Covid Lockdown, Robinhood Traders, and Liquidity in Stock and Option Markets

Abstract:

I examine the effects of active option trading on stock market liquidity during the Covid-19 lockdown, in connection with the rapidly growing retail trading activities in this episode. I find that stocks with actively traded options, and stocks held by more Robinhood users experience less deterioration in liquidity during the US Covid lockdown. However, a wider Robinhood base lessens the alleviation effect of actively traded options on the underlying stock's liquidity deterioration. This is consistent with the postulation that informed traders shift away from option markets and towards stocks where the stock liquidity is improved. Further analysis suggests that a wider stock market retail base is also associated with a smaller bid-ask spread in the option market. This is consistent with the previous theories and empirical evidence that option market makers offer slimmer spreads where their hedging costs in the underlying market are lower. My findings provide novel evidence on the joint stock-option dynamics in the Covid-19 episode, and the role Robinhood traders play in those dynamics.

1. Introduction

The COVID-19 pandemic has led to serial disruptions in global economy. The dramatic financial market movements and drastically increasing retail trading present new challenges to financial stability.[1] While many aspects of financial market have been extensively studied in the context of this episode, options and how they interact with the equity market during the pandemic have received much less attention. What are the impacts of this pandemic on the stock-option dynamic? Do retail investors contribute to these impacts? I aim to shed light on these questions by examining the association of the stock market liquidity with option trading in connection with the growing retail trading activities during the COVID-19 lockdown.

This study is motivated by the information link between the derivatives and underlying security markets well studied in the literature. Informed traders may value the higher leverage available in options markets (Black (1975)), and trading in the derivatives markets can provide mechanisms that reveal information about the underlying security (Danthine (1978), Grossman (1988), and Easley et al. (1998)). Therefore, stocks with actively traded options experience less information asymmetry, relative to stocks that are not actively traded in option markets. An alleviation in information asymmetry can motivate market makers to reduce their quoted bid-ask spreads (Glosten and Milgrom (1985)), and subsequently help improve the liquidity of the underlying stock. However, as the listing of option and option trading activity may be endougenous in connection with the liquidity of the underlying (Mayhew and Mihov (2005)), this informational mechanism is empirically challenging to disentangle.

[1] See https://www.wsj.com/articles/everyones-a-daytrader-now-11595649609 and https://www.fsb.org/work-of-the-fsb/covid-19-maintaining-financial-stability/covid-19-financial-stability-impacts/.

A few studies attempt to shed light on the joint informational mechanism in stock and option markets in the context of severe market condition changes. Ni and Pan (2020), for example, study the interaction between price discovery in banned stocks and trading and prices of options during the 2008 short sale ban. They find that informed investors trade derivatives in severely deteriorated market conditions, and option prices and more informationally efficient than stock prices during the ban. Battalio and Schultz (2011) find that the regulatory uncertainty in equity market dramatically increases bid-ask spreads for options on the banned stocks during the 2008 short sale ban. Griffith et al. (2020) find that during the episode of the 2016 tick-size pilot program ("the Pilot"), the liquidity deterioration in the stocks affected by the Pilot spills over to the option market, but having actively traded options alleviates the said stock market liquidity deterioration. I study this joint informational mechanism in the episode of COVID-19 lockdown.

In March 2020, the rapid development of the COVID-19 pandemic caused severe liquidity stress in financial markets. This provides a unique opportunity to study the informational role actively traded options play for the underlying stocks' liquidity in an episode with an exogenous shock to the market liquidity. While during the pandemic, bid-ask spreads are expected to increase for all stocks due to the jarring uncertainty, those facing greater information asymmetries (i.e. stocks with inactively traded, or no option series) might experience a more pronounced increase, as equity market makers hedge against the uncertainty.

An intriguing subject in this informational link is the role of retail investors. On March 13th, the US president declared national emergency, and most US states and territories have since issued stay-at-home orders in response. Academics and practitioners argue that with more free time on hand when staying at home, accompanied by the recent FinTech innovations in the broker-dealer

space, the retail investors' participation of stock trading has seen exponential growth.[2] Ozik et al. (2021) find that retail investors primarily are liquidity providers in equity market. As their participation in stock trading dramatically increases during the lockdown, they help alleviate the liquidity stress to a certain extent. Previous literature has established, both theoretically and empirically, that informed traders trade in both option and equity markets (Biais and Hillion (1994), Easley et al. (1998), and John et al. (2000)). Largely, they choose between the benefit of the leverage provided by the option market versus the advantage of the higher liquidity in equity market. During the COVID-19 lockdown, retail investors' liquidity providing can incentivize the informed traders to shift towards the equity market. This improved equity market liquidity, in turn, lessens options' role to provide information advantage for the underlying stock. Therefore, retail trading in stock market is expected to attenuate the positive effect of having actively traded options on the liquidity of the underlying during the lockdown. On the other hand, retail investors may play a similarly significant role as liquidity providers for options as they do for the equity market during the lockdown; in addition, the improved liquidity in stock market can potentially spillover to the option market through the link of the option market maker (Jameson and Wilhelm (1992) and Engle and Neri (2010)). Hence, options can also become more attractive to the informed traders in this episode. In summary, the role retail investors play in the stock-option dynamic during the COVID-19 lockdown is ultimately an empirical question, and I resort to the data to investigate this issue.

