal times. Compared to standard option investors who are less subject to constraints of limited attention and devote attention to trading no matter whether there are attention-distracting events, Mini option investors may be diverted these events and trade less. Therefore, we also predict that Mini option investors would trade less heavily around these events than standard option investors.

Using the same methodology as described in section 3.4.1, we perform an event study analysis of dollar trading volume on distracting-event days. As shown in Panel C of Table 5, the dollar trading volume (log($volume)) of Mini call (put) options is 3.9% (4%) lower on distracting days than normal times (Column 1). In comparison, the dollar trading volume of standard call (put) options is 0.7% (0.3%) lower on distracting days than normal times (Column 2). The difference in abnormal trading volume between Mini options and standard options is statistically significant (Column 3). Therefore, Mini option investors' attention is diverted by distracting events, and they reduce their trading activities to a larger extent than standard option investors.

[11] We exclude days on which headline of news segment contain the following keywords: banking, bankruptcy, default, depression, economic, economy, election, employment, equity, federal reserve, fed reserve, fed rate, finance, financial, inflation, interest rate, recession, stock market, treasury, and war.

To summarize, we examine how limited attention affects the trading activities of Mini option investors by comparing the intraday and daily trading patterns of Mini options and standard options. Firstly, we find that Mini option investors trade more (less) heavily at market open (close) than standard option investors. Secondly, the intense trading induced by limited attention at market opens further leads to larger price pressure and lower intraday returns of Mini options compared to standard options. Thirdly, attracted by attention-grabbing events (such as earnings announcements and extreme returns), Mini option investors would increase trading volume to a larger extent than standard option investors. Finally, Mini option investors would reduce trading activities more heavily on days when there are attention-diverting events (i.e., sensational news such as the MH17 plane crash).

4. Sentiment-driven trading

Kumar and Lee (2006) and Barber, Odean, and Zhu (2008) find that retail investors buy and sell stocks in concert, which is consistent with the systematic sentiment. In a survey paper, Baker and Wurgler (2007) also argue that retail investors are more likely than professionals to be subject to market sentiment. In this section, we investigate retail investors' sentiment trading using the unique setting of the Mini options market.

4.1 C/P ratio

Since the C/P ratio is often seen as an indicator of investor sentiment (Bandopadhyaya and Jones, 2008; Houlihan and Creamer, 2019; Gang et al., 2020)[12], we compare the preference of call versus put options of Mini option investors and statistically test the differences between Mini and standard option investors. C/P ratio is the daily dollar trading volume of call options divided by the daily dollar trading volume of call options and put options. It is calculated at the ticker-daily level.

[12] C/P ratio is also commonly used in investment industry and can be download from CBOE official website: https://www.cboe.com/us/options/market_statistics/historical_data/#volume-put-call-ratios.

If investors have no preference between call options and put options, then the C/P ratio is expected to be 0.5. If investors prefer call (put) options, then the C/P ratio would be greater (less) than 0.5.

Table 6 shows the C/P ratios of Mini options and standard options. C/P ratio is calculated for buy trades and sell trades separately. We classify an option transaction as buyer-initiated if it is executed above the mid-quote and as seller-initiated if it is below the mid-quote. Focusing our analysis on buy trades, we find that the mean C/P ratio of Mini options across all tickers is 0.630, suggesting that call options are more actively traded than put options in the Mini options market. More importantly, the mean C/P ratio of Mini options is approximately 10% higher than that of corresponding standard options (0.630 versus 0.573), and the difference is statistically significant at the 1% level. This indicates that compared to standard option investors, Mini option investors are more likely to buy call options than put options.

Dividing the full sample into options on individual stocks, S&P500 ETF, and Gold ETF, we find that the above result is more prominent for the S&P 500 ETF options. The mean C/P ratio of S&P500 Mini options is about 36% higher than that of standard options (0.545 versus 0.400). This suggests that, while standard options investors tend to buy put options on the S&P 500 index ETF to protect against market downside risks, Mini options investors tend to buy call options on index ETF to profit from upward market movements. The results using median values are qualitatively similar.

It is worth noting that, for both Mini options and standard options, the C/P ratio of individual stock options is higher than that of the S&P 500 ETF options. For example, among Mini options, the C/P ratio for individual stocks options is about 0.674/0.672 (buy/sell) and 0.545/0.514 (buy/sell) for the S&P 500 ETF options. However, the purpose of the analysis of the C/P ratio here is to show the difference of C/P ratio between Mini and standard options, and we find that there are larger differences (between Mini and standard options) in the case of the S&P 500 index options than in the case of individual stock options.

