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Abstract

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JEL classifications: G10; G12; G13; G14; G18.

Keywords: Limits to arbitrage; Short selling; Short squeeze; Gamma squeeze; Social media platforms.

*The views expressed in this article are solely those of the authors, who are responsible for the content, and do not represent the views of our employers. Any remaining errors are our own.

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Abstract

At the end of January 2021, a group of stocks listed on US stock exchanges experienced sudden surges in their stock prices, which - coupled with high short interest - led to brief short squeeze episodes. We argue that these short squeezes were the result of coordinated trading by retail investors, who discussed their trading strategies on social media platforms. Contrary to popular beliefs, bot activity on social media did not play a role. However, option markets played a central role in these events. Using hand-collected data we provide the first rigorous study of these short-squeezes and show that they significantly impeded market quality not only of the stocks at issue but also of their competitors. This evidence calls for tighter monitoring of social media platforms and a better understanding of the inter-linkages between these platforms, derivatives markets and equity markets.

1. Introduction

At the end of January 2021, multiple companies listed on United States (US) stock exchanges experienced surges in their stock prices, which - coupled with high short interest in each of these stocks - led to significant short squeezes in many of them. We argue that these sudden price spikes were the result of coordinated actions of traders through social media platforms.

The coordinated trading efforts of traders, a large proportion of which were retail investors, proved especially problematic for certain institutional traders who had shorted these stocks. To our knowledge, it was the first time that such coordinated trading efforts specifically targeted stocks with high short interest. While some of the short sellers publicly attempted to engage in discussions with retail traders to explain why they had shorted these stocks and what their expectations for the long-term financial outlook of these stocks were, more and more retail traders joined the crowd in purchasing the stocks. Taking a position in these securities was not confined only to the stock market. Many market participants used options to establish positions in the securities, as well.

Understanding what happened prior to and during these series of short-squeeze episodes is important for at least three reasons. First, while short squeezes did occur with some frequency historically, coordination among traders to target stocks with high short interest, as seen in these episodes, has not been seen before in quite this way.¹ The reason is that this type of coordination is a phenomenon made possible only in recent years through social media platforms. While behavior precipitating short squeezes is illegal in most countries, including the US, it is currently unclear whether the type of coordination undertaken by investors in these episodes is covered by the rules governing stock market trading. These were designed to ensure capital market efficiency. The latter relies to a large extent on the principle of arbitrage. If the price of an asset is too low relative to its discounted future cash flows, then arbitrageurs will buy it and drive the price up; if the price is too high, they will short sell it and drive the price down. Among the most important limits to this arbitrage process is the possibility of squeezes and corners. In a squeeze, short sellers find it difficult to acquire the securities they need to cover

¹See [Allen, Haas, Nowak, and Tengulov \(2021\)](#) for an account of the literature on squeezes and corners.

their short position because of a shortage of floating supply and the price rises as a result. A corner is an extreme form of short squeeze, where the buy side has almost complete control of all floating shares. While the coordination that took place on social media platforms was publicly observable and transparent, US regulators are in the process of establishing the extent to which the coordination has adversely impacted market efficiency and violated stock market regulations.

Second, understanding how these events could occur in one of the most advanced countries in the world with arguably some of the most sophisticated financial market regulations, namely the US, is important for policy reasons. We argue below that (i) the surge in prices of 13 stocks led to episodes of short squeezes in each of these stocks; (ii) changes in the number of mentions of a stock on social media platforms and in online forums is associated with changes in the respective stock's price; and (iii) part of the market relied on call options during and after these short squeezes to express their optimistic views about the relevant stocks, which likely exacerbated the squeeze events, while (iv) another part of the market used put options during and after the short squeezes to express their pessimistic views about the stocks, likely as a tool to circumvent the resulting squeezes. This evidence calls for tighter monitoring of social media platforms and better understanding of the inter-linkages between these platforms, derivatives markets and equity markets.

Third, the data available in modern markets allow us to study in detail the precise way in which short squeezes affect the operation of markets. This was not usually possible with historical manipulation events. This paper considers how the series of short squeezes in early 2021 impacted market quality in a stock market in which information is in many circumstances incorporated quickly but in others, such as when there is asymmetric information, can take some time. We provide evidence that in the case of coordinated trading by a large crowd of traders that results in a short squeeze, market quality is subsequently reduced in these stocks despite real-time surveillance by market regulators and continuous information processing. We also document negative spillover effects on the market quality of the product market competitors of the firms at issue.

The debate on the extent to which short selling and short squeezes should be regulated has

been around for more than a century. [Allen, Litov, and Mei \(2006\)](#) show that in the nineteenth and early twentieth century, squeezes and corners were not uncommon in US stock markets.² In 1934, the Securities and Exchange Act (the SEC Act) made illegal two broad categories of security market manipulation: action-based manipulation and information-based manipulation. In action-based manipulation, the manipulative strategy centers on implementing actions that change the actual or perceived value of the assets ([Wycoff \(1968\)](#)). More specifically, the SEC Act made it illegal for directors and officers to sell short the securities of their own firm, and generally restricted non-bona fide trading strategies. This made action-based manipulation difficult. Information-based manipulation involves providing false information or spreading false rumors to profit from subsequent market reaction ([Sobel \(1965\)](#)). To remove information-based manipulation, the SEC Act required firms to issue information to the public on a regular basis to, among other things, make the spreading of rumors more difficult. For example, it became illegal for anybody to attempt to raise or depress stock prices by making statements that they knew to be false. The SEC Act is actively enforced and with a number of well-publicized exceptions it has been successful in eradicating action-based and information-based manipulation.

[Allen, Haas, Nowak, and Tengulov \(2021\)](#) discuss a recent example of the stringent enforcement of the SEC Act. On August 7, 2018, during regular trading hours, Elon Musk, Tesla's Chief Executive Officer (CEO) and Chairman of the company, surprised investors by tweeting to his more than 22 million Twitter followers that he was considering taking Tesla private at USD 420 per share. This was an approximately 20% premium over the stock's trading price earlier that day.³ This tweet appears to have led to an immediate increase in Tesla's stock price, which led to a loss of about USD 1.3 billion for short sellers.⁴ US regulators - the US Department of Justice (DOJ) and the SEC - immediately investigated the events and Mr. Musk's tweet. After the conclusion of the investigations, both Tesla and Mr. Musk had to pay penalties. In addition, Mr. Musk had to step down as the chairman of Tesla's board and was replaced by an

²The authors provide a valuable theoretical framework that allows them to analyze several of these early stock market and commodity corners.

³"SEC sends Subpoena to Tesla in a Probe Over Musk Tweets," Wall Street Journal, August 15, 2018 ([Link](#)) See also the complaint "United States Securities And Exchange Commission vs. Elon Musk," September 27, 2018, ¶2.

⁴"Tesla call options soar on Musk tweet, short-sellers hit," Reuters, August 7, 2018 ([Link](#)).

independent chairman.⁵

The case of the stocks that experienced short squeezes in early 2021 is different from the Tesla case for one important reason: the coordination of market participants through social media platforms. While users of social media platforms have discussed trading strategies in special forums open to anybody interested in investments, trading strategies, and market events, our paper documents that this is the first time that social media platforms have been used to coordinate trading strategies across a large group of traders, i.e., to purchase stocks with high short interest. The public has attributed much of this trading to retail traders. Trading by retail investors has seen a significant increase during the COVID-19 pandemic (see, e.g., Ozik, Sadka, and Shen (2020)) and in this paper we also focus on whether retail traders contributed to the price increases of the stocks at issue. We focus on 13 stocks, which were at the center of the social media platform discussions and for which trading restrictions were put in place by brokers,⁶ and their competitors. We find that for the 13 target stocks, the sudden price surges at the end of January 2021 led to short squeezes, and that the price surges were fueled by retail trading activity and increased coverage of these stocks on social media platforms. When the short squeezes approached their peak and retail brokers started to restrict purchases in these stocks, both long and short investors used option markets in order to circumvent the impediments introduced in the stock market and continue to express their positive and negative views. In particular, we find that part of the market relied on call options during and after the short squeeze to express their optimistic views about the relevant stocks, which likely exacerbated the squeeze events (referred to as “gamma squeeze” by commentators and market participants), while another part of the market used put options during and after the short squeeze to express their pessimistic views about the stocks, likely as a tool to circumvent the resulting squeezes. We next turn our attention to the question whether professional stock market analysts anticipated the short-squeeze events. The evidence suggests that even professional market analysts were likely not anticipating the short-squeeze events and were left confused

⁵“Elon Musk will be ineligible to be reelected chairman for three years, but can keep the CEO position.” See, “Elon Musk to step down as chair of Tesla board, settles with SEC for USD 20 million,” CBS News, September 29, 2018 (Link).

⁶American Airlines, AMC, BlackBerry, Bed Bath & Beyond, Castor Maritime Inc., Express, Gamestop, Koss, Naked Brand Group, Nokia, Sundial Growers Inc., Tootsie Roll, and Trivago NV.

about the true fundamental value of the stocks at issue after the squeezes. We also investigate whether bots, i.e., accounts that were posting algorithmically by a computer, were contributing to the increase in social media posts. We do not find evidence of bot activity at any point in time over the sample period.⁷ Finally, we analyze if the short squeezes adversely impacted market quality. We find that market quality deteriorated for the stocks at issue. In addition, we document negative spillover effects to their competitors during and after the short-squeeze episodes. For example, we find that during the squeeze period relative bid-ask spreads and volatility for the 13 target stocks (their competitors) increased by 35% (30%) and 129% (37%), respectively.

Our paper is the first detailed study of the short squeezes that took place in late January 2021. Our findings contribute to the literature on short selling, short squeezes, and coordination of trading through social media platforms. Closely related to our contribution are [Kyle \(1984\)](#) and [Pirrong \(1993\)](#). They develop theories of squeezes in commodity futures markets, but many of their insights are also applicable to stock market squeezes. Kyle's theory shows how short squeezes can arise even though all traders are fully rational. Pirrong shows how squeezes influence informational risk and market quality as they hinder price discovery.

[Merrick Jr, Naik, and Yadav \(2005\)](#) investigate the trading behavior of market participants during an attempted delivery squeeze in the March 1998 long-term United Kingdom (U.K.) government bond futures contract traded on the London International Financial Futures and Options Exchange (LIFFE). Their results show that the differences in the penalties for settlement failures in cash and futures markets create conditions that favor squeezes. Four recent papers empirically examine short selling in relation to particular manipulative or abusive trading strategies. [Shkilko, Van Ness, and Van Ness \(2012\)](#) study episodes of significant intraday downward price pressures in individual stocks and find that price declines during such episodes are driven mainly by liquidity demanding non-short trading volume. The authors conclude that the influence of short sellers on prices is secondary to that of non-short sellers. [Fotak, Raman, and Yadav \(2014\)](#) investigate the effects of naked short selling on markets using the level of

⁷This is not to say that bots did not exist or attempt to influence market participants' sentiment. Most social media platforms have committed themselves to screening for bot activity on a real-time basis, and to stop any such activity as it occurs.

failures to deliver during settlement. They show that (naked) short sellers have positive effects on market quality and market efficiency, such as reducing volatility. How failed attempts to manipulate stocks can cause a surge in informational risk and a deterioration of market quality is shown in [Gehrig, Fohlin, and Haas \(2015\)](#). They provide evidence of how the failure of a short squeeze in the opaque trading environment of US stock markets in 1907 led to a decline of funding and market liquidity. [Allen, Haas, Nowak, and Tengulov \(2021\)](#) describe the evolution of securities law in the European Union in general and Germany in particular, and discuss the Volkswagen (VW) short squeeze in 2008 as an example of the problems that lack of regulatory enforcement can lead to. Using a unique hand-collected data set from criminal proceedings against Porsche and its executives, the authors were able to reconstruct how Porsche managed to create a short squeeze in the market for VW shares. They show that Porsche accumulated a significant ownership stake in VW through complex derivatives strategies. Once Porsche announced its secretly accumulated position in VW and desire to continue with its take-over plans, one of the largest short squeezes in history took place. This in turn had significant adverse consequences for market quality and price discovery.

A relatively young strand of literature discusses the effects of coordinated trading through social media platforms on financial markets. Much of this literature is focused on cryptocurrency markets, but recent empirical studies have branched out to stock markets (see, e.g., [Duz Tan and Tas \(2020\)](#), [Jiao, Veiga, and Walther \(2020\)](#), [Lyócsa, Baumöhl, and Vÿrost \(2021\)](#), [King and Koutmos \(2021\)](#), and [Hu, Jones, Zhang, and Zhang \(2021\)](#) among others). At a high-level, these studies find that social media platform attention contains information for predicting stock returns and increases trading volumes in the relevant stocks. This literature builds on the strand of literature that analyzes herding behavior in financial markets. A common observation of the latter literature is that market participation increases during a speculative episode, as investors with limited experience or expertise are attracted by market events. Theoretical models of asset bubbles characterize both rational and irrational herd behavior as being capable of generating contagion powerful enough to lead to stock market bubbles or crashes. At the center of these models is typically a fundamental information problem in which a rational investor uses the activity of others to learn about movements in market fundamentals, and then interacts with a

subset of less experienced agents (e.g., noise traders) that engage in herd behavior for reasons that may not be motivated by rational decision-making. Prominent examples of these studies are [DeLong, Shleifer, Summers, and Waldmann \(1987\)](#), [Scharfstein and Stein \(1990\)](#), [Banerjee \(1992\)](#), or [Scheinkman and Xiong \(2003\)](#) among many others. In a recent working paper, [Pedersen \(2021\)](#) presents a model of how trading strategy discussions and investment ideas can take on a dynamic of their own, ripple through social networks, and eventually affect market behavior and prices. He shows that by learning through the social network that investors are active in, echo-chamber effects and fake news that are distributed through these networks can lead to disagreement for extensive time periods. The model he presents predicts that this time-varying disagreement can generate significant trading with a spike in turnover, high volatility, price momentum as a bubble builds, and a value effect as the bubble bursts. [Pedersen \(2021\)](#) applies the events in late January 2021 to illustrate the insights of the model. [Barber, Lin, and Odean \(2021\)](#) also study the implication of attention-based trading, but in an empirical framework. For example, their study builds on and confirms the theoretical prediction that retail investors will be long in high-attention stocks, and that these long positions will lead to temporary price increases which tend to be followed by reversals. The authors also explain why retail trades positively predict stock returns but are typically not profitable.

Our paper contributes to and extends these existing studies in several ways. First, using detailed data from the securities lending market, we document that the sudden price surges at the end of January and the beginning of February 2021 led to short squeezes in the stocks at issue. Second, using hand-collected data for users' posts and comments from social media platform, we find that there is a pronounced association between social media platform activity and the price surges that fueled the short squeezes. Third, we document that options markets played an important role in the development and evolution of these short squeezes. In particular, part of the market relied on call options, which likely exacerbated the squeeze events (a gamma squeeze), while another part of the market used put options likely as a tool to circumvent the resulting squeeze constraints.⁸ Finally, we show that despite the modern market environment

⁸This evidence supports the argument that traders use the options market to circumvent restrictions in the equity market. [Battalio and Schultz \(2011\)](#) and [Grundy, Lim, and Verwijmeren \(2012\)](#) argue that when short selling is restricted in the equity market, investors do not migrate to the options market. On the other hand,

and continuous news streams short squeezes adversely impact market quality. Importantly, we show that the adverse market quality impact of the short squeezes was not only contained to the stocks at issue but also spilled over to their competitors.

The remainder of this paper is organized as follows. Section 2 of the paper reviews the events before and after the 2021 short squeeze episodes. Section 3 describes the underlying data. Section 4 analyzes the securities lending market. Section 5 summarizes the interaction between social media platforms and stock price behaviour. Section 6 investigates if retail traders contributed to the price increases. Section 7 analyzes the inter-play between the stock market and the options market. Section 8 analyzes the expectations of professional stock market analysts. Section 9 investigates if bots were contributing to social media posts. Section 10 discusses the effects of the short squeezes on market quality of the stocks at issue and their competitors. Section 11 concludes. The Internet Appendix provides details for additional robustness tests.