In the first set of tests, I examine whether having actively traded options alleviates the liquidity stress during the lockdown. Consistent with my hypothesis, I find that although the stock market liquidity deteriorates during this period, stocks with actively traded options have smaller

[2] See Ozik et al. (2021) and https://www.wsj.com/articles/trading-surge-strains-online-brokerages-11611692363.

bid ask spreads relative to their counterparts without. My second set of tests examine the role of retail trading. I find that bid-ask spreads of stocks with higher retail holdings are smaller; however, higher retail holdings also attenuate the alleviation effect of actively traded options for liquidity of the underlying stocks during the lockdown period. Further analysis suggests that higher retail holdings in equity market indeed is associated to improved option liquidity across traded options; however, when the untraded option quotes are taken into account, this effect is more ambiguous.

To provide more evidence that the COVID-19 lockdown, and in turn, the intensified retail attention, have affected both stock and options market liquidity, I examine bid-ask spreads in both markets surrounding the conclusion of the lockdown as well. I find that having actively traded options has a more significant liquidity improving effect during the lockdown period than after the economy is reopened; similarly, the retail holding also plays a more important role in liquidity providing during the lockdown. In summary, consistent with Ozik et al. (2021), the factors studied in this paper that mitigate the deteriorating stock market liquidity during the lockdown period are largely reversed at the conclusion of the lockdown. The joint dynamic of stock market retail base and option market liquidity is more mixed though. For put options, a wider stock market retail base plays an even more important role in improving the option bid-ask spread after the economy is reopen.

I contribute to the rich literature investigating the information link between derivatives markets and their underlying through the lens of the recent COVID-19 crisis that has caused significant disruptions in global economy. The Covid lockdowns have inspired several studies to investigate the financial market responses, such as the extensive impacts of this pandemic on stock market (e.g., Lyócsa et al. (2020), Zhang et al. (2020), Ozik et al. (2021), commodity markets (e.g., Amar et al. (2021), Czech et al. (2021)), and futures market (Cheng (2020), Banerjee (2021)). The

role and trading activities of option market have been less studied. I contribute to this literature by extending the investigation of the interaction of this global pandemic and option market activities, and the role of option trading activities in financial market liquidity during this pandemic.

I also provide a novel perspective regarding the role of retail investors in financial market. A rich literature suggests that retail trading has strong explanatory power in stock return comovement (Kumar and Lee 2006) and volatility (Foucault et al. (2011), improves stock liquidity (Ding and Hou (2015), Ozik et al. (2021)), but tend to over-trade and be over-confident (Barber and Odean (1998)). Many practitioners have argued that Robinhood, a stock trading app, has changed stock market investing,[3] and made trading easier and more accessible for retail investors. Since the Robinhood tracking website, Robintrack, made the number of Robinhood account users for each stock available, an increasing number of finance researchers have taken advantage of this measure and documented findings using this measure as a proxy for retail trading. Friedman and Zeng (2021) find that retail traders' trading is associated with higher volatility during the earnings announcement and may slow the incorporation of public information into stock price. Aharon et al. (2022) find that retail trading activity is associated with higher volatility for ADRs. I provide evidence that during the COVID lockdown, retail investors serve as important liquidity providers in stock market, and complement the mitigation effect that active option trading activities provide for stock liquidity deterioration.

The remainder of the paper is organized as follows. In Section 2, I describe the data sample, the construction of the main variables of interest, and the methodology for the empirical analysis. In Section 3, I present and discuss the empirical results. In Section 4, I provide some concluding remarks.

[3] For example, https://www.morningstar.com/articles/1032245/how-the-robinhood-era-is-changing-stock-market-investing.