<INSERT TABLE 6 HERE>

4.2 C/P ratio and market sentiment

Next, we relate time variation in the C/P ratio to other sentiment measures. We conjecture that the relation between the sentiment index and the C/P ratio would be stronger for Mini options. In order to examine this argument, we obtain the "*Daily News Sentiment Index*" from the official website of the Federal Reserve Bank of San Francisco. It is a high-frequency daily measure of economic sentiment based on lexical analysis of economics-related news articles. This index is described in Buckman et al. (2020) and is constructed based on the methodology developed in Shapiro, Sudhof, and Wilson (2020). We run regressions of both volume and dollar volume C/P ratios on the interaction of the *Mini* dummy variable and this daily sentiment index. The empirical regression is presented in Table 7. Ticker and date fixed effects are added, and standard errors are two-way clustered at ticker and date level. We find that the relation between the C/P ratio and sentiment index is significantly stronger for Mini options, as shown by the significant coefficients of the interaction terms in Panel A and Panel B. Taking the first column of Panel A as an example, the coefficient of the interaction term between *Mini* and *Sentiment* is 0.0703, which implies that one standard deviation increase in the sentiment index leads to 0.01 more increase in the C/P ratio for Mini options, and this represents 1.65% of the sample mean value.

In an additional analysis, we run the regression for stocks and ETFs separately and find significant results for stocks and SPY, which is generally consistent with the findings in Table 6. We also relate the C/P ratio with Baker and Wurgler (2006) index, which is measured at monthly frequency. The results remain qualitative similar and are not tabulated here for brevity. In sum, these results indicate that Mini option investors' trading is more likely to follow the market sentiment.

<INSERT TABLE 7 HERE>

5. Trading performance

In this section, we compare the trading performance of Mini option investors and standard option investors. As analyzed in Sections 3 and 4, Mini option investors' trading is more likely to be constrained by their limited attention and driven by market sentiment. Therefore, we conjecture that their trading performance would be worse compared to standard option investors.

We begin our analysis by comparing the order imbalance of Mini options and corresponding standard options. Order imbalance is measured as the total dollar trading volume of buy trades divided by the total dollar trading volume of buy and sell trades. It is calculated for call and put options separately at the ticker-daily level. As shown in Table 8, the mean and median of order imbalance are, in general, close to 0.5 for both Mini and standard options (calls and puts).[13] The order imbalance distribution of Mini options is more dispersed than that of standard options. For example, the standard deviation of order imbalance is much larger among Mini options than standard options (calls: 0.238 versus 0.140, puts: 0.258 versus 0.140). The 5th (95th) percentile of order imbalance is much smaller (larger) for Mini options than standard options.[14]

<INSERT TABLE 8 HERE>

Next, we explore the relation between order imbalance and future returns in Mini options to see whether retail investors experience positive or negative payoffs. Specifically, we explore and compare the predictive relationship between order imbalance and the option returns of the next trading day in Mini and standard options markets. Both Bauer, Cosemans and Eichholtz (2009) and Choy and Wei (2012) find that a higher level of retail trading participation in options is associated with lower returns. In the following regression, we measure order imbalance using the total trading volume of buy trades minus the total trading volume of sell trades and then divided by the total

[13] Cross-sectional analysis reveals that the order imbalance of Mini call options on S&P500 index ETF (0.548) is larger than that of standard call options (0.493) and the difference is statistically significant at the 1% level.
[14] This is likely due to the liquidity in Mini options being much lower than in standard options (as shown in Table 1), which could make order imbalance more volatile.

trading volume of buy and sell trades. It is calculated for every option contract on every trading day. We find that the order imbalance in Mini options significantly predicts the option return of the next trading day with a negative sign. The regression results are presented in the Panel A of Table 9. The coefficient of *Order_Imbalance* is -0.0056 (-0.0047) in Column 1 (Column 3) , with a significance level of 1% (5%). Economically, this implies that one standard deviation increase of order imbalance leads to 0.29% (0.35%) decrease in the volume-weighted (dollar-volume-weighted) Mini option return. However, we do not find a significant relation between order imbalance and the next day's option returns for standard options. Taken together, these results suggest that Mini option buying is associated with lower next-day returns.

<INSERT TABLE 9 HERE>

6. Robustness check

As discussed earlier, most of the trading volume in Mini options is concentrated in AAPL. Therefore, we check the robustness of our main results after excluding AAPL. We reproduce results in Tables 2 and 5 after excluding AAPL. Table 10 shows the trading of Mini and standard options at market open and close after excluding AAPL. Similar to our findings in Table 2, Mini option investors trade more actively at market opens and less actively at market closes compared to standard option investors. Table 11 shows the trading of Mini and standard options around attention-grabbing and attention-distracting events after excluding AAPL. After excluding AAPL, the number of earnings announcements decreases from 21 to 14, and extreme return days decrease from 16 days to 10 days. Similar to our findings in Table 5, Mini option investors would increase trading volume to a larger extent than standard option investors around attention-grabbing events and reduce trading activities more heavily on days when there are attention-diverting events. Overall, our results are robust after excluding AAPL from our sample.

<INSERT TABLE 10 HERE>

<INSERT TABLE 11 HERE>

7. Conclusion

Mini options are created as a tool for retail investors to trade options on extremely higher-priced securities. The coexistence of Mini options and standard options provides a novel setting to compare the trading behavior of retail investors with the rest of the investor community in the options market.

In this study, we first investigate how limited attention affects the trading behavior of Mni option investors and standard option investors. We find that Mini option investors trade more (less) heavily at market opens (closes) than standard option investors. The intense trading at market opens leads to higher price pressure and lower intraday returns of Mini options compared to standard options. In addition, Mini option investors would increase trading volume to a larger extent than standard option investors around attention-grabbing events and reduce trading activities more heavily on days when there are attention-diverting events.