2. Background

In this section, we review the events that led to a series of short squeezes in US stock markets in January and February 2021. In these two months, about a dozen stocks experienced erratic stock price movements. Figure 1 shows how starting in the fourth week of January, stock prices of 13 stocks increased by 100% to 1,500%. In contrast, the S&P 500 index remained almost flat over the same time period. The media has conjectured that these price movements were driven by retail investors who coordinated their trading strategies on social media platforms like Reddit, Twitter, and Stocktwits. Figure 2 shows how starting with the increase in erratic price movements in the fourth week of January, mentions of the 13 stocks on social media platforms increased and moved closely with the price increases.

[Insert Figure 1 here.]

Jones, Reed, and Waller (2021) provide evidence that traders move from the equity market to the options market when equity trading restrictions are implemented.

[Insert [Figure 2](#) here.]

We discuss social media platforms, retail trading through online broker dealers, the impacted stocks, as well as other relevant market participants.

2.1. Social media platforms and their contribution to the retail trading hype

Social media platforms provide forums to discuss and link different types of information, including news, fashion, politics, humor, support, or investment strategies. The websites differ in (i) the types of information covered and (ii) how the content is moderated. Some websites (e.g., Slashdot or Fark), employ administrators that decide which articles make it to the front page⁹. Other websites (e.g., Reddit or Digg) have less clearly outlined policies in their support of moderation¹⁰. Social media websites usually allow users to comment on and discuss the posts of other users. By creating a member account, users can follow each other's activity and stay up-to-date on recent posts, comments, and content posted by other users. Prominent examples of social media platforms used for investment discussions are: Twitter, Reddit, and Stocktwits. Below, we discuss - using as an example the social media forum r/wallstreetbets of Reddit - how social media platforms allow for the exchange, rating, and coordination of trading and trading-relevant information.

Reddit is a social media, web content rating, and web content discussion website. Registered members submit content to the site such as links, text posts, and images, which are then voted up or down by other members. Posts are organized by subject into user-created boards called "communities" or "subreddits," which cover a variety of topics such as news, politics, science, movies, video games, music, books, sports, fitness, cooking, pets, and image-sharing. Submissions with more up-votes appear towards the top of their subreddit and, if they receive enough up-votes, ultimately on the site's front page.¹¹ "r/wallstreetbets," also known as "Wall-

⁹"Slashdot Moderation," Slashdot, [Link](#); "Content," FARK.com, [Link](#)

¹⁰"Moderator Guidelines for Healthy Communities," Reddit Inc., [Link](#); "Digg Community Guidelines," digg, [Link](#)

¹¹Reddit was founded in 2005 by Steve Huffman, Alexis Ohanian, and Aaron Swartz. Condé Nast Publications acquired the website in October 2006. In 2011, Reddit became an independent subsidiary of Condé Nast's parent

StreetBets” or “WSB,” which has been attributed with having been one of the most active platforms for retail trader coordination in late January / early February, is a subreddit in which participants discuss stock and option trading.¹²

Reddit’s core content consists of posts from its users. Registered users can (i) post content, (ii) comment and vote on other users’ posts, and (iii) create their own subreddit on a topic of their choosing.¹³

2.2. *The short squeezes*

In early 2021, the attention of users of the previously discussed social media platforms focused on a group of stocks with high short interest. Ultimately, the combination of high short interest on the one hand and increased long positions in this set of stocks on the other hand, resulted in multiple short squeezes. In this subsection, we provide a timeline of how these short squeezes came about. For brevity, we only discuss GME. Similar events occurred for the other stocks in this group.

GME operates in the market for physical game media. This market has been in a state of decline since online services such as Xbox Live, PlayStation Network, Nintendo eShop, and Steam, all of which offer downloadable digital versions of games, have taken over.¹⁴ For the first time in 2017, GME reported a 16.4% drop in sales for the previous holiday season, but expressed optimism in its non-physical gaming businesses, which is the process by which video

company, Advance Publications. In October 2014, Reddit raised \$50 million in a funding round led by Sam Altman and including investors Marc Andreessen, Peter Thiel, Ron Conway, Snoop Dogg, and Jared Leto. Their investment valued the company at \$500 million then. In July 2017, Reddit raised \$200 million for a \$1.8 billion valuation, with Advance Publications remaining the majority stakeholder. In February 2019, a \$300 million funding round led by Tencent brought the company’s valuation to \$3 billion.

¹²Users frequently use slang such as “stonks” for stocks; “tendies” for gains or profits; “gay bears” for those who expect a stock to decline, or as a general insult; “DD” for analysis of potential trades (from “due diligence”); “bagholder” for one whose position has severely dropped in value; “diamond hands” for holding stocks adamantly; and “paper hands” for selling too early.

¹³A key feature to Reddit is that users can cast positive or negative votes, called “upvotes” and “downvotes,” respectively, for each post and comment on the site. The number of upvotes or downvotes determines the posts’ visibility on the site. Users can also earn an award for their posts and comments, a status that reflects their standing within the community and their contributions to Reddit. In the Reddit community, this is known as “karma.” The most popular posts from the site’s numerous subreddits are visible on the front page to those who browse the site without an account. By default for those users, the front page will display the subreddit “r/popular,” featuring top-ranked posts across all of Reddit. After a person has registered with Reddit, subreddits can be selected to show on the front page, instead of the default subreddit r/popular.

¹⁴“Why Digital Games Could Totally Dominate Physical Formats In Just a Few Years,” IGN, Link.

games are delivered without the exchange of storage media.¹⁵ Reasons cited for the decline in sales included industry weakness, promotional pricing pressure, and lower in-store traffic. From this point forward, sales and financial problems only got worse for GME. Over the period of 2017 through January 2019, GME tried to find a buyer, but was not able to due to a “lack of available financing on terms that would be commercially acceptable to a prospective acquirer.”¹⁶

Short sellers picked up on GME’s declining financial performance a couple of years ago. At the beginning of 2019, GME was selling for \$15. Reflective of its declining financial performance, share prices fell below \$4 by August 2019 as the company suffered continuing losses. The company responded to its low stock price by repurchasing significant quantities of shares.¹⁷ While this caused a temporary increase in the stock price, a mechanical effect of these repurchases was that the number of shares shorted relative to shares outstanding increased as well. In fact,

¹⁵ “No reindeer games: GameStop posts 16 percent holiday sales drop,” Dallas Business Journal, Link.

¹⁶ “GameStop Concludes Process to Pursue Sale of Company,” GME, Link. Following GME’s announcement that they were unable to find a buyer, GME’s share price dropped by 27% to a 14-year low. While GME was on the look-out for a buyer, the financial results of the company deteriorated. The fiscal year 2018 brought the biggest loss in GME’s history to date (see “GameStop Reports Fourth Quarter and Fiscal 2018 Results and Provides Fiscal 2019 Outlook,” GME, Link). For the 52-week period ending on February 2, 2019, GME reported a net loss of \$673 million (see “GameStop Reports Fourth Quarter and Fiscal 2018 Results and Provides Fiscal 2019 Outlook,” GME, Link). This was a change from the net profit of \$34.7 million in the previous year (see “GameStop Reports Fourth Quarter and Fiscal 2018 Results and Provides Fiscal 2019 Outlook,” GME, Link). While facing record losses and an overall decrease in financial performance, GME underwent several management changes at the executive level. In total, over the course of 2018 and 2019, GME underwent six turnovers of its chief executive officer position (e.g., “GameStop Names Michael K. Mauler as its New Chief Executive Officer,” GME, Link; “GameStop Announces Appointment of Daniel A. DeMatteo as Interim Chief Executive Officer and Resignation of Michael K. Mauler,” GME, Link; “GameStop Names George Sherman Chief Executive Officer,” GME, Link). Long-term CEO Paul Raines notified GME of his resignation on January 31, 2018 due to health reasons. Raines had been on medical leave since November 2017. Daniel DeMatteo, GME’s executive chairman stepped in as interim chief executive officer. On February 6, 2018, the company announced Michael K. Mauler as the new CEO and new member of the board of directors. On May 11, 2018, Mauler resigned due to “personal reasons” and chairman Daniel DeMatteo was again named interim CEO. On May 31, 2018, GME named Shane Kim as interim CEO. Kim was replaced by George Sherman in March 2019. Starting in 2019, GME tried to undergo a turnaround by (i) hiring outside consultants (see “GameStop Doubles-Down on Retail Innovation, Partners with R/GA to Re-Design the Future of the Cultural Gaming Experience,” GME, Link); (ii) laying off employees; (iii) redesigning stores (see “GameStop Doubles-Down on Retail Innovation, Partners with R/GA to Re-Design the Future of the Cultural Gaming Experience,” GME, Link); (iv) partnering with Microsoft (see “GameStop Announces Multi-year Strategic Partnership with Microsoft,” GME, Link); and (v) seeking restructuring of its finances (see “GameStop Announces Exchange Offer and Consent Solicitation,” GME, Link). Yet, these efforts appear to have been unsuccessful. GME did not meet analyst expectations in 2019 and was hit hard by the COVID-19 pandemic in 2020. Government efforts to slow the spread of COVID-19 required GME to close the physical operation of all of its 3,500 stores from March to May 2020 (see “GameStop Reports First Quarter Results,” GME, Link). Throughout this time, GME focused its sales on online and curbside sales. While digital sales grew by 519%, GME’s retail sales dropped by more than 30% in the same period from the prior year (see “GameStop Reports First Quarter Results,” GME, Link). The company reported a \$165 million loss in contrast to a \$6.8 million loss for the same quarter in 2019 (see “GameStop Reports First Quarter Results,” GME, Link).

¹⁷ “GameStop Announces Final Results of its Modified Dutch Auction Tender Offer,” GME, Link.

at times the reported short interest was higher than the shares outstanding.

In late 2020, on December 8, 2020, GME reported that it had “a positive start to the fourth fiscal quarter following the launch of the long-awaited next generation of video game consoles.”¹⁸ About a month later, on January 11, 2021, GME reported a continued effort to pull around the company and transform it into a profitable business. The company announced that it had appointed “three new directors” to accelerate the company’s “transformation.”¹⁹ Short sellers were not impressed by these announcements. Over the course of December 2020 and the first week of January 2021, short interest remained at elevated levels.

Other traders, however, reacted positively to these announcements. In January 2021, discussions involving GME intensified on social media platforms. As shown in Figure 6, the number of mentions of GME on the platforms Twitter, Stocktwits and r/wallstreetbets increased over the course of January 2021, and peaked in the last week of January at on average 100,000 mentions per day. Many of the users’ posts referenced that users had gotten into long positions in GME and called for others to do the same.

[Insert Figure 6 here.]

The same type of increase in the number of mentions on social media platforms can be observed for the other 12 stocks (see Figure 7 and Figure 8). Market participants entered into these long positions while being fully aware that significant short interest was outstanding for these stocks, and in particular for GME.²⁰ Two days after GME’s January 11 announcement, GME’s stock price closed at \$31.40, which is an increase of about 50% relative to GME’s stock price on January 11.

[Insert Figure 7 here.]

[Insert Figure 8 here.]

¹⁸ “GameStop Reports Third Quarter Results, A Positive Start to Fourth Quarter with November Comparable Store Sales Increasing 16.5% And Sustained Progress Toward Long-Term Strategic Objectives,” GME, Link.

¹⁹ “GameStop Announces Additional Board Refreshment to Accelerate Transformation,” GME, Link.

²⁰ During the first half of January 2021 the short interest for the five stocks with the biggest price increase during the short-squeeze period, namely Gamestop, Koss, Express, AMC, and the Naked Brand Group, was around 75%, 4%, 15%, 30%, 25%, respectively

The growing interest of retail traders in GME was noticed by short sellers. On January 19, Citron Research, an “online stock commentary source” (and at the time short in GME) published a post on Twitter that effectively called buyers of GME’s stock “suckers” and promised to explain “the 5 reasons GameStop \$GME buyers at these levels are the suckers at this poker game.”²¹ The tweet went on to say that the stock price will be “back to \$20 fast” and that Citron Research understands “short interest better than you and will explain.”²² On January 21, Citron Research explained its bearish view of GME in a Youtube video.²³

Traders were not stopped by these public announcements. On the contrary, as illustrated by Figure 6, after Citron Research’s Youtube video came out on January 21, GME was discussed more intensively on social media platforms with a marked uptick in the number of mentions of GME across the Twitter, Stocktwits, and r/wallstreetbets. Over the course of the next week, the number of mentions of GME increased exponentially on r/wsb as well as other social media platforms such as Twitter or Stocktwits. The increase in the number of GME mentions on these platforms coincides with an increase in GME’s stock price from \$30 to \$347.

Over time, the public debate between market participants with long positions and traders with short positions in GME and similar stocks ensued. This appears to have attracted more and more retail investors to “further [go] long on GameStop” and the other securities listed above.²⁴ Eventually, the stock price of GME (and some of the other securities) increased to levels such that investors shorting the securities were caught in a textbook short squeeze.²⁵ On January 27, 2021, driven by more market participants entering into long positions, the all-time highest intraday stock price for GME was \$483.00 (nearly 190 times the price of \$2.57 – the lowest stock price to date reached nine months earlier in April 2020). In pre-market trading hours the same day, it briefly hit over \$500, up from \$17.25 at the start of the month.²⁶

²¹Citron Research Tweet on January 19, 2021, Link.

²²Citron Research Tweet on January 19, 2021, Link.

²³“Andrew Left Bearish \$GME — ZingerNation,” Youtube, Link.

²⁴Case 3:21-cv-00781, Link.

²⁵See Allen, Haas, Nowak, and Tengulov (2021) for a detailed review of the literature on short squeezes.

²⁶According to data from TAQ in pre-market trading the price briefly hit USD 500, an increase of 338% compared to the previous closing. The evolution of GME’s stock price and order imbalances is shown in Figure A1 in the Internet Appendix. In addition, Figure A2 and Figure A3 plot the evolution of the stock prices and order imbalances of the other companies at issue, all of which experienced a similar stock price evolution as GME.

2.3. *The resolution*

On January 28, 2021 retail brokers restricted purchases of the thirteen companies; customers could no longer open new positions in these stocks, although they could still close them.²⁷ As an example of a retail broker instituting a purchasing ban, after the markets closed, Robinhood announced it would begin to allow “limited buys” of the affected securities starting the following day, although it was unclear what “limited buys” entailed (see “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link). Several brokerage firms, including Robinhood, stated on January 29, 2021 that the restrictions were the result of clearing houses raising the required collateral for executing trades.²⁸ Because there is a two-day lag between the moment when investors purchase a security and the moment cash and securities are actually exchanged, brokerage firms have to post collateral at clearing houses to guarantee the proper settlement of their clients’ orders. Clearing houses include the Depository Trust & Clearing Corporation (DTCC) for equities and the Options Clearing Corporation (OCC) for options. Clearing houses must have enough collateral on hand to settle a member’s outstanding transactions in the event any particular member firm fails—to prevent cascading failures of other members—and can demand additional collateral (i.e., margin calls) from members if market volatility starts to increase. Brokerage firms claimed that the increased collateral could not be provided in time, and, as a result, trading had to be halted. The DTCC, for example, increased the total industry-wide collateral requirements from \$26 billion to \$33.5 billion, noting that the large trading volumes in specific stocks “generated substantial risk exposures at firms that clear these trades [...] particularly if the clearing member or its clients are predominantly on one side of the market.”²⁹ On January 29, 2021 it was reported that Robinhood had raised an additional \$1 billion to protect the company from the financial pressure placed by the increased interest in particular stocks and met the

²⁷See, e.g., “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link. “GME set to close only,” eToro, Link; Twitter, M1 Finance, Link; Twitter, Public.com, Link; “Webull CEO: Here’s why Robinhood is restricting users from buying stocks like GameStop,” Yahoo Finance, Link.