2. Data and Empirical Methodology

a. Data

I obtain closing prices, shares outstanding, and share volume from the Center for Research in Security Prices (CRSP). I retain only daily stock observations with non-zero share volume. Then, I gather end-of-day historical option data from the Option Price Reporting Authority (OPRA) database by option series, i.e. unique underlying symbol, option type (call or put), strike price, and expiration date. These data include daily closing prices, closing NBBO bid and ask prices, and contract volume. I delete daily option observations with zero or missing NBBO. I also gather the daily Robinhood user account number data from the Robintrack website.

b. Variables of Interest

The main dependent variable of interest is the end of the day bid-ask spread, $Stock\ \%\ Spreads$, for each stock in the sample. It is computed as a percentage of the midpoint of the bid and the ask.[4] The variable is in percentage in my sample.

I compute several control variables as follows: following Alizadeh et al. (2002), I compute the range-based volatility variable volatility *Rvolt* as $LN(High\ Price_{i,t}) - LN(Low\ Price_{i,t})$. Alizadeh et al. (2002) show that this range-based volatility proxy is highly efficient and robust to microstructure noise. I also include market capitalization, *Mkt Cap*, trading volume, *Volume,* and *Price* as controls. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days.

In order to study the effect of the COVID lockdown on the option market liquidity in connection with the growing stock market retail trading, I compute the option bid-ask spread at

[4] In alternative analyses, I also study the bid-ask spread that is not scaled by the midpoint, and the results are qualitatively unchanged.

the end of each trading day, *Option % Spread*. First I compute the bid-ask spread as a percentage of the midpoint of the bid and the ask for each contract, then I compute the average across contracts for each stock weighted by open interest or trading volume, or the simple average.

$$Option\ \%\ Spreads_{i,t}^{k} = \sum_{j=1}^{n} w_j \frac{Ask_{i,j,t} - Bid_{i,j,t}}{M_t},$$

[Insert Table 1 Here]

An important control variable, *Retail*, is proxied by the Robinhood user account number obtained from Robintrack website.[5] Robintrack keeps track of how many Robinhood users hold a particular stock over time. Following the previous literature (e.g., Ozik et al. (2021), Pagano et al. (2021), and Aharon et al. (2022)), I adopt this measure to proxy for the retail trading activities in stock market.

In Panel A of Table 1, I report summary statistics for 3683 firms in the full sample over the US national lockdown period and the exact same number of days before the lockdown. The mean of the main dependent variable of interest, *Spread%Stock*, is .93, while the median is .19. The average daily trading volume *Volume* during this time period is about 1.8 million, with a median of .18 million. This indicates substantial variations in trading activity across the sample. The average daily price *Price* is $125.63 with a median of $16 suggesting high left skewness. The average *Rvolt* for a daily observation is 0.0782, suggesting an average daily price movement of 7.82 percent per day during this period. The average *Mkt Cap* is $7.95 billion this period, with a median of $.57 billion, suggesting high right sknewness. The average Robinhood user account

[5] https://www.robintrack.net/

number *Retail* is 4128.97, with a median of 428, which again suggests high right skewness in retail trading. About 44.1% of the stocks in the sample have actively traded options.

In Panel B of Table 1, I report summary statistics for the sample on which the "lockdown vs. reopen" analysis is conducted. Most variables show similar magnitudes and properties to the previous sample. The mean of the main dependent variable of interest, *Spread%Stock*, is .919, while the median is .19. The average daily trading volume during this time period is about 2.04 million, with a median of .39 million. This still indicates substantial variations in trading activity across the sample, and substantial growth from the previous sample. The average daily price is $117 with a median of $14.75 suggesting high left skewness. The average *Rvolt* for a daily observation is 0.0808, suggesting an average daily price movement of 8.08 percent per day from the daily low to the daily high during this period. The average *Mkt Cap* is $7.83 billion this period, with a median of $.53 billion, suggesting high right sknewness. The average Robinhood user account number is 6037. This is significantly higher than 4128.97 in the previous sample, indicating a substantial broad market retail growth. About 43.8% of the stocks in the sample have actively traded options, similar to the previous sample.

c. Empirical Methodology

First, following Ozik et al. (2021), I define the US national lockdown period as March 16th, 2020 – May 7th, 2020, which consists of 53 calendar days. Ozik et al. (2021) comprehensively study the geopolitical accounting of this event, taking information from national mobility data in US into account, and thoroughly discuss this definition of the lockdown period.[6] I conduct diff-in-diff analysis over two sample periods: 53 calendar days before vs. after lockdown (March 16th, 2020), and 53 calendar days before vs. after reopen (May 8th, 2020).

[6] In alternative analysis with slight variations of the lockdown-reopen period definition, the results are qualitatively unchanged.