We also find interesting differences in the C/P ratios and order imbalance between Mini option investors and standard option investors. Compared to standard option investors, Mini option investors' trading is more likely to be driven by market sentiment. Analysis of trading performance shows that the order imbalance of Mini options negatively and significantly predicts future option returns, suggesting that Mini options buying is associated with lower next-day returns. However, we do not find similar patterns in standard options.

Overall, as the Robinhood retail option traders have attracted a lot of attentions from industry and regulators since the 2020 Pandemic, our study of retail investors trading behavior and their market impact in the unique setting of Mini option market experiment could help a wide range of readers including regulators to better understand the ongoing surge of interest from retail investors in the option market.

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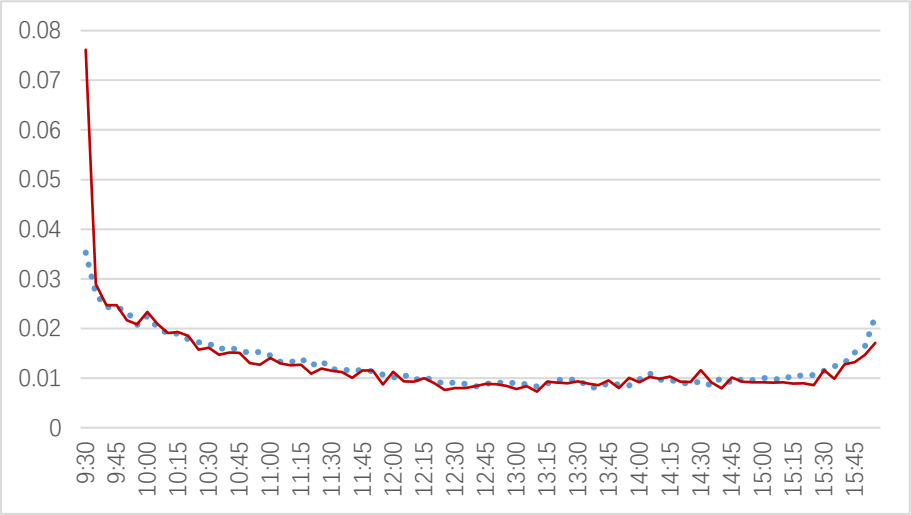
Figure 1: Intraday figures of proportional trading volume of Mini and standard options. This figure shows the intraday proportional trading volume of Mini options and standard options. Each day, the trading hours (from 9:30 to 16:00) are divided into 5-minute intervals (e.g., 9:30-9:35, 9:35-9:40). For each 5-minute interval in a trading day, we calculate the dollar trading volume of all Mini or standard options of a ticker and then divided it by the total daily trading volume of Mini or standard options of that ticker to get the intraday proportional trading volume. The dotted blue (solid red) lines show the intraday proportional trading volume of standard (Mini) options. The sample period is from March 18, 2013, to December 31, 2014.

Panel A: proportional trading volume of call options



Panel B: proportional trading volume of put options

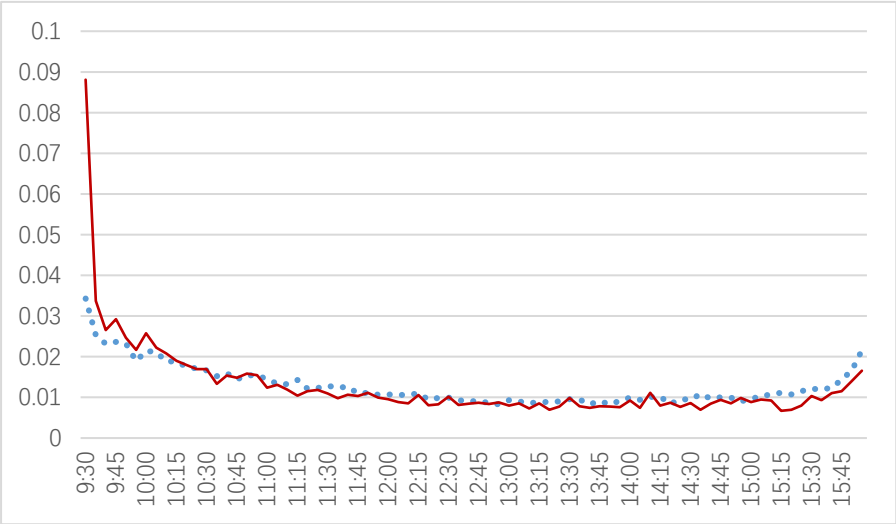


Table 1: Descriptive statistics

This table shows the total number of transactions and total dollar trading volume of Mini and standard options for the five most popular but extremely high-priced securities, including Apple (AAPL), Amazon (AMZN), Google (GOOG), SPDR Gold Trust ETF (GLD), and SPDR S&P 500 ETF Trust (SPY). Panel C presents the dollar trading volume by moneyness for Mini and standard options, separately. The sample period is from March 18, 2013, to December 31, 2014.