²⁸“Robinhood Fallout Sweeps Market After \$1 Billion Lifeline,” Bloomberg News, Link.

²⁹“Robinhood tightens GameStop trading curbs again as SEC weighs in,” Financial Times, Link.

collateral requirements of clearing houses.³⁰

As of January 29, 2021 Robinhood was still imposing limits on the trading of several stocks.³¹ On January 30, 2021 Robinhood announced it had increased the restrictions from the trading of 13 securities to 50, including companies such as Rolls-Royce Holdings and Starbucks Corporation.³² However, on January 31, 2021 Robinhood announced it had removed several of these restrictions and would only limit the trading of eight securities.³³

On February 1 and 2, 2021 the stock price for GME declined substantially, losing more than 80 percent of its value from its intraday peak price, recorded during the previous week (see Figure 6). GME shares lost 60% of their value on February 2, closing below \$100 for the first time in a week. Other assets affected by the short squeeze and put under broker trading restrictions, such as AMC and Blackberry shares, also declined in value. Despite the decline, some r/wallstreetbets users rallied to convince other users to hold on to the shares, arguing either that they would increase in value or that such an action would send a political message. On February 4, after market hours, Robinhood lifted all restrictions on long positions.³⁴

Based on the timeline of events above, we define the short squeeze period to be from January 26 through February 4 for the following reasons. First, the majority of the thirteen stocks experienced sharp price increases on January 26 (see Figure 1). Second, the thirteen stocks experienced a substantial increase in the number of mentions on social media platforms starting on January 26 (see Figure 2). The reverse is true for February 4, when all of these measures saw similarly substantial declines across the thirteen stocks. This is also the day when retail brokers lifted remaining trading restrictions. We therefore define this day as the end of the short squeeze period.³⁵

³⁰ “Robinhood Fallout Sweeps Market After \$1 Billion Lifeline,” Bloomberg News, Link.

³¹ “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link.

³² “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link.

³³ “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link.

³⁴ “Keeping Customers Informed Through Market Volatility,” Robinhood, Link; “Changes due to ongoing market volatility,” Robinhood, Link.

³⁵ Note that some of these stocks continued to experience high volatility with periods of large price increases after the end of these short squeeze episodes, but none of these periods rose to the level of further short squeezes.

3. Data

Our unique and primary data source is hand-collected data from the social media platforms Reddit, Twitter, Stocktwits. We complement these data with accounting and stock price information from Compustat as well as the annual reports and investor relations websites of the companies at issue and their competitors. Public press articles data are from Bloomberg. Data on analysts' target price forecasts and dispersion are retrieved from the I/B/E/S database. Intraday trades and quotes data are obtained from TAQ. Options markets data come from OptionMetrics, which provides aggregate options data for all 16 U.S. options exchanges such as the Chicago Board Options Exchange (Cboe) or Nasdaq BX Options. Data for the securities lending market are from Markit. The data sample includes the thirteen stocks that experienced trading bans by the majority of brokers³⁶ during January and February 2021, their main competitors³⁷ as well as companies included in broader stock market indices such as S&P 500.

4. Did the sudden price increases lead to a short squeeze?

In this section we investigate whether the sudden price increases led to a decrease in the amount of shares shorted (as measured by the ratio of value on loan relative to the market capitalization of the respective stock of interest). As before, for brevity, we only discuss GME. The majority of the other stocks experienced similar evolution of shares shorted.

As shown in Figure 3 in the weeks before the start of the short squeeze the amount of shorted GME shares fluctuated around 75%.³⁸ Starting January 26, as the stock price started to rapidly

³⁶We note that on January 28 Robinhood, among other brokers, initially implemented trading restrictions for thirteen stocks (see Fig A4 in the Internet Appendix for Robinhood's announcement). On Jan 30 Robinhood expanded the set of stocks to approximately 50, but only a day later they reverted to the previous number of stocks. In addition, to our knowledge none of the other brokers (e.g., Freetrade, Trading 212, Charles Schwab, E-Trade, eToro, WeBull, etc.) implemented restrictions for a wider set of companies than the initial 13. We therefore concentrate our test on the 13 stocks for which Robinhood put initially trading restrictions in place.

³⁷We use CapitalIQ to identify firms' competitors. CapitalIQ sources information from companies' SEC filings and analyst reports.

³⁸We note that the ratio of value on loan relative to the market capitalization of the respective stock represents a lower bound for the shares shorted. When using total shares available to the public (i.e., float) instead of market capitalization, shares shorted for GME often exceeded 100%. For a simple explanation of this phenomenon we refer to public press articles around the short squeeze period, see e.g., "GameStop Called Attention to the Share Lending Market. Here's What You Should Know," Wall Street Journal, 2021, Link.

increase, shares shorted started to decrease. On January 27, when GME's stock experienced an all-time intraday high of USD 483, shares shorted had dropped to approximately 30%. On January 28, Robinhood, among other brokers, started implementing trading limitations in GME and other stocks. This led to a reversal of the observed pattern with GME's stock price decreasing while shares shorted soared to approximately 60%. This trend proved to be short-lived, as another spike in GME's price on the next day resulted in a second dip in shares shorted – down to approximately 25%. We observe one more reversal in shares shorted with a peak at approximately 55% on February 3 as GME's stock price started to gradually decline. However, this spike again appears to be temporary and was followed by a steady decline in shares shorted in the last days of the short squeeze period and thereafter.

[Insert Figure 3 here.]

Figures 4 and 5 depict the evolution of the closing prices and the evolution of shares shorted for the remaining initially banned 12 stocks. In general, we observe similar patterns to the pattern described for GME, i.e., we observe steep declines in shares shorted concurrent with the sudden spikes in the stock price.

[Insert Figure 4 here.]

[Insert Figure 5 here.]

Furthermore, if there was a short squeeze, we should not only observe a decrease in the demand for securities loans for the purposes of short selling, but also increasing fees on loans and changes in tenure of loans.

To test how these variables changed over time, as mentioned before, we differentiate between the following time periods: 1) *Pre-SSqueeze* is defined as two weeks (10 trading days) before the short squeeze started, i.e., before January 26, 2021; 2) *SSqueeze* is defined as the short squeeze period, which is from January 26, 2021 through February 04, 2021; and 3) *Post-SSqueeze* is

defined as two weeks (10 trading days) after February 04, 2021.³⁹ We restrict the sample to two weeks around the event days for the sake of symmetry (i.e., as of the time this draft was written data was available only through February 19, 2021). We estimate the following regression model:

$$Y_{i,t} = \alpha + \beta_1 SSqueeze + \beta_2 Post-SSqueeze + \epsilon_{i,t}, \quad (1)$$

Here $Y_{i,t}$ represents one of the variables discussed above. Table 1 provides summary statistics and definitions of the variables, and Table 2 presents the results. On average, we observe a statistically significant decrease during the short squeeze period in Value on Loan of 5.28 percentage points or 25% (relative to Value on Loan of 21.26% before the short squeeze period). After the squeeze period, Value on Loan decreased even further. Furthermore, we observe an average increase during the squeeze period in stock average fees (SAF) of 388 b.p. or 42% (relative to SAF of 929 b.p. before the short squeeze period). After the squeeze period SAF decrease but remain at elevated levels compared to the period before. We also find an average decrease in Tenure during the squeeze period of 8 days or 14% (relative to loan Tenure of 57.7 days before the squeeze). Average Tenure continued to decrease after the squeeze period. We find no statistically significant change in Utilization. However, we note that Utilization is computed as the ratio of the value of open loans to the total value of lendable assets. Since we find that value of open loans decreased during the squeeze it is likely that total value of lendable assets (supply side) decreased as well (and therefore we observe no change in Utilization).

Overall, the evidence presented in this section is consistent with the behaviour of stocks that experienced short squeezes.

[Insert Table 1 here.]

[Insert Table 2 here.]

³⁹In robustness estimations we plan to define the *Pre-SSqueeze* and the *Post-SSqueeze* periods as 15 and 20 trading days before/after the event period.

5. Did social media platforms contribute to these price increases?

In this section we focus on the interaction between social media platforms and the evolution of the market prices of the relevant stocks listed above. In particular, in this section we describe the joint time-series evolution of the daily number of mentions of the stocks at issue on social media platforms (e.g., Twitter, Stocktwits, Reddit) and the daily closing prices for these stocks. We are particularly interested to analyze if any association between these time series exists. To perform this analysis, we use the hand-collected data described in Section 3, which includes counts of posts and comments referencing the relevant stocks from the social media platforms Reddit, Twitter, Stocktwits, as well as public press searches. We complement these data with information on securities prices from Compustat.

First, we analyze the joint evolution of mentions on social media platforms and prices for GME. We use GME as an example since it attracted a lot of media coverage, but we also discuss all other stocks at issue. Figure 6 depicts the evolution of GME's closing price and the evolution of the number of times GME was mentioned on social media platforms starting at the beginning of January 2021. An interesting pattern emerges – it appears that movements in the number of mentions frequently coincide with movements and direction in the stock price. For example, around January 15, we observe a small increase in the number of mentions. During the same period, we also observe an increase in the stock price. Beginning on January 26, the number of mentions increases and then decreases steeply. This coincides with an increase and decrease in GME's stock price. After February 4, we see a gradual decrease in both number of mentions and GME's stock price. Over the time period analyzed, the correlation coefficient between the two time-series is 0.85.

[Insert Figure 6 here.]

Figures 7 and 8 depict the evolution of the closing prices and the evolution of the number of times a company was mentioned on social media platforms for the remaining initially banned 12 stocks. Overall, we observe similar patterns for each of the stocks when compared to the

pattern described for GME above. Over the time period analyzed, the correlation coefficients for each of the stocks range from 0.33 to 0.84.

[Insert [Figure 7](#) here.]

[Insert [Figure 8](#) here.]

6. Did retail traders contribute to these price increases?

In this section we focus on the interaction between retail traders and market prices of the stocks at issue. More specifically, we analyze whether the trading activity of retail traders impacted stock price movements during the short squeeze period. To identify retail trading activity we follow [Boehmer et al. \(2021\)](#), who provide a methodology to identify retail order flow using publicly available equity transaction data. In particular, we measure retail traders' directional trades by computing two scaled order imbalance measures for each stock and period: i) *mroibvol* – a measure, which is based on the number of shares traded, and ii) *mroibtrd* – a measure, which is based on the number of trades. For institutional background and methodology we refer the reader to [Boehmer et al. \(2021\)](#). To test how the impact of retail traders' activity changed over the period of interest, similar to previous analyses, we differentiate between the following time periods: 1) *SSqueeze* is defined as the short squeeze period, which is from January 26, 2021 through February 04, 2021; and 2) *Post-SSqueeze* is defined as two weeks (10 trading days) after February 04, 2021. We estimate the following regression model:

$$\begin{aligned}
 Y_{i,t} = & \alpha + \beta_1 SSqueeze + \beta_2 Post-SSqueeze + \beta_3 mroib_{i,t-1} \\
 & + \beta_4 SSqueeze \times mroib_{i,t-1} + \beta_5 Post-SSqueeze \times mroib_{i,t-1} \\
 & + \beta_6 Controls_{i,t-1} + \epsilon_{i,t},
 \end{aligned}$$

We follow the market microstructure literature and measure returns ($Y_{i,t}$) over intervals of

30 seconds, one minute, and two minutes. $mroib_{i,t-1}$ is referring to one of the two retail trading activity measures discussed above ($mroibvol_{i,t-1}$ and $mroibtrd_{i,t-1}$). These are measured at the same frequency as returns. We also include various control variables. Here, the coefficient of interest is β_4 . If retail trading behaviour contributed to variation of stock returns during the short squeeze period for the stocks at issue, one would expect to find that β_4 is positive and statistically significant.

Panels A and B of Table 3 summarize the results of these estimations for $mroibvol$ and $mroibtrd$, respectively. We find that β_4 is positive and statistically significant in all specifications. This is strong evidence that retail traders' activity is significantly correlated with returns of the relevant stocks during the short squeeze period.

[Insert Table 3 here.]

7. Did options markets contribute to these price increases?

In this section we turn to assessing whether market participants traded in the options market in order to make long and short bets on the price performance of the stocks at issue. Specifically, this section focuses on the questions i) whether traders used call options to benefit from the positive price performance, and whether this, in turn, resulted in additional upward-pressure on the stocks, and ii) whether traders used put options in order to circumvent the short squeezes.

We start with analyzing options open interest⁴⁰ (separately for put and call options) for the periods around the short squeezes. To cover the spectrum of option moneyness, we differentiate between in-the-money (ITM), at-the-money (ATM), and out-of-the-money (OTM) options. In a second analysis, we analyze trading volume of ITM, ATM, and OTM options around the short squeezes.⁴¹ As before, we estimate the following regression model:

⁴⁰Open interest is the total number of contracts outstanding (long or short). Open interest is typically used as a measure of market activity. High open interest indicates that traders have opened option contracts and are participating in the market for this option, and vice versa for low open interest in a given options contract.

⁴¹Trading volume is a measure of how much of a given financial asset has traded over a period of time. For options, trading volume is measured in number of contracts per day.

$$Y_{i,t} = \alpha + \beta_1 SSqueeze + \beta_2 Post-SSqueeze + \epsilon_{i,t}, \quad (2)$$

Here $Y_{i,t}$ represents either daily option open interest per stock or daily option trading volume per stock.

Table 4 presents the results for option open interest and Table 5 presents the results for option trading volume. On average, we observe a statistically significant increase in open interest for ITM and OTM call options both during and after the short squeezes. We also observe a statistically significant increase in option trading volume for OTM call options. In addition, we see a small negative change of open interest and trading volume for ATM call options during the squeeze. However, this change is marginally statistically significant for open interest and not statistically significant for trading volume, and, therefore, we do not discuss these results here. Open interest of ITM call options increased statistically significantly and economically significantly during the short squeeze by 133,663 contracts or 87% (relative to open interest of ITM call options of 153,733 contracts per day before the squeeze). Open interest of OTM call options increased statistically significantly and economically significantly during the short squeeze by 165,368 contracts or 51% (relative to open interest of OTM call options of 326,348 contracts before the squeeze). These results indicate that traders relied on call options during and after the squeeze to express their optimistic views on these stocks. In addition, the increased usage of call options likely caused option counterparties to increase their hedging activities by buying the underlying shares, which, in turn, can have contributed to additional upward price pressure on the stock price.⁴²

[Insert Table 4 here.]

⁴²This has been referred to as “a gamma squeeze.” In particular, when a trader buys call options, it creates a risk for the counterparty that sold these options. In other words, if the underlying shares rise above the strike price, the option writer (seller) will have to acquire the shares in the open market, at a loss, to fulfill the contract obligation. Despite many ways to hedge this risk, in essence, somebody along the hedging chain has to buy the underlying shares, then the call options are converted into the so called covered calls. Put it simply, if the options market maker has sold an option that goes up in value as the stock goes up, the more the stock goes up, the more the market maker loses. The market maker would typically hedge this exposure by buying something else that goes up in value as the stock goes up - usually, the stock itself, which, in turn, exerts additional upward price pressure on the stock itself, i.e., a gamma squeeze.

[Insert Table 5 here.]