In order to study how having actively traded options affects the liquidity of the underlying stock over the period of global pandemic, I conduct the following diff-in-diff analysis:

$$Stock\ \%\ Spreads_{i,t} = \alpha + \beta_1 Lockdown_t + \beta_2 Act.Options_i + \beta_3 Lockdown_t \times Act.Options_i + \beta_4 Price_{i,t} + \beta_5 MktCAP_{i,t} + \beta_6 Volume_{i,t} + \beta_7 RVolt_{i,t} + \varepsilon_{i,t}\ , \quad (1)$$

I then take a step further, and study this relation in connection with the rapidly growing retail trading during the pandemic. I include the Robinhood account user number *Retail* in my analysis:

$$\begin{aligned} Stock\ \%\ Spreads_{i,t} = {} & \alpha + \beta_1 Lockdown_t + \beta_2 Act.Options_i + \beta_3 Retail_{it} + \\ & \beta_4 Lockdown_t \times Act.Options_i + \beta_5 Retail_{it} \times Lockdown_t + \beta_6 Lockdown_t \times \\ & Act.Options_i \times Retail_{it} + \beta_7 Volume_{i,t} + \beta_8 Price_{i,t} + \beta_9 MktCAP_{i,t} + \\ & \beta_{10} RVolt_{i,t} + \varepsilon_{i,t}\ , \end{aligned} \quad (2)$$

I am also intrigued whether the option market liquidity has been affected during the global pandemic in connection with the growing retail trading. In order to investigate this, I conduct the following analysis:

$$\begin{aligned} Option\ \%\ Spreads^k_{i,t} = {} & \alpha + \beta_1 Lockdown_t + \beta_2 Retail_t + \beta_3 Lockdown_t \times Retail_i \\ & + \beta_4 O/S_{i,t} + \beta_7 Price_{i,t} + \beta_8 Stock\%Spread_{i,t} + \beta_9 MCAP_{i,t} \\ & + \beta_{10} RVolt_{i,t} + \varepsilon_{i,t}\ , \end{aligned} \quad (3)$$

Where the dependent variable is one of the option bid-ask spreads measures constructed for each stock as defined in 2.a.

3. Empirical Results

a. Baseline Analysis

I begin my empirical analysis be conducting the baseline analysis outlined by equation (1), where the dependent variable is the end of the day bid-ask spread of each stock. I are especially interested in the coefficient estimate of the diff-in-diff term $Lockdown_t \times Act.Options_i$. Note that *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. I include as control variables the following stock characteristics: *Volume, Price, Mkt Cap,* and *RVolt*. In various specifications, I also incorporate day[7] and/or firm fixed effects. I report t-statistics in parentheses obtained from robust standard errors clustered at the stock level in Table 2.

[Insert Table 2 Here]

In Table 2, I find that coefficient of the diff-in-diff term $Lockdown_t \times Act.Options_i$ is significantly negative across specifications. The magnitude of the coefficient is around 55 bps. Considering that the average bid-ask spread over the entire sample period is less than 1 percent, this impact from having actively traded options is economically significant over the lockdown period, too. I also find that, consistent with the previous literature, the stock market liquidity is severely impacted during the lockdown. More expensive stocks and more volatile stocks in general are less liquid, while stocks with larger trading volume, and larger market capitalization are more liquid. Consistent with Ozik et al. (2021), larger retail trading base, proxied by the Robinhood user account number *Retail*, is associated with higher liquidity, suggesting that retail traders provide market liquidity during the COVID lockdown.

b. Analysis in connection with retail trading

[7] In doing so I must remove one daily dummy variable to include the time-invariant Lockdown indicator variable.

The role of retail trading has been long studied. Ozik et al. (2021) present an in-depth discussion on the impact of retail trading activities during the lockdown on broad market liquidity. They adopt the Robinhood user account number as a proxy for retail trading, and document strong and robust evidence that rapid growing retail trading activities during the lockdown period provide liquidity for the stock market. Previous literature suggests that informed traders weigh between the high leverage provided by options and high liquidity provided by equities (Biais and Hillion (1994), Easley et al. (1998), and John et al. (2000)), and tend to shift towards the stock market where stock liquidity is enhanced. In this section, I study the joint dynamic of active option trading, retail activities, and stock market liquidity by conducting the analysis presented in Equation (2). I report the results in Table 3.