Panel A: Total number of transactions

	Mini		Standard	
	Call	Put	Call	Put
AAPL	234,324	111,100	6,527,732	3,025,268
AMZN	46,540	30,594	1,091,102	849,811
GOOG	60,969	36,181	777,834	496,797
GLD	17,678	16,468	1,068,408	888,258
SPY	24,478	30,478	4,623,643	6,397,448
Total	383,989	224,821	14,088,719	11,657,582

Panel B: Total dollar trading volume ($)

	Mini		Standard	
	Call	Put	Call	Put
AAPL	253,541,249	98,714,718	51,022,801,550	21,851,209,485
AMZN	44,717,330	33,849,675	4,819,610,482	3,614,858,843
GOOG	105,023,468	59,686,724	7,557,021,884	3,911,546,388
GLD	8,947,484	9,492,856	3,829,229,169	3,343,053,761
SPY	33,934,110	30,058,869	35,282,615,621	52,392,567,229
Total	446,163,641	231,802,841	102,511,278,706	85,113,235,706

Panel C: Dollar trading volume ($) by moneyness

	Mini		Standard	
	Call	Put	Call	Put
In-the-Money	69,328,408	54,190,192	23,036,790,784	33,034,176,512
At-the-Money	191,745,328	105,377,072	47,595,704,320	38,291,427,328
Out-of-the-money	185,089,904	72,235,576	31,878,782,976	13,787,631,616

Table 2: Trading of Mini and standard options at market opens and closes

This table shows the regression analysis of the intraday proportional trading volume of Mini options and standard options traded on the same day. Each day, the trading hours (from 9:30 to 16:00) are divided into 5-minute intervals (e.g., 9:30-9:35, 9:35-9:40). For each 5-minute interval of a trading day, we calculate the dollar trading volume of all Mini or corresponding standard options of a ticker and then divide it by the total daily trading volume of Mini or *corresponding* standard options of that ticker to get the intraday proportional trading volume. The sample period is from March 18, 2013, to December 31, 2014. The dependent variable is the intra-day proportional trading volume. *Mini* is the indicator for Mini options. *First5* is an indicator variable for the first 5-minute interval, i.e., 9:30-9:35. *Last5* is the indicator variable for the last 5-minute interval, i.e., 15:55-16:00. We also add *Maturity*, *NBBO midpoint*, *Market Cap*, *Stock Price*, and *Idiosyncratic Vol* as control variables. *Maturity* is the natural logarithm of the number of days to maturity. *NBBO midpoint* is the natural logarithm of NBBO midpoint price of options. *Market Cap* is the natural logarithm of market capitalization calculated as stock price times the number of shares outstanding. *Stock Price* is the natural logarithm of intraday stock price. *Idiosyncratic Vol* is calculated using daily returns of the prior month based on the Fama-French 4-factor model. Regression equations are shown below. Ticker and date fixed effects are included. The standard errors are two-way clustered at the ticker and date level. t-statistics are shown in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed t-tests.

$$Proportional\ trading\ volume_{\,5-min} =$$

$$\alpha + \beta_1 * First5 + \beta_2 * Last5 + \beta_3 * Mini + \beta_4 * First5 * Mini + \beta_5 * Last5 * Mini + Controls + Ticker\ FE + Date\ FE + \varepsilon$$

	Call			Put		
	Mini	Standard	Pooled	Mini	Standard	Pooled
First5	0.0639***	0.0227***	0.0227***	0.0757***	0.0218***	0.0217***
	(7.00)	(9.08)	(9.07)	(8.98)	(6.50)	(6.49)
Last5	0.0050**	0.0103***	0.0103***	0.0049*	0.0094***	0.0093***
	(3.58)	(10.04)	(10.12)	(2.61)	(6.33)	(6.32)
Mini			-0.0019***			-0.0016**
			(-7.33)			(-4.14)
*First5*Mini*			0.0412**			0.0539***
			(3.99)			(6.08)
*Last5*Mini*			-0.0053**			-0.0044***
			(-2.98)			(-4.64)
Constant	-0.0254	-0.0334	-0.0266	-0.1027	-0.1113	-0.105
	(-0.45)	(-0.63)	(-0.48)	(-1.01)	(-1.45)	(-1.14)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Ticker FE	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	173,160	174,252	347,412	168,714	173,940	342,654
R-Squared	0.03	0.02	0.03	0.03	0.02	0.03

Table 3: Demand-pressure effect

This table shows the regression analysis of option price difference on the net demand pressure difference. The dependent variable is the price differences (*Price Diff* or *ImpliedVol Diff*), measured by the difference in price or implied volatility between Mini options and corresponding standard options. The independent variable of interest is the demand pressure difference (*Demand Pressure Diff*), measured by the difference in demand pressure between Mini options and corresponding standard options. Option demand pressure is calculated as the total dollar trading volume of buy trades minus the total dollar trading volume of sell trades and then divided by the total dollar trading volume of buy and sell trades. An option transaction is classified as buyer-initiated if it is executed above the mid-quote and as seller-initiated if it is below the mid-quote. Both price difference and demand pressure difference are calculated for every option contract at every trading day for every 5-minute interval. *Market Open Dummy* is equal to one if the trading time is within the first 30-minute interval (9:30:00-9:59:59); otherwise, it equals 0. The sample period is from March 18, 2013, to December 31, 2014. Regression equations are shown below. We also add *Maturity*, *NBBO midpoint*, *Market Cap*, *Stock Price*, and *Idiosyncratic Vol* as control variables. *Maturity* is the natural logarithm of the number of days to maturity. *NBBO midpoint* is the natural logarithm of NBBO midpoint price of options. *Market Cap* is the natural logarithm of market capitalization calculated as stock price times the number of shares outstanding. *Stock Price* is the natural logarithm of intraday stock price. *Idiosyncratic Vol* is calculated using daily returns of the prior month based on the Fama-French 4-factor model. Ticker and date fixed effects are included. The standard errors are two-way clustered at the ticker and date level. t-statistics are shown in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed t-tests.