We also observe a statistically significant increase in option open interest and trading volume for ITM and OTM put options both during and after the short squeeze. For example, open interest of ITM put options increased during the short squeeze by 23,095 contracts or 63% (relative to open interest of ITM call options of 36,495 contracts before the squeeze). Open interest of OTM put options increased during the short squeeze by 229,115 contracts or 77% (relative to open interest of OTM put options of 296,176 contracts before the squeeze). These results suggest that - in addition to trading and opening more call option contracts - market participants also traded and opened more put options contracts during and after the squeeze to express their pessimistic views on these stocks. The increase of put options usage was likely due to the fact that traders were constrained to short the shares in the equity market (due to the short squeezes) and used the options market to circumvent these constraints. The option trading volume results largely support these interpretations.⁴³

8. Did professional stock market analysts expect the short-squeeze events?

By analyzing the time series evolution of mean and dispersion of stock analysts' price target estimates for the period around the short squeeze we aim to answer the following questions: (i) did analysts expect the prices of the stocks at issue to increase (or decrease) before the short squeeze period, and (ii) did the press release make it difficult for analysts to determine a new price target estimate. Figures 9 and 10 present aggregate analyst price target forecasts for the stocks at issue. We note that I/B/E/S provides estimates only for nine of the stocks at issue. In general we observe two patterns: i) some of the stocks experience a gradual increase in their stock price estimates over time, e.g., GME, and ii) some of the stocks experienced a gradual decrease in their stock price estimates over time, e.g., AMC. For dispersion in price targets the patterns are similar. While the majority of the stocks at issue experienced an increase

⁴³In Table A5 and Table A6 in the Internet Appendix we provide individual plots for price and open interest for the impacted stocks with traded options.

in price targets dispersion during and after the short-squeeze period, indicating an increase in disagreement and confusion among analysts, some stocks experienced no change. Overall, this evidence suggest that even professional market analysts were likely not anticipating the short-squeeze events and were rather confused about the true fundamental value of the stocks at issue.

[Insert [Figure 9](#) here.]

[Insert [Figure 10](#) here.]

9. Were bots contributing to social media posts?

At the height of the short squeeze, the public press started to turn its focus to questions of fake postings on social media platforms.⁴⁴ Several news articles discussed the extent to which both positive and negative sentiment on meme stocks were seeded by automated social media accounts that were posting algorithmically by a computer (also known as “bots”)⁴⁵ instead of manually through a human. In this section, we are interested in analyzing the posting behavior of users on social media platforms. In particular, we aim to answer the following questions: (1) Were bots contributing to social media posts? (2) If they were, did they try to influence market sentiment in a particular direction? (3) If bots did contribute to market sentiment, were they successful in impacting stock prices in the direction they wanted to?

The posting behavior of bots on social media platforms has been studied by the information technologies field. A prominent paper, which received wide coverage both among academics as well as the general public, is by [Golbeck \(2015\)](#). The author applies a quantitative tool known as Benford’s Law to social and behavioral features of users in online social networks. Benford’s Law is based on an observation that many naturally occurring datasets have specific patterns

⁴⁴ “Traders Who Launched GameStop Frenzy Are Turning Against New Members,” *The Wall Street Journal*, February 2, 2021, ([Link](#)); “Bots hyped up GameStop on major social media platforms, analysis finds,” *Reuters*, February 26, 2021, ([Link](#)).

⁴⁵ “Bot or not? The facts about platform manipulation on Twitter,” *Twitter*, May 18, 2020, ([Link](#)).

of digits that appear in them. In particular, Benford's Law states the likelihood of seeing the numbers 1, 2, and 3 in the leading digit. While intuition might suggest that each digit 1-9 is equally likely, Benford's Law states that in many naturally occurring datasets the first digit should be a 1 in approximately 30% of observations, while observations with a first digit of 2, 3, 4, and so on, should be increasingly unlikely.⁴⁶ Benford's Law further assigns specific probabilities to how unlikely these subsequent leading digits should be. In her study, [Golbeck \(2015\)](#) shows that the distribution of first significant digits of friends and follower counts for users in these systems follow Benford's Law. The author also discusses and shows how this tool can be applied to detect suspicious or fraudulent activity.

We apply Benford's Law analysis for social media platforms using the number of posts that a user submitted on a daily basis during the time periods before, during, and after the January 2021 short squeezes.⁴⁷ User posts have been scrapped from Reddit, Twitter, and Stocktwits for the same periods and stocks analyzed above in Section 5. Users are split into two groups: users that already had an account with one of the three platforms before January 26 (old users), and users that opened an account during the short squeeze period after January 26 (new users). New users joined social media platforms with the hope to learn from and / or contribute to the discussions that were taking place on these platforms. If bots were among these new users, since they operate algorithmically, one would expect to see uniform posting patterns (e.g., same amount of posts each day at the same time).

We present our analyses at different levels of granularity. Figure 11, shows that for (i) the 13 impacted stocks in our sample, (ii) for both new and existing users combined, and (iii) across all three social media platforms analyzed, Benford's Law holds true for each of the three

⁴⁶E.g., a leading digit of 2 should appear in approximately 17.6% of observations. However, reasonable deviations from these precise probabilities are expected even in legitimate datasets. See, e.g., [Aloosh and Li \(2019\)](#), Figure 11 (showing an exchange found to have legitimate volume with a leading digit of 1 occurring in 40% of observations).

⁴⁷The academic finance field has recently started to apply Benford's Law to measure the degree of "fake volume" in the crypto currency market. For example, two recent papers by [Aloosh and Li \(2019\)](#) and [Cong et al. \(2020\)](#) study this question for the Bitcoin (BTC) market by applying Benford's Law to trade sizes observed on exchanges. [Aloosh and Li \(2019\)](#) analyze the distribution of the leading digits from a data sample of all trade sizes. Specifically, this application of Benford's Law indicates that legitimate trades are more likely to occur in trade sizes that begin with the number one (e.g., 100 units, 15,000 units, or 120,000 units) than any other digit. [Cong et al. \(2020\)](#) apply this methodology as well and find exchanges with order size data that violates Benford's Law.

periods analyzed. We observe leading digits of each value occurring with approximately the correct frequency for each of the three periods analyzed including the short squeeze period. The findings shown in Figure 11 are confirmed when analyzing the sample more granularly. Figure 12 shows that for all stocks Benford’s Law holds true when we differentiate between existing and new users and when we focus on the short squeeze period for each of the three social media platforms separately. We also perform the same analyses on a stock-by-stock basis and find that Benford’s Law also holds for each of the 13 stocks analyzed during the short squeeze period (see the charts in Figure A7 in the Internet Appendix A.5). To summarize, among the user posts data from Reddit, Twitter, and Stocktwits, we do not find evidence of bot activity at any point in time over the sample period. This is not to say that bots did not exist or attempt to influence market participants’ sentiment. Most social media platforms have committed themselves to screening for bot activity on a real-time basis, and to stop any such activity as it occurs.⁴⁸

[Insert Figure 11 here.]

[Insert Figure 12 here.]

To corroborate the evidence presented above, we analyze the hourly posting patterns of users on Reddit, Twitter, and Stocktwits. If bots were among these users, since they operate algorithmically, one would expect to see uniform posting patterns also with respect to the time or frequency at which these new user accounts post (e.g., at the same time of the day, at regular frequencies) or posting patterns that are in line with time zones of foreign countries (outside of US business hours). As before, we present our analyses at different levels of granularity. Figure 13 shows that for (i) the 13 impacted stocks in our sample, (ii) for both new and existing users combined, and (iii) across all three social media platforms analyzed, hourly posting patterns of users did not change across all three periods analyzed. Most of the users’ postings happen during US business hours, and we do not observe a change in this pattern from before to during

⁴⁸See, for example, “Bot or not? The facts about platform manipulation on Twitter,” Twitter, May 18, 2020, (Link).

to after the short squeeze period. The findings shown in Figure 13 are confirmed when analyzing the sample more granularly. Figure 14 shows that for all stocks, the hourly posting pattern when a user posted a message did not change for old versus new users when focusing on the short squeeze period and when analyzing each of the three platforms separately. The posting hour did not change when new users joined the platform and is similar across all three platforms. We perform the same analyses on a stock-by-stock basis and find that similar to the results from the Benford's Law analyses, also the hourly posting pattern analyses do not show any signs of bot activity for each stock in our sample during the short squeeze period (see the charts in Figure A8 in the Internet Appendix A.5).

[Insert Figure 13 here.]

[Insert Figure 14 here.]

10. Did the short squeezes distort market quality?

In this section, we describe the extent to which the short squeezes affected stock market quality of the impacted stocks and their competitors. To quantify the impact of the short squeeze, we follow [Allen, Haas, Nowak, and Tengulov \(2021\)](#) and analyze (i) price metrics (e.g., spreads and volatility of returns) and (ii) volume metrics (e.g., trading volume and depth at the best bid and best offer (BBO)). To assess how market quality changed during the short squeeze, we examine the evolution of these metrics over time.⁴⁹ As before, our analyses focus on the following periods: (i) the period before January 26, 2021, (ii) the period during the short squeeze (January 26, 2021 through February 04, 2021), and (iii) the period after February 04, 2021.

⁴⁹Price and volume measures are intertwined in that higher quality markets often exhibit lower spreads and volatility as well as higher volumes and depth (see e.g., [Allen, Haas, Nowak, and Tengulov \(2021\)](#)). Together these metrics provide measures of “market quality” ([Harris, 2002](#)). The following papers among others, apply price and volume metrics to assess changes in market quality over time: [Bessembinder \(2003\)](#); [Diether, Lee, and Werner \(2009\)](#); [Chordia, Roll, and Subrahmanyam \(2011\)](#); [O’Hara and Ye \(2011\)](#); and [Allen, Haas, Nowak, and Tengulov \(2021\)](#).

As explained in [Allen, Haas, Nowak, and Tenulov \(2021\)](#), the literature on repeated trading and herding in efficient markets explains the difficulties that market participants of all types (unsophisticated and informed) face when evaluating surprising news. This literature describes that some market participants are faster in evaluating certain surprising news than others. The academic literature refers to these traders as “informed traders.” All other traders are referred to as “liquidity traders” or “uninformed traders.” The literature suggests that changes in the proportion of informed and liquidity traders leads to changes in spreads, volatility, and volume. First, [Glosten and Milgrom \(1985\)](#) demonstrated that bid-ask spreads are expected to be higher when informed trading is higher due to increased adverse selection risk. Second, volatility is expected to be higher when informed trading is higher. The intuition behind this finding is that volatility is caused by an increase in information being incorporated into prices, which is mainly driven by an increased proportion of informed trading ([Foster and Viswanathan, 1990](#); [Holden and Subrahmanyam, 1992](#); [Wang, 1998](#)). While this process is ongoing, prices fluctuate between the previous fundamental value and the new fundamental value. Third, the literature suggests that the relation between volume and informed trading could be either positive or negative. If informed traders are the reason for changes in volume the relation is expected to be positive, but if liquidity traders are the reason for changes in volume the relation is expected to be negative.

We hypothesize that the events described above changed the ratio of informed and uninformed market participants in the relevant stocks during the short squeeze period. In particular, it might be that the short squeeze induced informed traders, who previously did not act on their information, to trade because they were worried that the value of their information would turn out to be obsolete in the future. Alternatively, informed traders might have decided not to trade because the trading frenzy and discussions on social media platforms left them confused about the fundamental value of relevant stocks at issue. These contradicting hypotheses imply that the proportion of informed traders can be subject to change during a short squeeze by either increasing or decreasing. Based on the literature referenced above, we hypothesize that the change in the magnitude of informed trading leads to a change in spreads, volatility, and trading volume during the short squeeze period, and with either a continuation or reversion to

pre-squeeze levels after the short squeeze period. To test the extent to which the short squeeze impacted market quality of the 13 stocks more generally, we also examine changes in market quality of their competitors.

10.1. Market quality: Methodology

To test how market quality changed over time, similar to before, we differentiate between a *Pre-SSqueeze* period, a *SSqueeze* period and a *Post-SSqueeze* period. As before, we estimate the following regression model:

$$Y_{i,t} = \alpha + \beta_1 SSqueeze + \beta_2 Post-SSqueeze + \epsilon_{i,t}, \quad (3)$$

where $Y_{i,t}$ represents one of the price and volume metrics of interest. Table 6 provides definitions and summary statistics for these variables. i is a firm index and t denotes time in minutes. *SSqueeze* is a dummy taking the value of one if a trading day is during the short squeeze period, which we currently define as January 26 through February 04, 2021. *Post-SSqueeze* is a dummy taking the value of one if the trading day is after February 04, 2021. This model is estimated separately for the short-squeezed stocks at issue, the competitors of the five most-impacted short-squeezed stocks (i.e., GME, Koss, Express, AMC, and the Naked Brand Group), and the competitors of all 13 stocks.⁵⁰ The coefficient α measures the average level of a given metric in the *Pre-SSqueeze* period. The coefficient β_1 measures the change in the average level of a given metric from the *Pre-SSqueeze* period to the *SSqueeze* period. The coefficient β_2 measures the change in the average level of a given metric from the *Pre-SSqueeze* period into the *Post-SSqueeze* period. Statistical inference is based on HAC standard errors, i.e., standard errors robust to heteroscedasticity and serial correlation.

[Insert Table 6 here.]

⁵⁰We use CapitalIQ to identify firms' peers. CapitalIQ sources information from companies' SEC filings and analyst reports.

10.2. *Market quality: Results*

Table 7 presents the results for all 13 stocks. We observe that relative bid-ask spreads were on average 0.97% before the short squeeze period and increased by 0.34 percentage points during the short squeeze period. This is an increase of 35%. Spreads increased even further after the short squeeze period. Volatility, was on average 0.0034 before the squeeze period.⁵¹ During the short squeeze period, volatility increased by 0.0044, which is an increase of 129%. After the squeeze period, volatility decreased by 0.0002 compared to the period before the short squeeze. Trading volume was on average 262,802 shares per minute before the short squeeze. It increased by 318,691 shares per minute during the short squeeze period, which represents an increase of 121%. It dropped after the squeeze period compared to the period during the short squeeze but remained higher compared to the period before the short squeeze. Before the squeeze period, depth at the BBO was evenly distributed between the bid and the ask sides. The average bid quote size per minute was 111,105 shares; the ask quote size was 111,296 shares. During the short squeeze period, we observe an increase in both the bid and ask sides, i.e., bid size increased by 219,113 shares whereas the increase in the ask size was 225,566 shares. After the short squeeze period, we see that these effects remain. Trading volume initiated from buy orders versus sell orders was slightly skewed towards buy volume in the period before the short squeeze. During the short squeeze period trading volume initiated by buy orders increased much more than trading volume initiated by sell orders. This evidence corroborates the short squeeze, which was followed by an increased in demand of shares. After the short squeeze period, trading volume initiated from the buy orders and sell orders decreased proportionally but remained at

⁵¹We measure volatility as the rolling standard deviation of realized one-minute returns over 15 minutes. We also estimated all regression models with a measure for volatility over 30-minute non-overlapping windows. Results are qualitatively and quantitatively very similar (not tabulated).

an elevated level compared to the period before.⁵²

[Insert Table 7 here.]