[Insert Table 3 Here]

For brevity, I do not report the output for the control variables, and focus on the results reporting the OLS regression with the Day fixed effect.[8] The coefficient of Lockdown is significantly positive, suggesting overall liquidity deterioration post lockdown. The coefficient of *Lockdown* x *Act.Option* is significantly negative, suggesting that stocks with actively traded options are significantly more liquid compared to their counterparts without active option trading. These findings are consistent with the analysis from the previous section. Consistent with Ozik et al. (2021), I find that the stocks with a wider retail base are associated with better liquidity during the lockdown, evidenced by the significantly negative coefficient of *Lockdown* x *Retail*. Interestingly, the coefficient of the 3-way interaction term, $Lockdown \times Act.Options \times Retail$, is significantly positive. This suggests that the improving effect of having actively traded

[8] The results are robust across various control and fixe effect specifications.

options on stock liquidity, is somewhat lessened by a larger retail base. This finding is in line with the remark that informed traders may shift towards the stock market where liquidity is well provided; given the strong evidence that retail investors primarily are liquidity providers, especially during the COVID-19 lockdown, a wider retail base may attract the informed traders towards the stock market, hence lessen the mechanism for active option trading to alleviate the information asymmetry and improve the liquidity of the underlying.

c. *Option market liquidity*

In this section, I examine whether the rapidly growing retail trading during the COVID-19 lockdown affects the option market liquidity by conducting the analysis presented in Equation (3). Since the market maker's cost to hedge is an important component in the option bid ask spread (Jameson and Wilhelm (1992) and Engle and Neri (2010)), an improved stock bid-ask spread may mitigate the option market maker's liquidity concern and improve option market liquidity as well. I divide my analysis by calls and puts, and report the results in Table 4.

[Insert Table 4 Here]

As shown in Table 4, the signs of coefficients for *Lockdown* and *Retail* in the regression analysis are consistent with the perception that the liquidity of option market deteriorates during the lockdown, but a wider retail base appears to mitigate the effect, but to a much lesser extent compared to this mitigating effect in stock market. Interestingly, the coefficient of the interaction term *Lockdown* x *Retail*, is significantly negative in two out of three specifications, suggesting that either the improving effect of retail trading in stock market spills over to the option market, or the measure proxying for stock market retail trading, *Retail*, might be indicative of potential retail trading in option market. Note that the third option liquidity measure is a simple average bid-ask spread across all listed option contracts, including those quotes with zero trading volume. The

insignificance of the coefficient in the third specification for call options, and the significant positive coefficient for put options, provide limited evidence that quoted option prices without any trading activities do not see improved liquidity along with the increased retail base in stock market.

d. *Reopen*

In this section, I study active option trading, stock liquidity, option liquidity, and retail trading activities jointly at the conclusion of the lockdown period. More specifically, I re-investigate Equation (2) and Equation (3), replacing the variable *Lockdown* with *Reopen*. The variable Reopen is a dummy variable that equals 0 over the lockdown period (March 16th – May 7th of 2020), and 1 over the same number of days after reopen (May 8th – June 29th of 2020).

[Insert Table 5 Here]

I report the results for the re-investigation of Equation (2) in Table 5. The coefficient of *Reopen* x *Act.Option* is .74 and statistically significantly, indicating that active option trading plays a more significant role in alleviating the illiquidity of the underlying during the lockdown period than the reopen period. The coefficient of the 3-way interaction term *Reopen* x *Act.Option* x Retail is -.03 and statistically significant, opposite to the finding of the previous analysis over the pre vs. post lockdown period, indicting a reversed effect as well. Many of my other findings are consistent with Ozik et al. (2021): market-wide stock bid-ask spreads are reduced after the lockdown – the coefficient of *Reopen* is -1.1, both statistically and economically significant. The coefficient of *Reopen* x *Retail* is significantly positive, suggesting that the retail base has a more significant role in liquidity providing during the lockdown period, compared to the period when the US economy is reopen.

[Insert Table 6 Here]

I then re-investigate Equation (3), namely the effect of reopen on the option market liquidity, and report the results in Table 6. As shown in Panel A, the results from Panel A Table 4 are almost completely reversed. The bid-ask spreads for call options are smaller after the economy is reopen, and a wider retail base in stock market appears to be associated with more improved liquidity for call options during the lockdown period relative to the reopen period. Again, when non-traded options are taken into account, the results have different implications. The non-traded quotes demonstrate better quality with a wider stock retail base post reopen relative to the lockdown period.

The results for put options are presented in Panel B. Interestingly, the coefficients on *Reopen* x *Retail* are significantly negative across all specifications. A wider retail base in stock market plays an even more significant role in improving the option liquidity after the economy is reopen, even when the nontraded option quotes are taken into account. Also, the put option bid-ask spread does not necessarily get smaller when the lockdown is over, contrary to the results from all the other analyses.