$$Price\ Diff_{5-min}\ or\ \ ImpliedVol\ Diff_{5-min}$$

$$= \alpha + \beta_1 * Demand\ Pressure\ Diff + \beta_2 * Market\ Open\ Dummy +$$

$$\beta_3 * Market\ Open\ Dummy * Demand\ Pressure\ + Controls + Ticker\ FE + Date\ FE + \varepsilon$$

	Price Diff	*ImpliedVol Diff*
Demand Pressure Diff	0.0421***	0.0007***
	(6.89)	(7.25)
Market Open Dummy	0.0044	-0.0001
	(0.51)	(-0.11)
*Market Open Dummy*Demand Pressure Diff*	0.0396***	0.0006**
	(5.82)	(4.08)
Constant	-0.7168	0.0712
	(-1.21)	(1.05)
Controls	Yes	Yes
Ticker FE	Yes	Yes
Date FE	Yes	Yes
No. of Obs.	93,065	93,065
R-Squared	0.03	0.18

Table 4: Intraday returns versus overnight returns

This table reports the delta-hedged returns of Mini options and standard options for intraday and overnight periods separately. The sample period is from March 18, 2013, to December 31, 2014. Panel A presents the results for the full sample, and Panel B presents the results for subsamples for call and put separately. The t-test equal to 0 is executed for each group, and the t-test for the difference between Mini and Standard option return is also executed. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Full Sample

	Standard		Mini		Mini-Standard Diff	
	Intraday	Overnight	Intraday	Overnight	Intraday	Overnight
AAPL	0.010***	-0.009***	0.006***	-0.009***	-0.004***	-0.000
AMZN	0.021***	-0.026***	0.013***	-0.030***	-0.008**	-0.004
GOOG	0.020***	-0.021***	0.013***	-0.022***	-0.007***	-0.001
GLD	0.047***	-0.028	0.046***	-0.045**	-0.001	-0.017*
SPY	0.017***	-0.011***	0.012***	-0.008	-0.006**	0.003

Panel B: Call and Put

	Standard Call		Mini Call		Mini-Standard Diff	
	Intraday	Overnight	Intraday	Overnight	Intraday	Overnight
AAPL	0.009***	-0.007***	0.005***	-0.008***	-0.004***	-0.001
AMZN	0.017***	-0.023***	0.013***	-0.026***	-0.004	-0.003
GOOG	0.020***	-0.021***	0.011***	-0.021***	-0.009***	0.000
GLD	0.017*	-0.039	0.015	-0.044	-0.002	-0.005
SPY	0.007**	-0.009	0.002	-0.004	-0.005	0.005

	Standard Put		Mini Put		Mini-Standard Diff	
	Intraday	Overnight	Intraday	Overnight	Intraday	Overnight
AAPL	0.014***	-0.013***	0.009***	-0.013***	-0.005***	0.001
AMZN	0.028***	-0.035***	0.013**	-0.040***	-0.015	-0.005
GOOG	0.022***	-0.021**	0.016***	-0.025**	-0.005	-0.004
GLD	0.081***	-0.018	0.083***	-0.046*	0.002	-0.028*
SPY	0.025***	-0.014***	0.018***	-0.011	-0.007**	0.002

Table 5: Trading of Mini options and standard options around attention-grabbing and attention-distracting events

This table reports event study results for options trading volume. Trading volume is defined as the logarithm of daily dollar volume. We define normal trading volume as the average trading volume in a 100-day window that is centered on the event day. Abnormal trading volume is the trading volume on event day minus normal trading volume and then divided by normal trading volume. Panel A shows the abnormal trading volume of Mini options and standard options during earnings announcements. Panel B shows the abnormal trading volume of Mini options and standard options on the next day after their underlying stocks are ranked as daily winners/losers. Following Kumar, Ruenzi, and Ungeheuer (2019), we define daily winners/losers as stocks with daily returns ranked as top 80 or bottom 80 in the CRSP universe. Panel C shows the abnormal trading volume of Mini options and standard options on distracting days. Following Peress and Schmidt (2020), we define distracting days as days with high news pressure based on news broadcast data. Column (1) reports the abnormal trading volume for Mini options. Column (2) reports the abnormal trading volume for standard options. Column (3) tests for the difference between Mini and standard options. Below each number, we show t-statistics in parenthesis and z-statistics for nonparametric rank test the square brackets. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Panel A: earnings announcements