Panels A and B of Table 8 present the results for the competitors of the 13 short-squeezed stocks. Panel A presents the results of the market quality tests for the competitors of the five most-impacted stocks (i.e., GME, Koss, Express, AMC, and the Naked Brand Group); Panel B presents the results of the market quality tests for the competitors of all 13 companies. For the competitors of the five (13) companies we observe that relative bid-ask spreads were on average 100 (158) b.p. before the short squeeze period and increased by 25 (47) b.p. during the short squeeze period. This is an increase of 25 (30)%. Spreads decreased after the short squeeze period compared to the period during the squeeze, but remained at elevated levels with an increase of 15 (40) b.p. compared to the period before the short squeeze. Volatility was on average 0.0016 (0.0030) before the squeeze period and increased during the short squeeze

⁵²In the Internet Appendix we present results for GME and the remaining 12 stocks separately. In particular, Panel A of Table A1 presents the results for GME and Panel B for the other twelve stocks that became subject to short squeezes over the same time period. For GME, we observe that relative bid-ask spreads were on average 1.3 percentage points before the short squeeze period and increased by 0.96 percentage points during the short squeeze period. This is an increase of 74%. Spreads increased even further after the short squeeze period. Volatility, was on average 0.0068 before the squeeze period. During the short squeeze period, volatility increased by 0.0104, which is an increase of 153%. After the squeeze period, volatility decreased by 0.0018 compared to the period before the short squeeze. Trading volume was on average 211,845 shares per minute before the short squeeze. It decreased by 36,583 shares per minute during the short squeeze period, which represents a decrease of 17.3%. It dropped by 150,009 shares after the squeeze period compared to the period before the short squeeze. These effects are likely due to the trading restrictions implemented by some retail brokers during the squeeze period. Before the squeeze period, depth at the BBO lived predominantly on the ask side. The average bid quote size per minute was 9,995 shares; the ask quote size was 11,285 shares. This changed during the short squeeze period, where the increase in the bid size was 7,499 shares whereas the increase in the ask size was 4,138 shares. This evidence corroborates the impact of the trading bans. Still, we see an increase in the demand side likely due to short sellers trying to cover their short positions. After the short squeeze period, we see a proportional decrease in both bid quote and ask quote size compared to the pre-squeeze period. Trading volume initiated from buy orders versus sell orders was skewed towards buy volume in the period before the short squeeze. During the short squeeze period trading volume initiated by buy orders decreased much more than trading volume initiated by sell orders, which again corroborates the impact of the trading restrictions. After the short squeeze period, trading volume initiated from the buy orders and sell orders decreased proportionally. Panel B of Table A1 presents evidence for the remaining twelve short-squeezed stocks. For the remaining twelve stocks we observe that relative bid-ask spreads were on average 94 basis points (b.p.) before the short squeeze period and increased by 29 b.p. during the short squeeze period. This is an increase of 31%. Spreads decreased after the short squeeze but remain elevated by 15 b.p. compared to the period before the short squeeze. Volatility was on average 0.0031 before the squeeze period and increased during the short squeeze period by 0.0039, which is an increase of 126%. After the squeeze period, volatility reverts back to the period before the short squeeze. Trading volume increased during and after the short squeeze period. Similarly, bid and ask quote sizes, and signed trading volume increased both during and after the short squeeze.

period by 0.0004 (0.0011), which is an increase of 25 (37)%. After the squeeze period, volatility decreased compared to the short squeeze period, but remained at elevated levels by 0.0001 (0.0004) compared to the period before the short squeeze. Trading volume for the competitors of the five companies remained the same during the short squeeze period and decreased after the short squeeze. For the remaining competitors it increased both during and after the short squeeze. Bid and ask quote sizes increased during the short squeeze, and decreased after the short squeeze. Buy volume increased during the squeeze, with no change in sell volume. After the squeeze, we see a decrease in the signed trading volume of the competitors of the five companies and an increase in the signed volume for all other competitors. This is consistent with the aggregate trading volume behaviour of the competitors.

Overall, we interpret the evidence presented in this section as deterioration in the market quality of all 13 short-squeezed stocks during the short squeeze period. Furthermore, the evidence is consistent with a deterioration in the market quality of the competitors during the short squeeze period.

[Insert Table 8 here.]

11. Conclusion

At the end of January 2021, a group of stocks listed on US stock exchanges experienced sudden surges in their stock prices, which - coupled with high short interest - led to brief short squeeze episodes. We argue that these short squeezes were the result of coordinated trading by investors, who discussed their trading strategies on social media platforms. In addition, option markets played a central role in these events. Using hand-collected data we provide the first rigorous academic study of these short-squeezes.

Understanding what happened during these series of short-squeeze episodes is important for at least three reasons. First, while short squeezes did occur with some frequency historically, coordination among traders to target stocks with high short interest, as seen in these episodes, has not been seen before in quite this way. The reason is that this type of coordination is

a phenomenon made possible only in recent years through social media platforms. While the coordination that took place on social media platforms was publicly observable and transparent, US regulators are in the process of establishing the extent to which the coordination has adversely impacted market quality and efficiency. Our paper sheds light on this point.

Second, understanding how these events could occur in one of the most advanced countries in the world with arguably some of the most advanced financial market regulations is important for policy reasons. We argue that (i) the surge in prices of the impacted stocks led to episodes of short squeezes in each of these stocks; (ii) changes in the number of mentions of a stock on social media platforms and in online forums is associated with changes in the respective stock's price; and (iii) part of the market relied on call options during and after the short squeeze to express their optimistic views about the relevant stocks, which likely exacerbated the squeeze events (a gamma squeeze), while another part of the market used put options during and after the short squeeze to express their pessimistic views about the stocks, likely as a tool to circumvent the resulting squeeze constraints.

Third, the data available in modern markets allow us to study in detail the precise way in which short squeezes affect the operation of markets. This was not usually possible with historical manipulation events. This paper considers how the series of short squeezes in early 2021 impacted market quality in a stock market in which information is in many circumstances incorporated quickly but in others, such as when there is asymmetric information, can take some time. We provide evidence that in the case of coordinated trading by a large crowd of traders that results in a short squeeze, market quality is subsequently reduced in these stocks despite real-time surveillance by market regulators and continuous information processing. Importantly, we also document negative spillover effects on the market quality of the competitors of the firms at issue.

Overall, this evidence calls for tighter monitoring of social media platforms and better understanding of the inter-linkages between these platforms, derivatives markets and equity markets.

Appendix: Tables and Figures

Fig. 1 Evolution of returns of the 13 stocks: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of returns of the 13 stocks initially banned by Robinhood on Jan 28. The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.

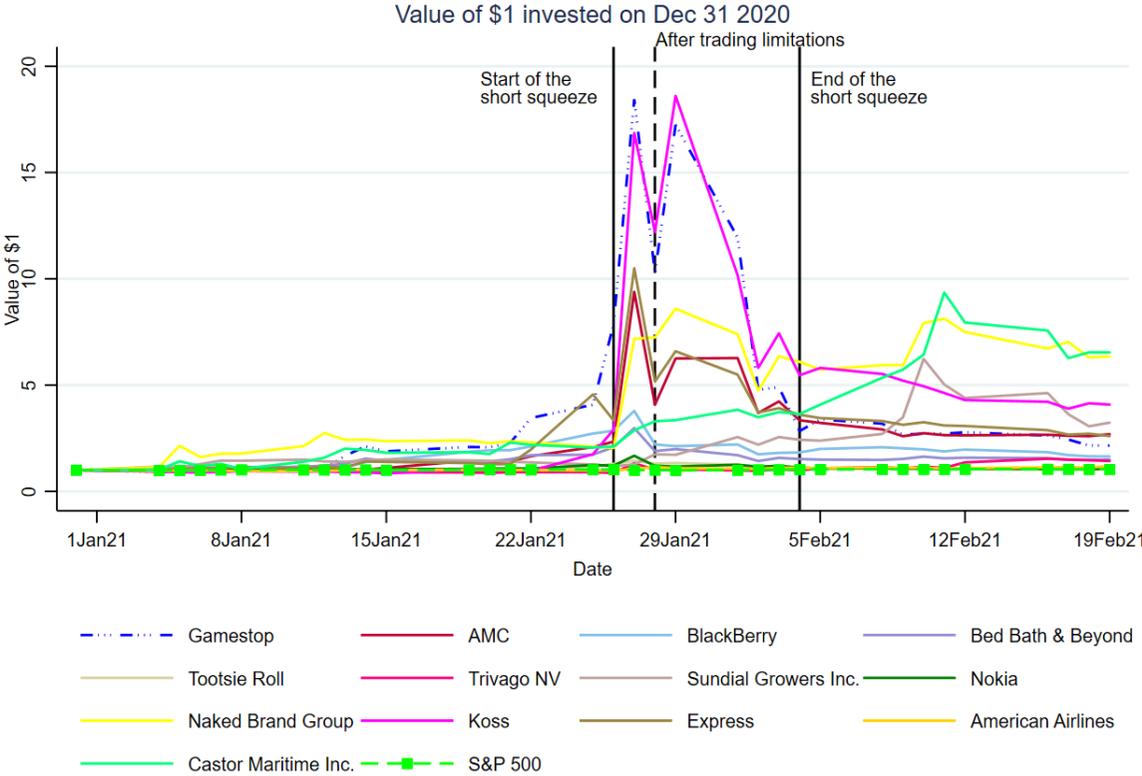


Fig. 2 Evolution of mentions of the 13 stocks on social media platforms: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of mentions of the 13 stocks initially banned by Robinhood on Jan 28. The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter as well as other news platforms.

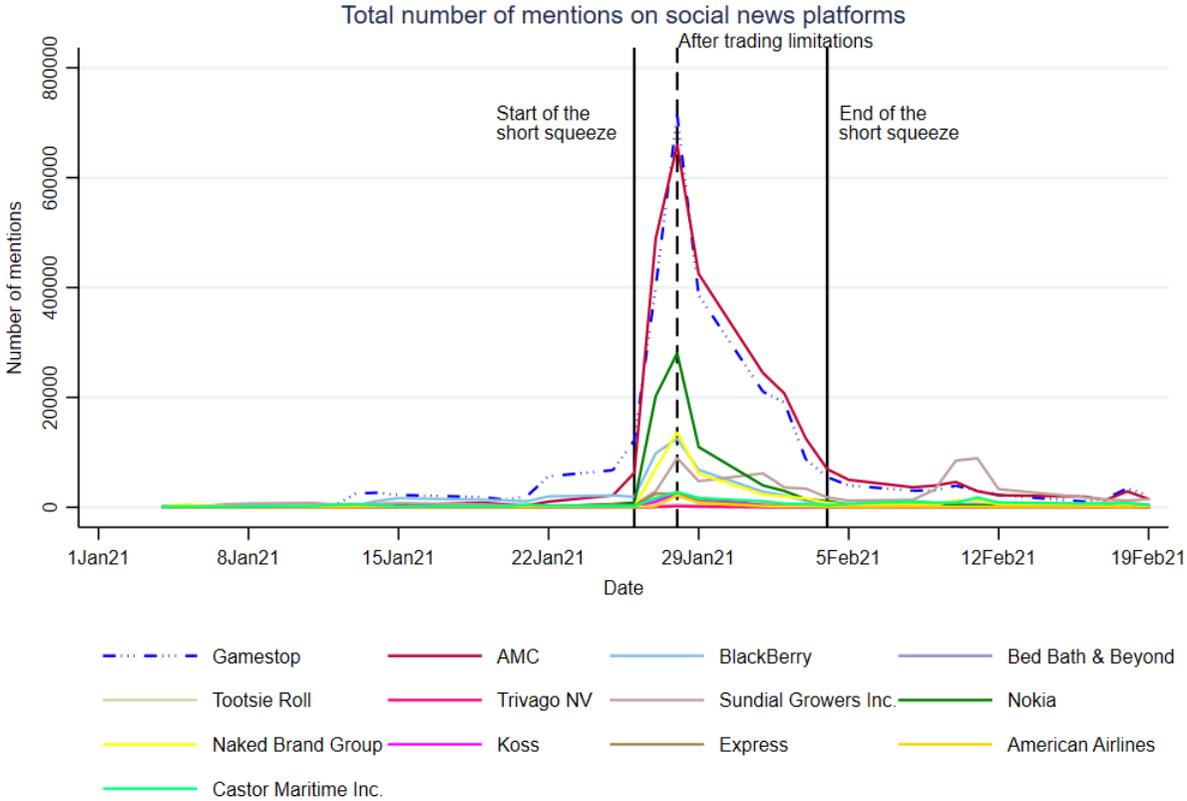


Fig. 3 Evolution of daily Value on Loan and Price for Gamestop: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of GME’s close price (lhs) and the evolution of value on loan relative to market capitalization (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

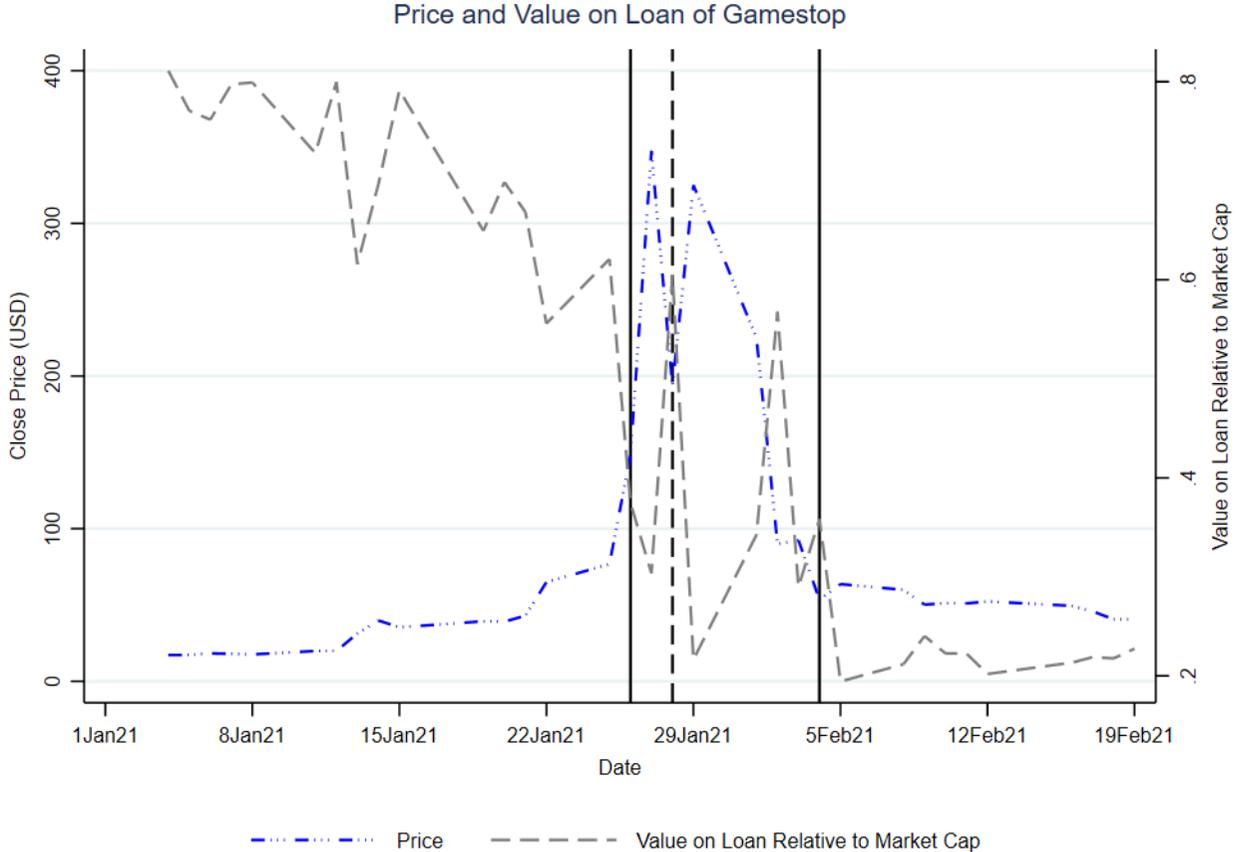


Fig. 4 Evolution of daily Value on Loan and Price for the remaining initially banned 12 stocks: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of close price (lhs) and the evolution of value on loan relative to market capitalization (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