4. Concluding Remarks

In this paper, I study the effect of actively traded options on the liquidity of the underlying stock within the context of the US COVID-19 lockdown. I find that stocks with actively traded options experience the deterioration of liquidity to a lesser extent during this episode. This is consistent with the literature suggesting the information link between option and equity market. Namely, stocks with actively traded options have an additional channel for information to be incorporated into market prices, which plays an especially important role in alleviating the information asymmetry at a time of great uncertainty. I also find that retail investors provide liquidity in stock market, and this effect is especially strong during the COVID-19 lockdown period in US,

consistent with Ozik et al. (2021). Interestingly, for stocks with active option trading, a wider retail base is associated with a lessened liquidity improving effect from the active option trading, consistent with the postulation that informed traders shift towards stocks where better liquidity is provided, and shift away from option market when the equity market is highly liquid. In other words, retail investors complement the role of actively traded options in improving stock market liquidity. Further analysis suggests that during the COVID-19 lockdown in US, option market also experiences deteriorated liquidity, but options with a wider stock market retail base is affected to a lesser extent.

I also study the conclusion of the COVID-19 lockdown on May 8th, 2020. I find that, consistent with the literature, many effects are reversed when the economy is reopened. However, the liquidity of put options sees even stronger association with higher retail holding in stock market post lockdown.

My study documents strong evidence on the information link between derivatives markets and their underlying; the role of this link in alleviating information asymmetry and mitigating the liquidity deterioration is especially important at a time of great uncertainty. I also discuss the important role of retail investors before, during, and after the COVID-19 lockdown in market liquidity provision. I extend the burgeoning literature studying the financial impacts of the global pandemic on financial markets to the option market and to its joint dynamic with equity market.

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Table 1. Summary Statistics

This table displays summary statistics that describe the samples used in the two sets of diff-in-diff analyses: Before vs. After Lockdown (Panel A) and Before vs. After Reopen (Panel B). one studying before. *Retail* is the daily Robinhood user account number for each stock. Volume is the daily trading volume in thousand. Price is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days.

VARIABLES	N	mean	sd	min	median	max
			Panel A: Before vs. After Lockdown			
Retail	253,714	4,117	22,905	0	420	813,667
Act. Option	256,618	0.441	0.496	0	0	1
Stock%Spread	256,618	0.935	2.35	-2.289	0. 198	198.3
Price	256,618	125.6	5,045	0.0736	15.98	344,081
RVol	256,618	0.0782	0.0727	0	0.0593	3.290
Mkt Cap	256,618	7,946	44,184	0.598	568.07	1.435e+06
Volume	256,618	1,825	6,846	0.00100	181.79	706,293
			Panel B: Before vs. After Reopen			
Retail	260,711	6,037	32,373	0	575	926,485
Act. Option	263,551	0.438	0.496	0	0	1
Stock%Spread	263,476	0.919	2.254	-2.894	.202	198.3
Price	263,476	117.0	4,576	0.0736	14.75	302,235
RVol	263,476	0.0808	0.0692	0	0.0632	3.290
Mkt Cap	263,476	7,831	45,821	0.764	528.369	1.589e+06
Volume	263,476	2,043	8,007	0.00100	391.786	706,293

Table 2. COVID-19 Lockdown and Active Option Trading

This table presents the following OLS regression results from various specifications.

$$Stock\ \%\ Spreads_{i,t} = \alpha + \beta_1 Lockdown_t + \beta_2 Act.Options_i + \beta_3 Lockdown_t \times Act.Options_i + \beta_4 Price_{i,t} + \beta_5 MktCAP_{i,t} + \beta_6 Volume_{i,t} + \beta_7 RVolt_{i,t} + \varepsilon_{i,t}\ ,$$

Retail is the daily Robinhood user account number for each stock. Volume is the daily trading volume in thousand. Price is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. *Lockdown* is a dummy variable equal to one during the lockdown period (Mar. 16th, 2020 to May 7th, 2020), and zero over the exact same number of days prior to the lockdown (Jan. 23rd, 2020, to Mar. 15th, 2020) as defined in Ozik et al. (2021)

	(1)	(2)	(3)	(4)	(5)	(6)
Lockdown	0.65***	0.52***	0.54***	0.58***	0.54***	1.43***
	(24.62)	(15.45)	(19.72)	(18.31)	(13.70)	(12.14)
Act.Option	-1.12***	-1.12***	0.26***		0.04	
	(-28.70)	(-28.73)	(3.69)		(0.61)	
Lockdown x Act.Option	-0.56***	-0.56***	-0.55***	-0.54***	-0.55***	-0.55***
	(-21.15)	(-21.18)	(-20.98)	(-20.71)	(-21.07)	(-46.67)
Volume			-0.00***	-0.00***	-0.00***	-0.00***
			(-4.78)	(-4.74)	(-4.47)	(-5.86)
Price			0.00***	0.00***	0.00***	0.00***
			(10.00)	(6.22)	(7.88)	(8.57)
Mktcap			-0.29***	-0.26***	-0.25***	-0.10***
			(-16.31)	(-6.77)	(-16.49)	(-2.72)
RVol			3.75***	3.81***	2.90***	3.03***
			(8.89)	(8.84)	(5.48)	(6.17)
Retail			-0.30***	-0.39***	-0.25***	-0.31***
			(-8.11)	(-6.60)	(-6.58)	(-14.62)
Constant	1.24***	1.11***	6.11***	6.40***	5.29***	3.66***
	(32.14)	(28.95)	(20.86)	(10.49)	(20.32)	(6.33)
Day FE	No	Yes	No	No	Yes	Yes
Firm FE	No	No	No	Yes	No	Yes
Observations	256,618	256,618	252,668	252,668	252,668	252,668
Number of id	3,632	3,632	3,596	3,596	3,596	3,596