	(1) Mini	(2) Standard	(3) Difference
call	0.151	0.108	0.043
	(10.54)***	(6.84) ***	(1.98)**
	[3.92] ***	[3.92] ***	[3.09] ***
put	0.156	0.112	0.044
	(8.17) ***	(11.31) ***	(2.07)**
	[3.80] ***	[3.92] ***	[2.98] ***
N	21	21	

Panel B: extreme returns

	Mini	Standard	Difference
call	0.171	0.098	0.073
	(13.30)***	(9.02)***	(4.34)***
	[3.52]***	[3.52] ***	[3.41] ***
put	0.159	0.115	0.044
	(8.01) ***	(10.17) ***	(1.93)**
	[3.52] ***	[3.52] ***	[2.84] ***
N	16	16	

Panel C: distracting events

	Mini	Standard	Difference
call	-0.039	-0.007	-0.032
	(-4.69)***	(-1.84)*	(-3.46)***
	[-4.12]***	[-1.83] *	[-3.66] ***
put	-0.040	-0.003	-0.037
	(-3.54) ***	(-0.60)	(-2.97)***
	[-3.16] ***	[-0.70]	[-3.94] ***
N	56	56	

Table 6: C/P ratio of Mini and standard options

This table shows the C/P ratio for Mini options and standard options. C/P ratio is the daily dollar trading volume of call options divided by the daily dollar trading volume of call options and put options. C/P ratio is first calculated at the ticker-daily level and then averaged across ticker and time. We classify an option transaction as buyer-initiated if it is executed above the mid-quote and as seller-initiated if it is below the mid-quote. The sample period is from March 18, 2013, to December 31, 2014. A *t*-test is used to test the statistical significance of the difference in mean values. Wilcoxon signed-rank test is used in examining the statistical significance of the difference in median values. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Buy			Sell		
	Mini	Standard	Diff	Mini	Standard	Diff
Mean						
All	0.630	0.573	0.056***	0.627	0.584	0.042***
Stocks	0.670	0.640	0.031***	0.672	0.645	0.027***
S&P500 ETF	0.545	0.400	0.145***	0.514	0.429	0.086***
Gold ETF	0.591	0.548	0.043***	0.602	0.560	0.042***
Median						
All	0.663	0.582	0.080***	0.664	0.592	0.072***
Stocks	0.690	0.658	0.032***	0.699	0.657	0.041***
S&P500 ETF	0.557	0.386	0.171***	0.512	0.418	0.094***
Gold ETF	0.608	0.551	0.057***	0.639	0.562	0.077***
N. of Obs.						
All	2,239	2,263	4,502	2,240	2,263	4,503
Stocks	1,351	1,357	2,708	1,348	1,357	2,705
S&P500 ETF	450	453	953	451	453	904
Gold ETF	438	453	891	441	453	894

Table 7: C/P ratio and daily news sentiment index

This table shows the regression analysis of the C/P ratio on market sentiment. Market sentiment is measured using the *Daily News Sentiment Index* of the Federal Reserve Bank of San Francisco (*Sent*), which is the daily measure of economic sentiment based on lexical analysis of economics-related news articles (Shapiro, Sudhof, and Wilson, 2020). The dependent variable is volume C/P ratio in Panel A, and dollar volume C/P ratio in Panel B. *Mini* is the indicator variable for Mini options. The independent variable of interest is the interaction between *Mini* and *Sent*. The sample period is from March 18, 2013, to December 31, 2014. We also add *Maturity*, *NBBO midpoint*, *Market Cap*, *Stock Price* and *Idiosyncratic Vol* as control variables. *Maturity* is the natural logarithm of the number of days to maturity. *NBBO midpoint* is the natural logarithm of NBBO midpoint price of options. *Market Cap* is the natural logarithm of market capitalization calculated as stock price times the number of shares outstanding. *Stock Price* is the natural logarithm of intraday stock price. *Idiosyncratic Vol* is calculated using daily returns of the prior month based on the Fama-French 4-factor model. For regressions that include multiple tickers, the ticker and date fixed effect are added, and the standard errors are two-way clustered at the ticker and date level. For ticker-by-ticker regression, the date fixed effect is added, and the standard errors are adjusted for heteroskedasticity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

$$C/P\ Ratio = \alpha + \beta_1 * Mini + \beta_2 * (Mini * Daily\ Sentiment\ Index)$$
$$+Controls + Ticker\ FE + Date\ FE + \varepsilon$$

Panel A: Volume C/P ratio

	Full Sample	Stocks	GLD	SPY
Mini	0.0222**	0.0071*	0.0144	0.0420***
	(2.61)	(2.21)	(0.78)	(2.85)
*Mini*Sent*	0.0703*	0.0885**	-0.0519	0.0614
	(2.20)	(2.59)	(-0.77)	(1.10)
Constant	0.3392	-0.2331	0.3589***	0.3211***
	(0.76)	(-0.29)	(3.34)	(2.63)
Controls	Yes	Yes	Yes	Yes
Ticker FE	Yes	Yes	No	No
Date FE	Yes	Yes	Yes	Yes
No. of Obs.	9,005	5,413	1,785	1,807
R-Squared	0.28	0.28	0.31	0.36