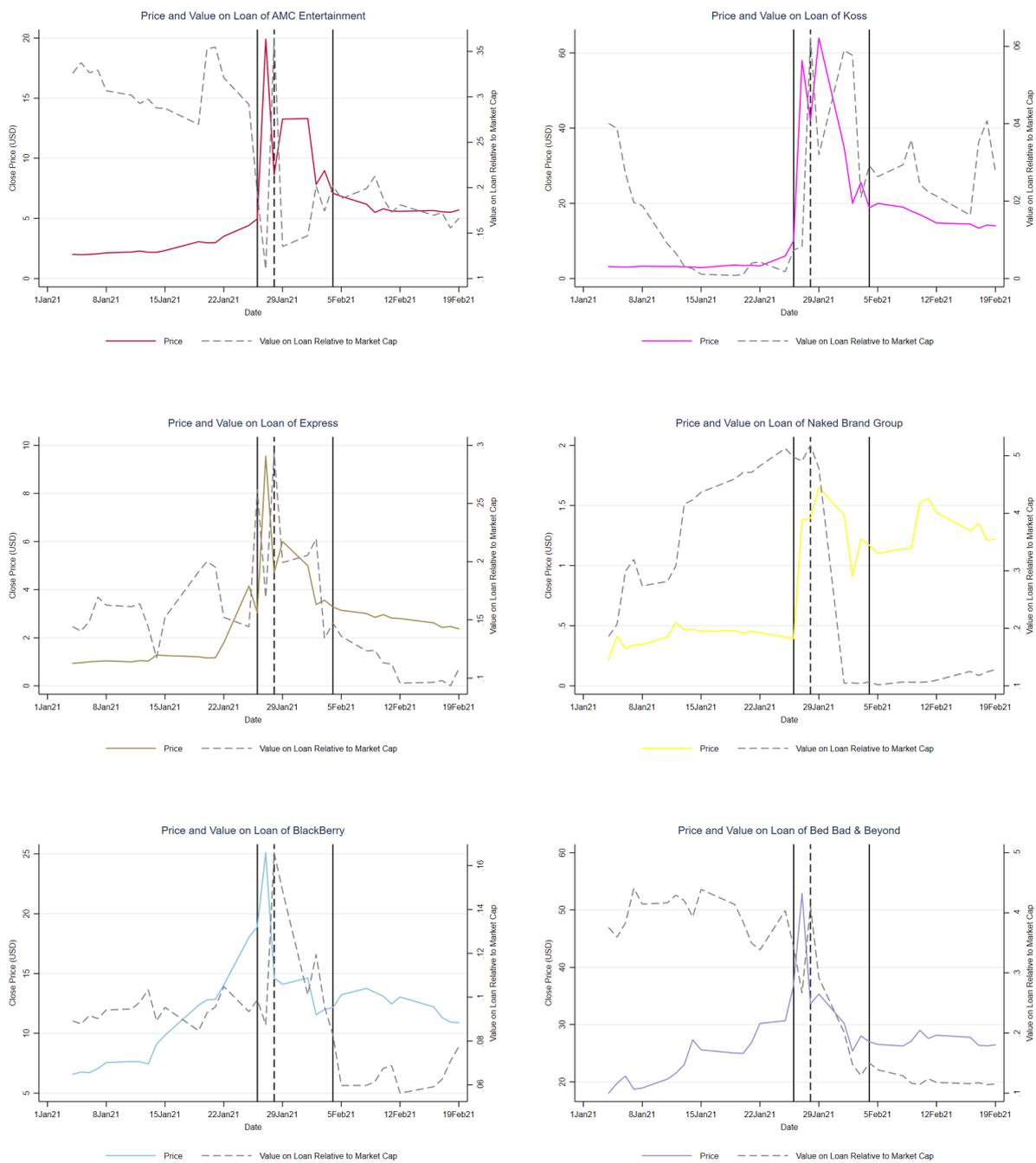


Fig. 5 Evolution of daily Value on Loan and Price for the remaining initially banned 12 stocks (cont'd): Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of close price (lhs) and the evolution of value on loan relative to market capitalization (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

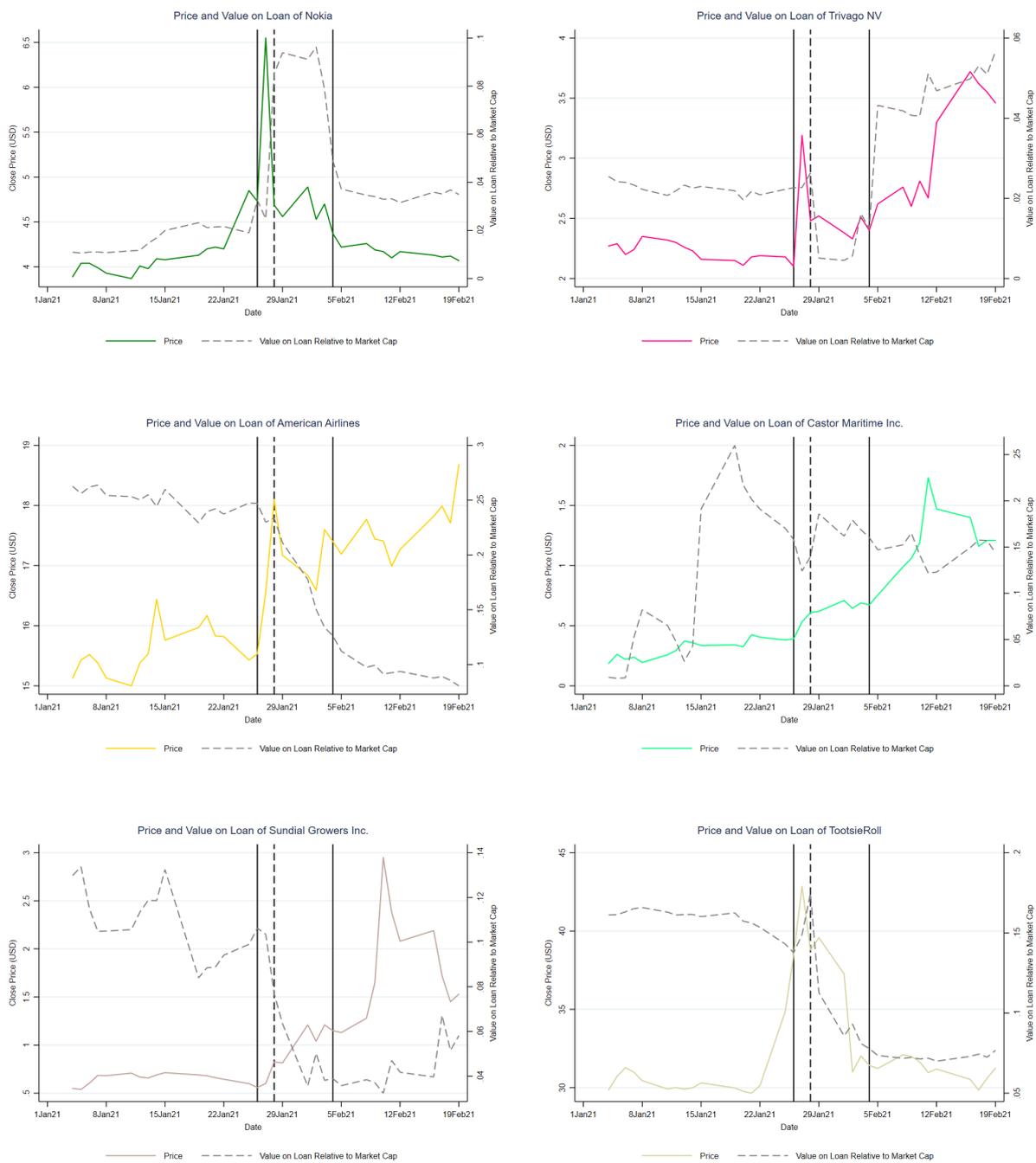


Table 1 Descriptive statistics for the securities lending market: This table presents descriptive statistics for the securities lending market measures for the 13 stocks impacted by the short squeezes. We present descriptive statistics for the following variables: 1.) Value on Loan is the ratio of the total value of open securities loans relative to a company’s market capitalization; 2.) SAF is the average fees for stock borrow transactions in the respective security in basis points; 3.) Tenure is the average tenure for securities loans in days; 4.) Utilisation is the ratio of the value of open loans to the total value of lendable assets. The data cover the period Jan 11, 2021 through Feb 19, 2021, i.e., ten trading days before and ten trading days after the short squeeze period (Jan 26 through Feb 04 included). The data frequency is daily. Data come from IHS Markit.

All 13 short-squeezed stocks										
	Obs	Mean	Std. Dev.	Min	Max	P1	P25	P50	P75	P99
Value on Loan	364	.1565	.1471	.0008	.7997	.0018	.0564	.1143	.2007	.6986
SAF	364	1098.114	1874.481	25.25	9950	27.5	56.86	209.43	1756.94	9350
Tenure	364	49.4359	58.126	.551	295.2443	.7678	15.4668	29.9418	56.6982	246.2324
Utilisation	364	49.2404	21.4666	2.8262	98.0662	3.729	33.4542	54.1806	64.0552	89.6528

Table 2 Securities lending market measures during and after the short squeeze period: This table reports the results from the securities lending market regression estimation described in Equation 1. The dependent variables are defined in Table 1. We present results for all 13 short-squeeze stocks. The data set covers the period Jan 11, 2021 through Feb 19, 2021. The data frequency is daily. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. t-statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from IHS Markit.

	(1) Value on Loan	(2) SAF	(3) Tenure	(4) Utilisation
Post-SSqueeze	-0.1147*** (-32.440)	162.3571*** (5.738)	-16.7438*** (-25.662)	-13.0847*** (-13.304)
SSqueeze	-0.0528*** (-3.577)	387.9544*** (4.734)	-7.8775*** (-4.868)	-4.2810 (-1.500)
Pre-SSqueeze	0.2126*** (62.905)	929.2848*** (49.655)	57.6666*** (108.693)	55.1366*** (81.966)
Observations	364	364	364	364
Adjusted R^2	0.104	0.001	0.009	0.064

Fig. 6 Evolution of Gamestop’s price and number of mentions: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of GME’s close price (lhs) and the evolution of the number of times GME was mentioned on social media platforms (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

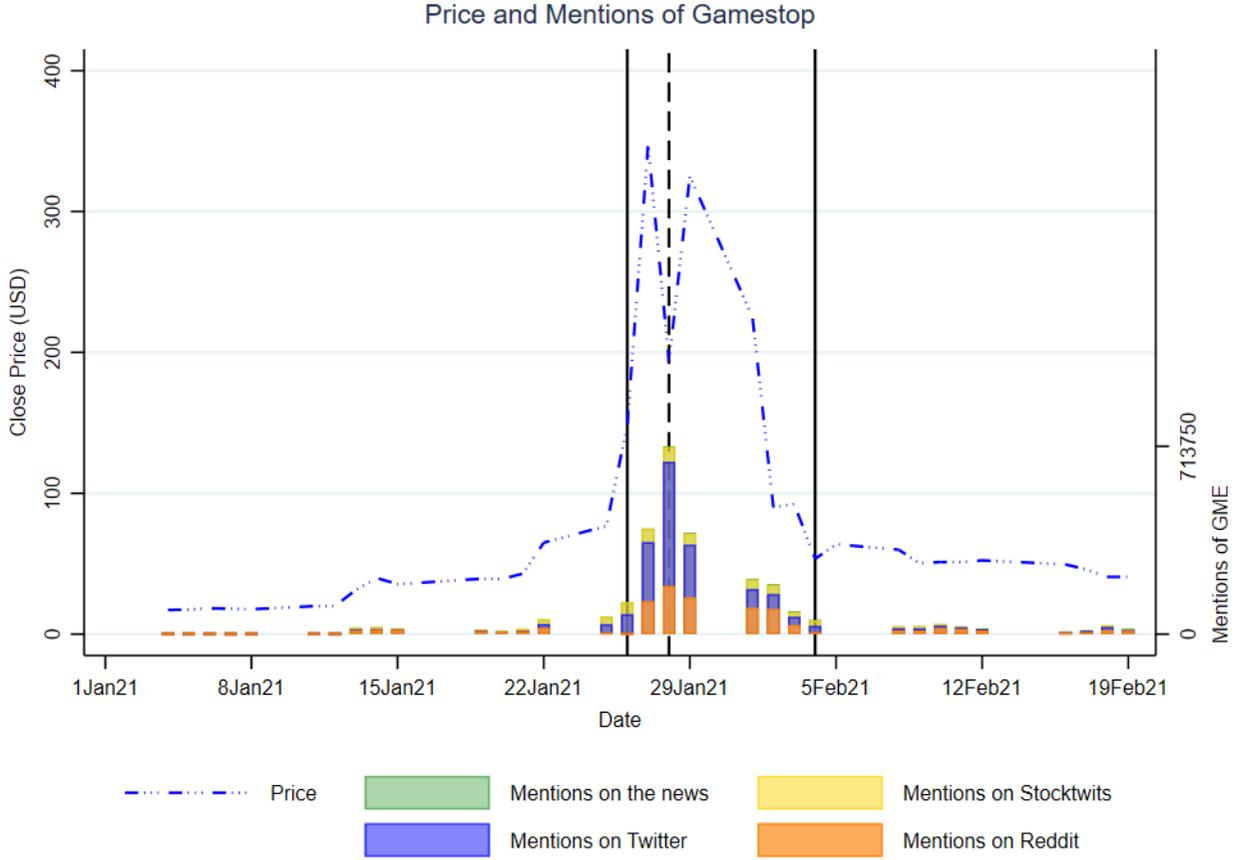


Fig. 7 Evolution of price and number of mentions for the remaining initially banned 12 stocks: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of close price (lhs) and the evolution of the number of times a company was mentioned on social media platforms (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

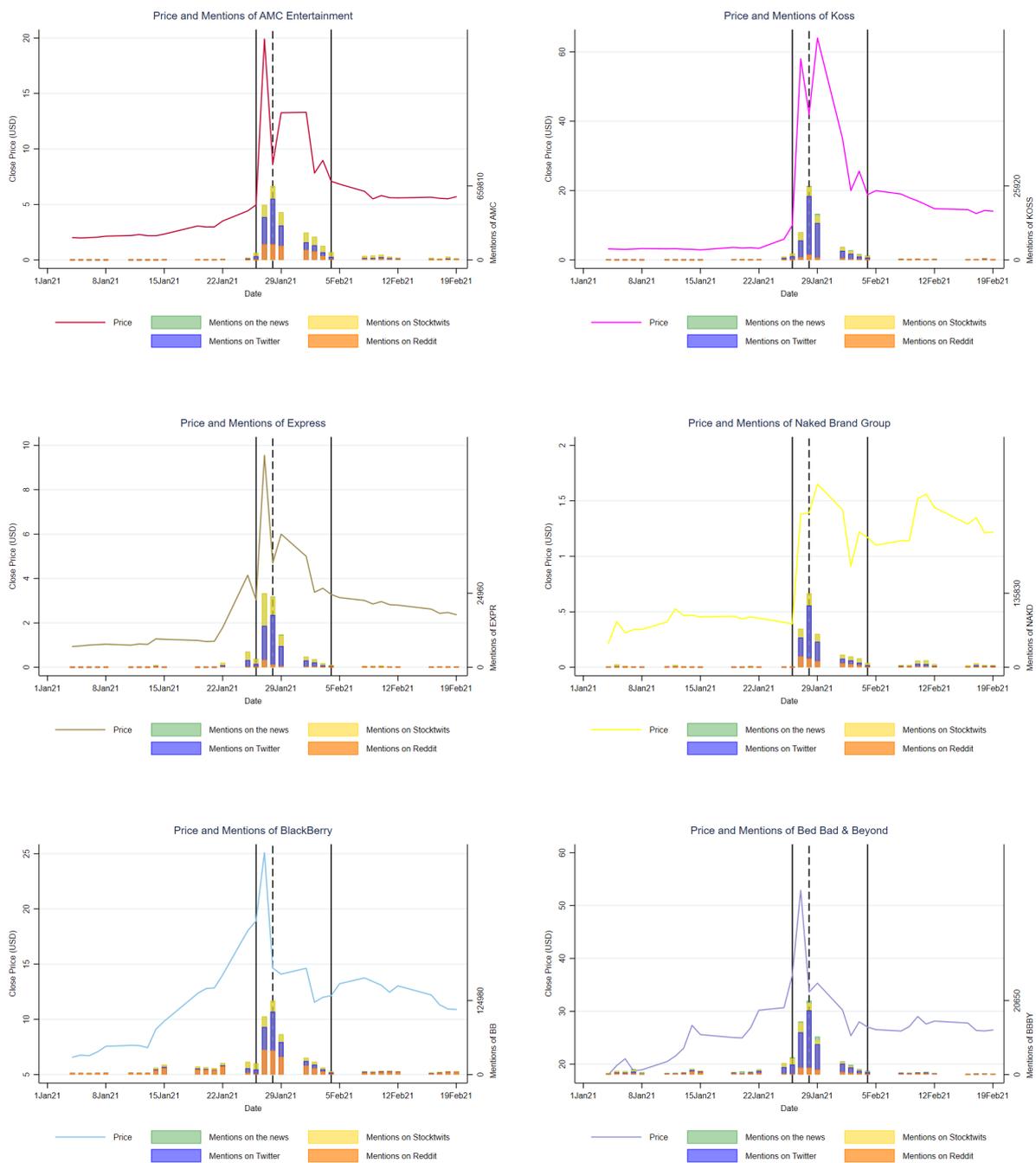


Fig. 8 Evolution of price and number of mentions for the remaining initially banned 12 stocks (cont'd): Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of close price (lhs) and the evolution of the number of times a company was mentioned on social media platforms (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, started implementing trading limitations in GME and other stocks.