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. COVID-19 Lockdown, Active Option Trading, and Retail Traders

This table presents the following OLS regression results from various specifications.

$$Stock\ \%\ Spreads_{i,t} = \alpha + \beta_1 Lockdown_t + \beta_2 Act.Options_i + \beta_3 Retail_{it} + \beta_4 Lockdown_t \times Act.Options_i + \beta_6 Retail_{it} \times Lockdown_t + \beta_7 Lockdown_t \times Act.Options_i \times Retail_{it} + \beta_8 Price_{i,t} + \beta_9 MktCAP_{i,t} + \beta_{10} RVolt_{i,t} + \varepsilon_{i,t} ,,$$

Retail is the daily Robinhood user account number for each stock. Volume is the daily trading volume in thousand. Price is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. *Lockdown* is a dummy variable equal to one during the lockdown period (Mar. 16th, 2020 to May 7th, 2020), and zero over the exact same number of days prior to the lockdown (Jan. 23rd, 2020, to Mar. 15th, 2020) as defined in Ozik et al. (2021)

	$Stock\ \%\ Spreads_{i,t}$
Lockdown	1.56***
	(15.28)
Act.Option	-0.08
	(-1.14)
Retail	-0.19***
	(-5.12)
Lockdown x Act.Option	-1.96***
	(-17.46)
Lockdown x Retail	-0.19***
	(-12.68)
Lockdown x Act.Option x Retail	0.24***
	(14.13)
Constant	4.89***
	(19.19)
Controls	Yes
Day FE	Yes
Observations	252,668
Number of id	3,596

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. COVID-19 Lockdown, Active Option Trading, and Retail Traders

This table presents the following OLS regression results from various specifications.

$$Option\ \%\ Spreads_{i,t}^{j} = \alpha + \beta_1 Lockdown_t + \beta_2 Retail_{it} + \beta_3 Lockdown_t \times Retail_i + \beta_4 O/S_{i,t} + \beta_5 Price_{i,t} + \beta_6 Stock\%Spread_{i,t} + \beta_7 MCAP_{i,t} + \beta_8 RVolt_{i,t} + \varepsilon_{i,t}$$

$Option\ \%\ Spreads_{i,t}^{j}$ is one of the option bid-ask spread measures. Column (1) presents the result with option bid-ask spread calculated as the average across contracts weighted by the open interests. Column (2) presents the result with option bid-ask spread calculated as the average across contracts weighted by the trading volume. Colume (3) presents the results with the option bid-ask spread calculated as the simple average across contracts. *Retail* is the daily Robinhood user account number for each stock. *O/S is* the daily option to stock volume ratio. *Price* is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. *Lockdown* is a dummy variable equal to one during the lockdown period (Mar. 16th, 2020 to May 7th, 2020), and zero over the exact same number of days prior to the lockdown (Jan. 23rd, 2020, to Mar. 15th, 2020) as defined in Ozik et al. (2021)

Panel A: Call Options			
	(1)	(2)	(3)
Lockdown	69.51***	59.70***	22.08***
	(70.80)	(53.23)	(36.12)
Retail	-11.99***	-8.32***	-8.43***
	(-59.55)	(-35.81)	(-49.44)
Lockdown x Retail	-1.28***	-1.90***	-0.04
	(-19.96)	(-24.47)	(-0.79)
Controls	Yes	Yes	Yes
Day and Firm FE	Yes	Yes	Yes
Observations	243,051	192,979	256,710
Panel B: Put Options			
	(1)	(2)	(3)
Lockdown	23.08***	38.08***	20.56***
	(28.52)	(35.14)	(32.24)
Retail	-2.71***	-4.42***	-5.88***
	(-12.49)	(-17.98)	(-32.01)
Lockdown x Retail	-0.67***	-1.49***	0.23***
	(-10.47)	(-18.53)	(4.46)
Controls	Yes	Yes	Yes
Day and Firm FE	Yes	Yes	Yes
Observations	241,019	178,320	256,710