Panel B: Dollar Volume C/P ratio

	Full Sample	Stocks	GLD	SPY
Mini	0.0330***	0.0146	0.0277	0.0294*
	(3.68)	(1.26)	(1.45)	(1.95)
*Mini*Sent*	0.0765*	0.0888*	-0.0785	0.1037*
	(1.89)	(2.27)	(-1.14)	(1.68)
Constant	-1.7529**	-3.2933**	0.3047***	0.5684***
	(-2.58)	(-2.90)	(2.69)	(4.49)
Controls	Yes	Yes	Yes	Yes
Ticker FE	Yes	Yes	No	No
Date FE	Yes	Yes	Yes	Yes
No. of Obs.	9,005	5,413	1,785	1,807
R-Squared	0.28	0.31	0.34	0.40

Table 8: Order imbalance of Mini and standard options

This table shows the order imbalance of Mini options and standard options. Order imbalance is measured as the total dollar trading volume of buy trades divided by the total dollar trading volume of buy and sell trades. It is calculated at the ticker-daily level. We classify an option transaction as buyer-initiated if it is executed above the mid-quote and as seller-initiated if it is below the mid-quote. The sample period is from March 18, 2013, to December 31, 2014. A *t*-test is used to test the statistical significance of the difference in mean values. Wilcoxon signed-rank test is used in examining the statistical significance of the difference in median values. F-test is used to examine the statistical significance of the difference in standard deviations. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Call			Put		
	Mini	Standard	Diff	Mini	Standard	Diff
Mean						
All	0.505	0.490	0.015***	0.503	0.499	0.004
Stocks	0.492	0.493	-0.001	0.494	0.494	-0.001
S&P500 ETF	0.549	0.485	0.064***	0.526	0.517	0.009
Gold ETF	0.500	0.487	0.014	0.510	0.496	0.015
Median						
All	0.503	0.490	0.013**	0.511	0.500	0.011*
Stocks	0.497	0.494	0.003	0.497	0.493	0.004
S&P500 ETF	0.558	0.488	0.070***	0.536	0.514	0.022*
Gold ETF	0.505	0.474	0.031	0.535	0.491	0.043*
Standard deviation						
All	0.234	0.104	0.130***	0.263	0.118	0.145***
Stocks	0.190	0.107	0.083***	0.240	0.129	0.111***
S&P500 ETF	0.278	0.062	0.215***	0.258	0.053	0.205***
Gold ETF	0.294	0.126	0.168***	0.326	0.128	0.198***
N. of Obs.						
All	2,249	2,263	4,512	2,191	2,259	4,450
Stocks	1,354	1,357	2,711	1,316	1,353	2,669
S&P500 ETF	451	453	904	449	453	902
Gold ETF	444	453	897	426	453	879

Table 9: Order imbalance and future returns

This table shows the prediction analysis of order imbalance and next-day option returns of Mini options and standard options. The dependent variables are the volume-weighted (dollar-volume-weighted) average option returns, which are calculated as the difference between the next trading day's volume-weighted (dollar-volume-weighted) average option price and today's volume-weighted (dollar-volume-weighted) average option price, divided by volume-weighted (dollar-volume-weighted) average option price. The independent variable of interest is order imbalance, measured as the total trading volume of buy trades minus the total trading volume of sell trades, and then divided by the total trading volume of buy and sell trades. It is calculated for every option contract on every trading day. The sample period is from March 18, 2013, to December 31, 2014. We also add *Maturity*, *NBBO midpoint*, *Market Cap*, *Stock Price*, and *Idiosyncratic Vol* as control variables. *Maturity* is the natural logarithm of the number of days to maturity. *NBBO midpoint* is the natural logarithm of NBBO midpoint price of options. *Market Cap* is the natural logarithm of market capitalization calculated as stock price times the number of shares outstanding. *Stock Price* is the natural logarithm of intraday stock price. *Idiosyncratic Vol* is calculated using daily returns of the prior month based on the Fama-French 4-factor model. Regression equations are shown below. Ticker and date fixed effects are included. The standard errors are two-way clustered at the ticker and date level. t-statistics are shown in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, based on two-tailed t-tests.

$$Option\ Future\ Return = \alpha + \beta_1 * OrderImbalance + Controls + Ticker\ FE + Date\ FE + \varepsilon$$

	Volume-weighted Return		Dollar-Volume-weighted Return	
	Mini	Standard	Mini	Standard
Order_Imbalance	-0.0056***	-0.0002	-0.0047**	-0.0001
	(-4.84)	(-0.24)	(-3.90)	(-0.02)
Constant	-0.7959**	-0.3565*	-0.7970**	-0.3604*
	(-3.56)	(-2.65)	(-3.55)	(-2.66)
Controls	Yes	Yes	Yes	Yes
Ticker FE	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes
No. of Obs.	99,312	548,422	99,312	548,422
R-Squared	0.03	0.01	0.03	0.02

Table 10: Trading of Mini and standard options at market opens and closes (*Apple* excluded)