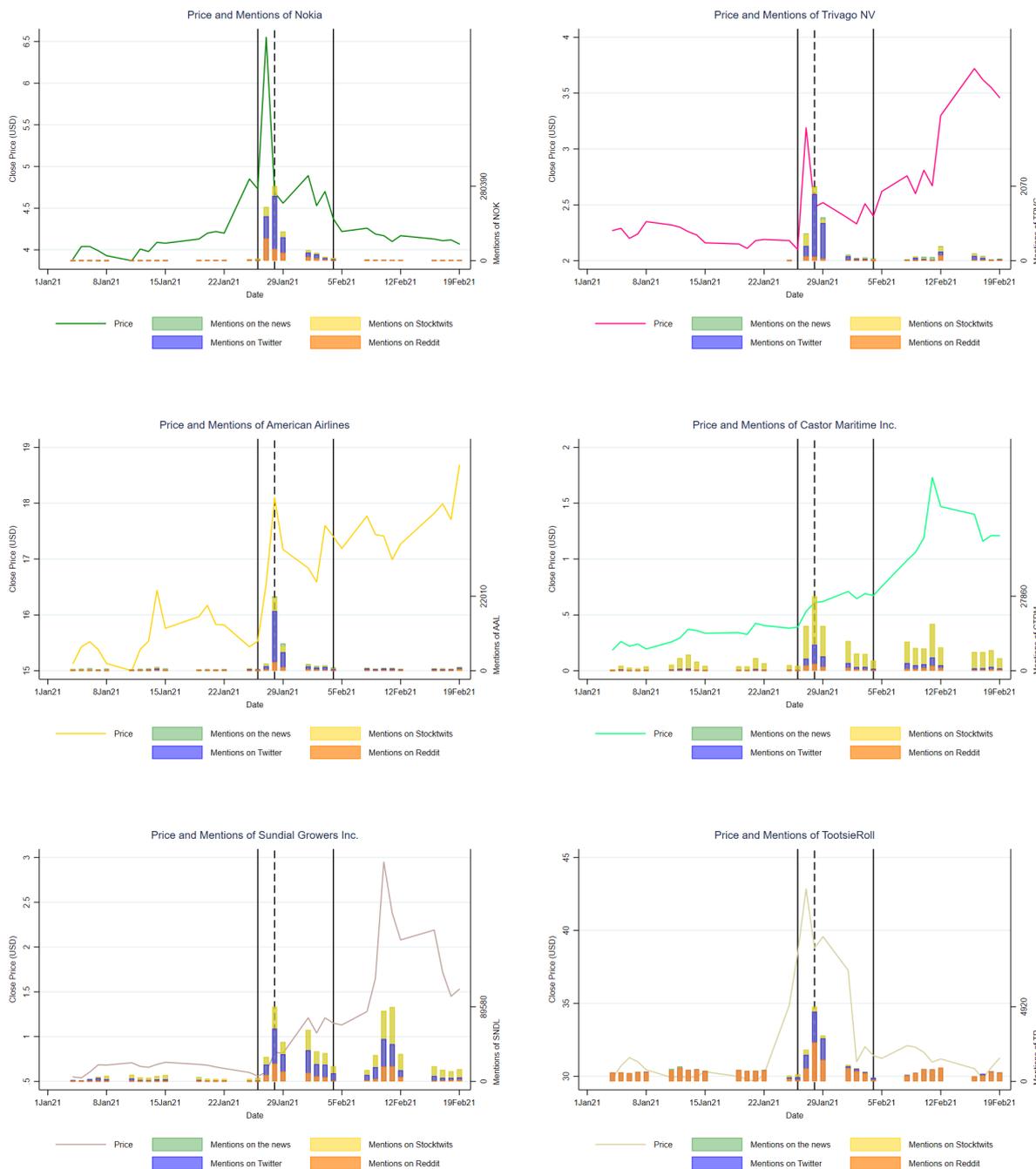


Table 3 Explaining return variation during the short squeeze period using marketable retail order imbalances:

This table reports estimation results on whether retail investors' trading activity can explain variation in short-term returns during the short squeeze period. The data set covers the period Jan 11, 2021 through Feb 19, 2021. We present results for all 13 short-squeeze stocks. The dependent variable is individual stock returns computed over different short-term periods (30-seconds, 1-minute, and 2-minute). The main independent variables are two scaled marketable retail order imbalance measures: mroibvol (based on the number of shares traded) and mroibtrd (based on the number of trades) (see [Boehmer et al. \(2021\)](#)) in Panel A and Panel B, respectively. To capture retail trading activity during the different periods we interact these variables with corresponding dummies for the period during the short squeeze (SSqueeze) and the period after the short squeeze (Post-SSqueeze). We define the short squeeze period as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze as the two weeks (10 trading days) after Feb 04, 2021. As additional independent variables, we include the previous period return (Return (t-1)), as well as the daily return (Daily Return), log market cap (Size), daily turnover (Turnover), and daily price dispersion (Price Dispersion), all measured at the end of the previous day. t-statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from TAQ and Compustat.

	(1)	(2)	(3)
Panel A	30-second Return	1-minute Return	2-minute Return
SSqueeze	-0.0000 (-0.615)	-0.0001 (-0.904)	-0.0001 (-0.430)
Post-SSqueeze	-0.0000 (-1.331)	-0.0001** (-2.067)	-0.0002 (-1.390)
mroibvol	0.0002*** (4.828)	0.0003*** (4.994)	0.0005*** (3.375)
mroibvol x SSqueeze	0.0006*** (6.779)	0.0010*** (6.183)	0.0016*** (4.603)
mroibvol x Post-SSqueeze	0.0001*** (3.986)	0.0002*** (2.877)	0.0004*** (2.823)
Return (t-1)	-0.0696*** (-3.606)	-0.0636*** (-2.852)	-0.1212*** (-2.801)
Daily Return	0.0001 (0.699)	0.0000 (0.128)	0.0006 (0.906)
Size	-0.0000 (-1.575)	-0.0001** (-2.239)	-0.0000 (-0.973)
Turnover	-0.0000 (-0.833)	-0.0001 (-1.071)	-0.0002 (-1.159)
Price Dispersion	-0.0001 (-0.679)	-0.0002 (-0.495)	-0.0000 (-0.056)
Constant	0.0005* (1.770)	0.0012** (2.462)	0.0011 (1.215)
Observations	181,290	98,267	52,000
Adjusted R^2	0.005	0.005	0.014

	(1)	(2)	(3)
Panel B	30-second Return	1-minute Return	2-minute Return
SSqueeze	-0.0001 (-1.337)	-0.0002 (-1.590)	-0.0002 (-1.027)
Post-SSqueeze	-0.0000 (-0.866)	-0.0001 (-1.557)	-0.0001 (-1.029)
mroibtrd	0.0002*** (3.666)	0.0004*** (3.897)	0.0006** (2.558)
mroibtrd x SSqueeze	0.0006*** (4.169)	0.0010*** (4.063)	0.0019*** (3.325)
mroibtrd x Post-SSqueeze	0.0001 (1.110)	0.0001 (0.805)	0.0003 (0.993)
Return (t-1)	-0.0678*** (-3.531)	-0.0618*** (-2.787)	-0.1196*** (-2.771)
Daily Return	0.0001 (0.988)	0.0001 (0.413)	0.0007 (1.097)
Size	-0.0000 (-1.634)	-0.0001** (-2.324)	-0.0000 (-1.048)
Turnover	-0.0000 (-1.072)	-0.0001 (-1.330)	-0.0002 (-1.377)
Price Dispersion	-0.0002 (-0.760)	-0.0002 (-0.590)	-0.0001 (-0.152)
Constant	0.0005* (1.737)	0.0013** (2.452)	0.0011 (1.207)
Observations	181,290	98,267	52,000
Adjusted R^2	0.005	0.005	0.014

Table 4 Option open interest during and after the short squeeze period: This table reports the results from the open interest regression estimation described in Equation 2. The dependent variable in each regression is total option daily open interest per stock. We perform the estimation separately for call and put options. The data set covers all 13 banned stocks and the period Jan 11, 2021 through Feb 19, 2021. The data frequency is daily. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. Options moneyness categories are defined as follows: i) at-the-money (ATM) options with $S/X \geq 0.95$ and $S/X \leq 1.05$; ii) in-the-money (ITM) options with $S/X > 1.05$ for calls (reverse for puts); iii) out-of-the-money (OTM) options with $S/X < 0.95$ for calls (reverse for puts), where S is the price of the underlying stock and X is the exercise price. t -statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from OptionMetrics.

	(1) ATM Call	(2) ITM Call	(3) OTM Call	(4) ATM Put	(5) ITM Put	(6) OTM Put
Post-SSqueeze	-10,181.1169 (-1.215)	58,820.1696*** (3.691)	354,108.7700*** (13.228)	21,157.8537*** (2.844)	64,299.8000*** (10.542)	194,216.7752*** (9.988)
SSqueeze	-22,445.6214* (-1.989)	133,663.0888*** (4.954)	165,368.0703*** (3.104)	-15,027.4412*** (-2.920)	23,095.0147** (2.055)	229,114.8611*** (7.314)
Pre-SSqueeze	91,336.4118*** (21.244)	153,733.0345*** (13.684)	326,348.5500*** (16.757)	48,570.4412*** (13.378)	36,494.9600*** (6.708)	296,176.2759*** (26.343)
Observations	208	258	279	208	279	258
Adjusted R^2	0.001	0.046	0.035	0.026	0.086	0.025

Table 5 Option trading volume during and after the short squeeze period: This table reports the results from the trading volume regression estimation described in Equation 2. The dependent variable in each regression is total option daily trading volume per stock. We perform the estimation separately for call and put options. The data set covers all 13 banned stocks and the period Jan 11, 2021 through Feb 19, 2021. The data frequency is daily. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. Options moneyness categories are defined as follows: i) at-the-money (ATM) options with $S/X \geq 0.95$ and $S/X \leq 1.05$; ii) in-the-money (ITM) options with $S/X > 1.05$ for calls (reverse for puts); iii) out-of-the-money (OTM) options with $S/X < 0.95$ for calls (reverse for puts), where S is the price of the underlying stock and X is the exercise price. t -statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from OptionMetrics.

	(1) ATM Call	(2) ITM Call	(3) OTM Call	(4) ATM Put	(5) ITM Put	(6) OTM Put
Post-SSqueeze	-16,348.0856 (-1.629)	-7,677.0324 (-0.392)	24,372.2000 (1.141)	958.9740 (0.247)	6,615.9800*** (3.360)	-16,001.5955 (-0.860)
SSqueeze	-9,345.7225 (-0.994)	50,467.8810 (1.409)	142,097.3578*** (4.393)	-1,368.8287 (-0.407)	12,839.0618*** (3.629)	81,314.1220*** (3.317)
Pre-SSqueeze	51,012.3676*** (6.014)	47,370.3793*** (3.196)	85,657.8700*** (4.473)	17,183.1029*** (6.240)	5,304.2800*** (3.484)	60,849.8506*** (3.523)
Observations	208	258	279	208	279	258
Adjusted R^2	0.005	0.019	0.068	-0.008	0.052	0.063

Fig. 9 Evolution of price targets (in USD) for the initially banned stocks: Jan 2020 – March 2021: These figures plot the evolution of monthly average price target estimates of stock analysts. The shaded areas around the average price targets denote 95% confidence intervals. The vertical lines denote the start and the end of the short-squeeze period. We use data from the I/B/E/S Summary History file.

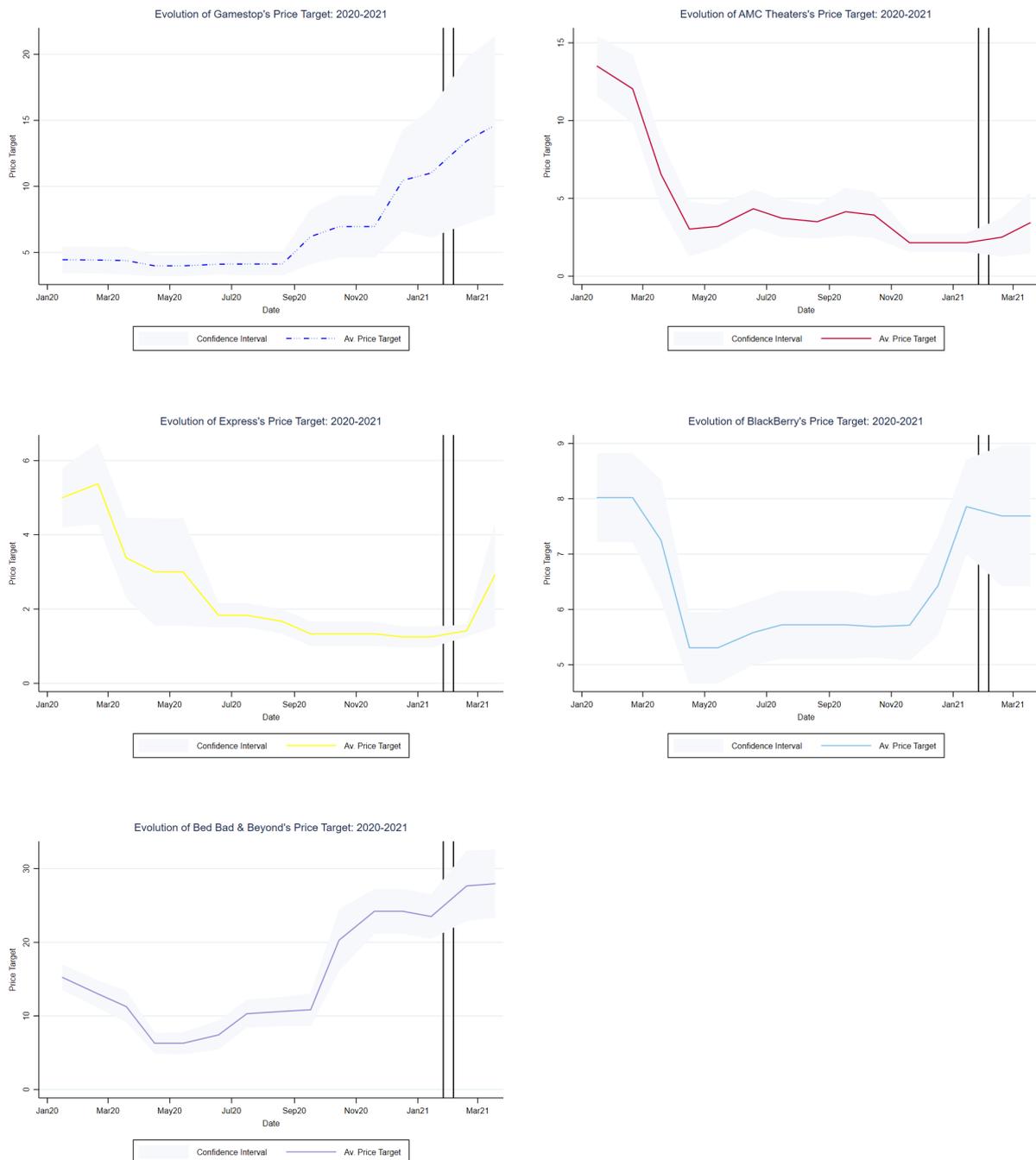


Fig. 10 Evolution of price targets (in USD) for the initially banned stocks: Jan 2020 – March 2021: These figures plot the evolution of monthly average price target estimates of stock analysts. The shaded areas around the average price targets denote 95% confidence intervals. The vertical lines denote the start and the end of the short-squeeze period. We use data from the I/B/E/S Summary History file.