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. COVID-19 Reopen, Active Option Trading, and Retail Traders

This table presents the following OLS regression results from various specifications.

$$Stock\ \%\ Spreads_{i,t}^{j} = \alpha + \beta_1 Reopen_t + \beta_2 Act.Options_i + \beta_3 Retail_{it} + \beta_4 Reopen_t \times Act.Options_i + \\ + \beta_6 Retail_{it} \times Reopen_t + \beta_7 Reopen_t \times Act.Options_i \times Retail_{it} + \beta_8 Price_{i,t} + \beta_9 MktCAP_{i,t} + \beta_{10} RVolt_{i,t} + \varepsilon_{i,t}\ ,,$$

Retail is the daily Robinhood user account number for each stock. Volume is the daily trading volume in thousand. Price is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. *Lockdown* is a dummy variable equal to one during the lockdown period (Mar. 16th, 2020 to May 7th, 2020), and zero over the exact same number of days prior to the lockdown (Jan. 23rd, 2020, to Mar. 15th, 2020) as defined in Ozik et al. (2021)

VARIABLES	(1)
Reopen	-1.10***
	(-9.85)
Act.Option	-0.34***
	(-3.17)
Retail	-0.31***
	(-6.61)
Reopen x Act.Option	0.74***
	(9.23)
Reopen x Retail	0.07***
	(5.62)
Reopen x Act.Option x Retail	-0.03***
	(-2.63)
Constant	6.93***
	(17.05)
Controls	Yes
Day FE	Yes
Observations	259,706
Number of id	3,606

Robust z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. COVID-19 Reopen, Active Option Trading, and Retail Traders

This table presents the following OLS regression results from various specifications.

$$Option\ \%\ Spreads_{i,t}^{j} = \alpha + \beta_1 Lockdown_t + \beta_2 Retail_{it} + \beta_3 Lockdown_t \times Retail_i + \beta_4 O/S_{i,t} + \beta_5 Price_{i,t} + \beta_6 Stock\%Spread_{i,t} + \beta_7 MCAP_{i,t} + \beta_8 RVolt_{i,t} + \varepsilon_{i,t}$$

$Option\ \%\ Spreads_{i,t}^{j}$ is one of the option bid-ask spread measures. Column (1) presents the result with option bid-ask spread calculated as the average across contracts weighted by the open interests. Column (2) presents the result with option bid-ask spread calculated as the average across contracts weighted by the trading volume. Colume (3) presents the results with the option bid-ask spread calculated as the simple average across contracts. *Retail* is the daily Robinhood user account number for each stock. *O/S is* the daily option to stock volume ratio. *Price* is the end of the day stock price or the midpoint of the bid and the ask. *Rvolt* is range-based volatility of Alizadeh, Brandt, and Diebold (2002), or the natural log of the daily high price minus the natural log of the daily low price. *Mkt Cap* is the market capitalization in million $. *Stock%Spread* is the percentage bid-ask spread at the end of the day for each stock. *Act. Options* is an indicator variable equal to one if the stock has at least one option trade in more than 80% of trading days the previous year, and zero if the stock has no option series or less than one option trade in fewer than 20% of pre-sample days. *Lockdown* is a dummy variable equal to one during the lockdown period (Mar. 16th, 2020 to May 7th, 2020), and zero over the exact same number of days prior to the lockdown (Jan. 23rd, 2020, to Mar. 15th, 2020) as defined in Ozik et al. (2021)

Panel A: Call Options			
	(1)	(2)	(3)
Reopen	-38.82***	-35.52***	-22.46***
	(-40.24)	(-28.21)	(-31.20)
Retail	-7.86***	-7.74***	-8.59***
	(-24.77)	(-20.84)	(-33.79)
Reopen x Retail	0.51***	0.14*	-1.38***
	(9.13)	(1.87)	(-32.48)
Controls	Yes	Yes	Yes
Day and Firm FE	Yes	Yes	Yes
Observations	243,051	192,979	256,710
Panel B: Put Options			
	(1)	(2)	(3)
Lockdown	15.48***	13.19***	-4.74***
	(16.50)	(11.06)	(-6.36)
Retail	-9.58***	-6.54***	-8.36***
	(-29.70)	(-16.15)	(-31.82)
Reopen x Retail	-1.97***	-0.42***	-1.48***
	(-33.67)	(-5.30)	(-33.20)
Controls	Yes	Yes	Yes
Day and Firm FE	Yes	Yes	Yes
Observations	240,212	177,038	255,813

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1