This table shows the regression analysis of the intraday proportional trading volume of Mini options and standard options traded on the same day. Each day, the trading hours (from 9:30 to 16:00) are divided into 5-minute intervals (e.g., 9:30-9:35, 9:35-9:40). For each 5-minute interval of a trading day, we calculate the dollar trading volume of all Mini or corresponding standard options of a ticker and then divide it by the total daily trading volume of Mini or *corresponding* standard options of that ticker to get the intraday proportional trading volume. The sample period is from March 18, 2013, to December 31, 2014. The dependent variable of the following regressions is the intra-day proportional trading volume. *Mini* is the indicator for Mini options. *First5* is an indicator variable for the first 5-minute interval, i.e., 9:30-9:35. *Last5* is the indicator variable for the last 5-minute interval, i.e., 15:55-16:00. We also add *Maturity*, *NBBO midpoint*, *Market Cap*, *Stock Price*, and *Idiosyncratic Vol* as control variables. *Maturity* is the natural logarithm of the number of days to maturity. *NBBO midpoint* is the natural logarithm of NBBO midpoint price of options. *Market Cap* is the natural logarithm of market capitalization calculated as stock price times the number of shares outstanding. *Stock Price* is the natural logarithm of intraday stock price. *Idiosyncratic Vol* is calculated using daily returns of the prior month based on the Fama-French 4-factor model. Regression equations are shown below. Ticker and date fixed effects are included. The standard errors are two-way clustered at the ticker and date level. t-statistics are shown in parentheses. ***, **, and * denote *significance* at the 1%, 5%, and 10% levels, respectively, based on two-tailed t-tests.

$$Proportional\ trading\ volume_{\,5-min} =$$

$$\alpha + \beta_1 * First5 + \beta_2 * Last5 + \beta_3 * Mini + \beta_4 * First5 * Mini + \beta_5 * Last5 * Mini + Controls + Ticker\ FE + Date\ FE + \varepsilon$$

	Call			Put		
	Mini	Standard	Pooled	Mini	Standard	Pooled
First5	0.0688***	0.0214***	0.0214***	0.0808***	0.0222**	0.0222**
	(6.89)	(7.85)	(7.75)	(9.37)	(5.26)	(5.22)
Last5	0.0047*	0.0096***	0.0095***	0.0044	0.0094**	0.0093**
	(2.65)	(10.76)	(10.93)	(1.93)	(4.89)	(4.85)
Mini			-0.0021***			-0.0022***
			(-17.89)			(-14.58)
*First5*Mini*			0.0473**			0.0586***
			(4.41)			(6.01)
*Last5*Mini*			-0.0048			-0.0048**
			(-2.19)			(-4.80)
Constant	0.1410***	0.1372**	0.1376**	0.1782**	0.1523*	0.1628**
	(7.66)	(3.28)	(5.58)	(3.40)	(3.16)	(3.29)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Ticker FE	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	138,294	139,386	277,680	134,082	139,074	273,156
R-Squared	0.03	0.02	0.03	0.03	0.02	0.03

Table 11: Trading of Mini options and standard options around attention-grabbing and attention-distracting events (*Apple* excluded)

This table reports event study results for options trading volume. Trading volume is defined as the logarithm of daily dollar volume. We define normal trading volume as the average trading volume in a 100-day window that is centered on the event day. Abnormal trading volume is the trading volume on event day minus normal trading volume and then divided by normal trading volume. Panel A shows the abnormal trading volume of Mini options and standard options during earnings announcements. Panel B shows the abnormal trading volume of Mini options and standard options on the next day after their underlying stocks are ranked as daily winners/losers. Following Kumar, Ruenzi, and Ungeheuer (2019), we define daily winners/losers as stocks with daily returns ranked as top 80 or bottom 80 in the CRSP universe. Panel C shows the abnormal trading volume of Mini options and standard options on distracting days. Following Peress and Schmidt (2020), we define distracting days as days with high news pressure based on news broadcast data. Column (1) reports the abnormal trading volume for Mini options. Column (2) reports the abnormal trading volume for standard options. Column (3) tests for the difference between Mini and standard options. Below each number, we show t-statistics in parenthesis and z-statistics for nonparametric rank test the square brackets. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Panel A: earnings announcements

	(1) Mini	(2) Standard	(3) Difference
call	0.179	0.130	0.049
	(12.67)***	(6.13) ***	(1.89)**
	[3.18] ***	[3.18] ***	[2.27] **
put	0.179	0.131	0.048
	(10.25) ***	(14.15) ***	(2.51)**
	[3.18] ***	[3.18] ***	[2.76] ***
N	14	14	

Panel B: extreme returns

	Mini	Standard	Difference
call	0.193	0.110	0.083
	(13.66)***	(7.73)***	(4.13)***
	[2.80]***	[2.80] ***	[2.60] ***
put	0.184	0.133	0.051
	(7.25) ***	(10.47) ***	(1.79)*
	[2.80] ***	[2.80] ***	[2.40] **
N	10	10	

Panel C: distracting events

	Mini	Standard	Difference
call	-0.048	-0.008	-0.040
	(-4.72)***	(-1.74)*	(-3.54)***
	[-4.16]***	[-1.90] *	[-3.75] ***
put	-0.046	-0.004	-0.042
	(-3.33) ***	(-0.79)	(-2.78)***
	[-3.10] ***	[-0.85]	[-3.77] ***
N	56	56	