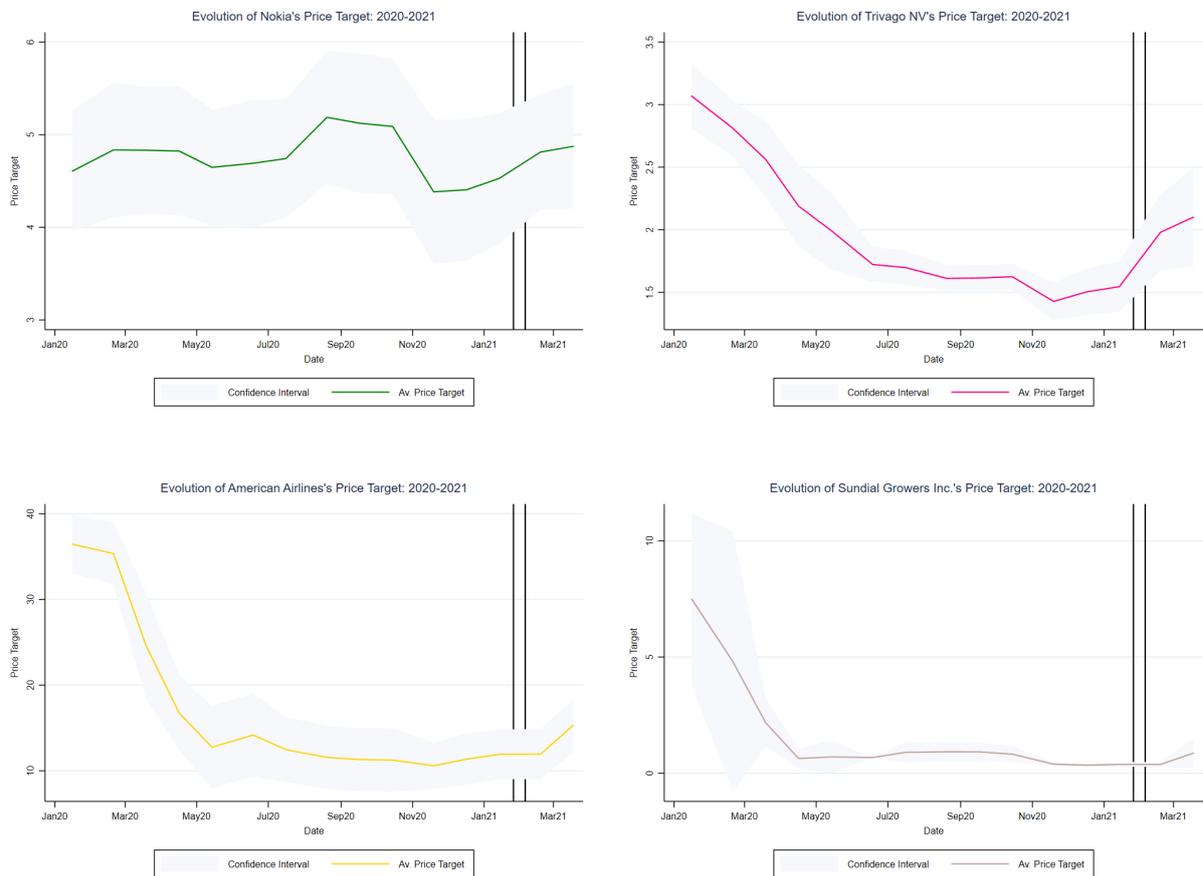


Fig. 11 Benford’s Law of count of social media mentions of the 13 stocks: Jan 11, 2021 – Feb 19, 2021: This figure shows the probability of the first digit of the count of social media mentions across the 13 stocks split into three time periods: before, during, and after the short squeezes. We define the period before the short squeeze as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period as Jan 26, 2021 through Feb 04, 2021. We define the period after the short squeeze as the two weeks (10 trading days) after Feb 04, 2021. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.

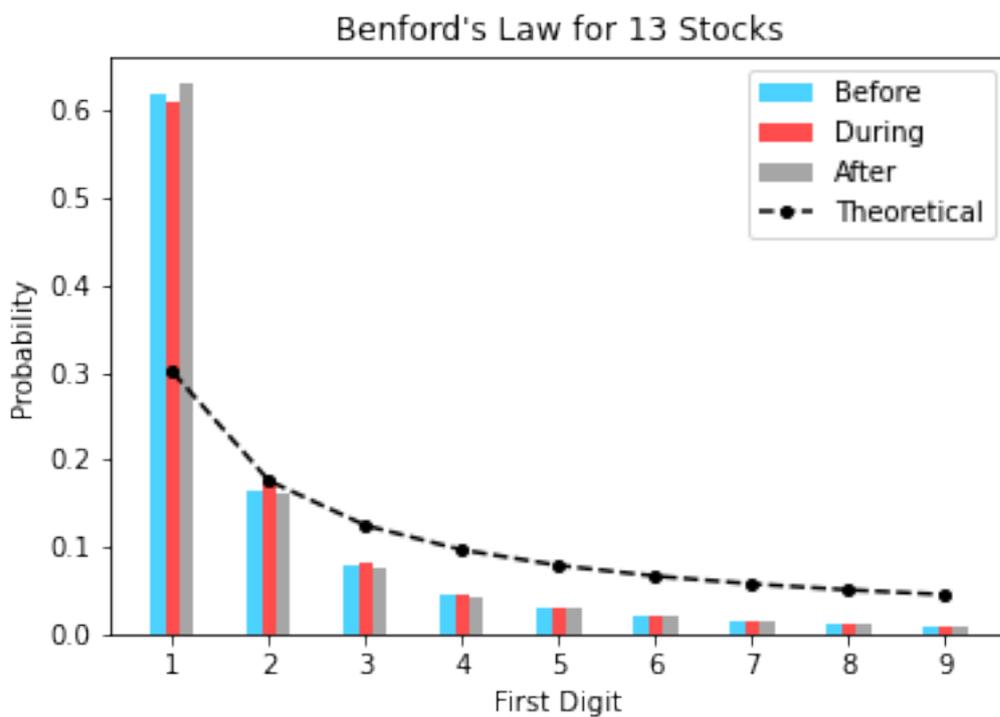


Fig. 12 Benford's Law of count of social media mentions of the 13 stocks for new and old users: Short squeeze period: This figure shows the probability of the first digit of the count of social media mentions for the short squeeze period across the 13 stocks by social media platform. Users are split into two groups: users that already had an account with one of the three platforms before January 26 (Old users), and users that opened an account during the short squeeze period after January 26 (New users). The start of the short squeeze period is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.

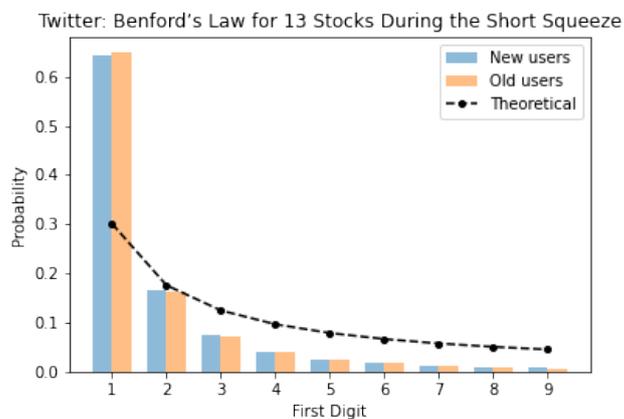
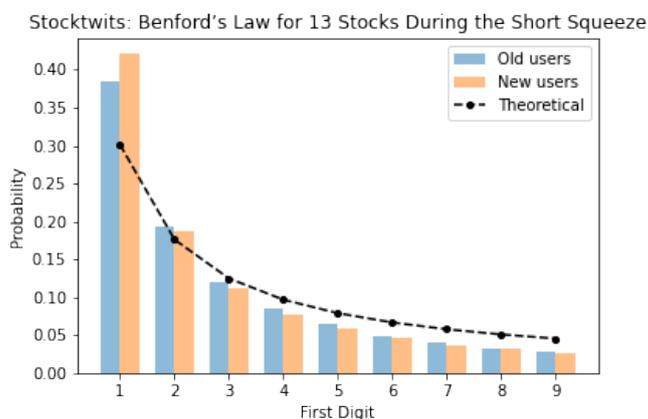
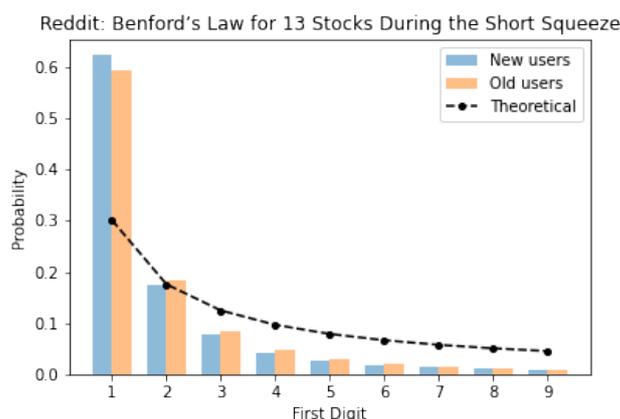


Fig. 13 Hourly posting patterns of social media mentions for the 13 stocks: Jan 11, 2021 – Feb 19, 2021: This figure shows the hourly posting pattern in NY time for social media mentions across the 13 stocks split into three time periods: before, during, and after the short squeezes. We define the period before the short squeeze as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period as Jan 26, 2021 through Feb 04, 2021. We define the period after the short squeeze as the two weeks (10 trading days) after Feb 04, 2021. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.

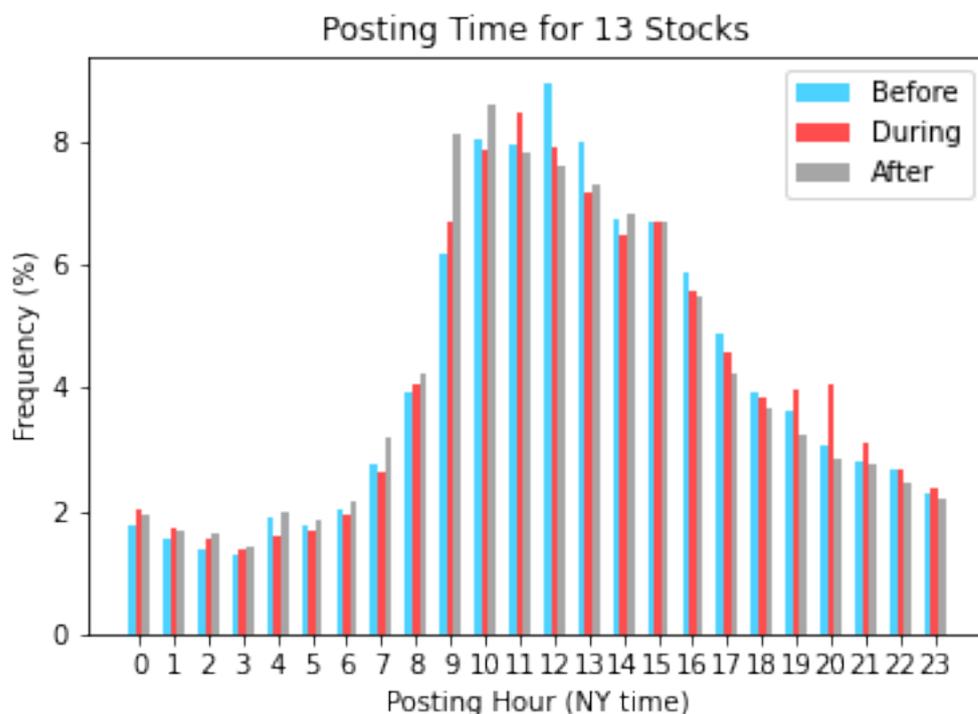


Fig. 14 Hourly posting patterns of social media mentions for the 13 stocks for new and old users: Short squeeze period:

This figure shows the hourly posting pattern in NY time for social media mentions for the short squeeze period across the 13 stocks by social media platform. Users are split into two groups: users that already had an account with one of the three platforms before January 26 (Old users), and users that opened an account during the short squeeze period after January 26 (New users). The start of the short squeeze period is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.

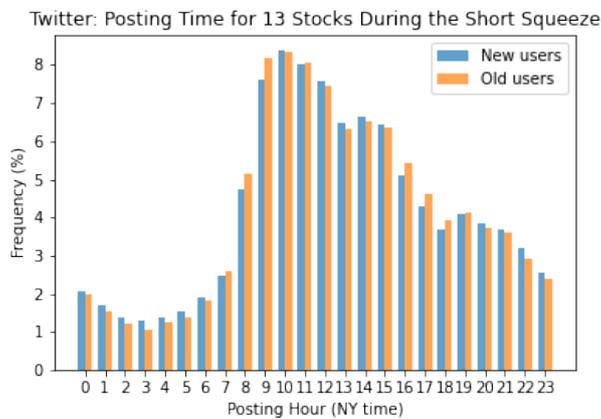
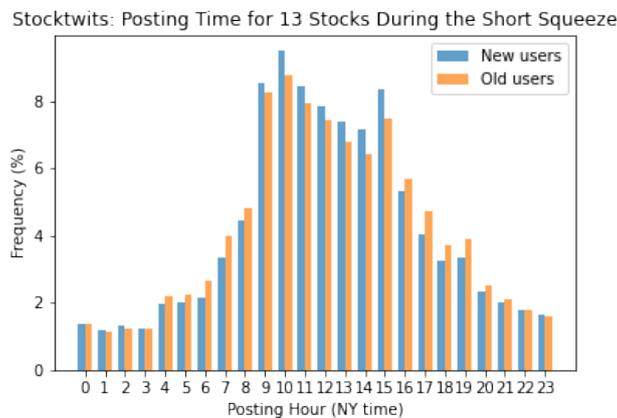
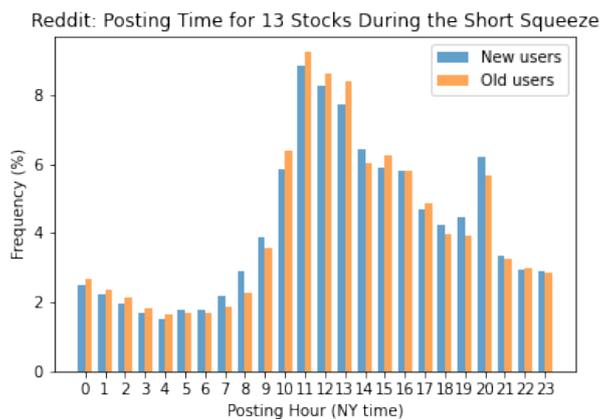


Table 6 Descriptive statistics: This table presents descriptive statistics for the 13 stocks impacted by the short squeeze, the competitors of the 5 most-impacted short-squeeze stocks, and the competitors of all 13 short-squeeze stocks in panels A, B, and C respectively. We present descriptive statistics for the following variables: 1.) Spread is the relative spread measured as: $\frac{(Ask_{i,t}-Bid_{i,t})}{m_{i,t}}$, where: $m_{i,t} = \frac{(Ask_{i,t}+Bid_{i,t})}{2}$; 2.) Volatility is the rolling standard deviation of realized returns over a window of fifteen minutes; 3.) Volume is the total trading volume; 4.) Bid Size is the total number of shares quoted at the bid; 5.) Ask Size is the total number of shares quoted at the ask; 6.) Buy Volume is the number of shares traded into buy-side trading volume; 6.) Sell Volume is the number of shares traded into sell-side trading volume. To differentiate between buy- and sell-side, we apply the algorithm proposed by Lee and Ready (1991). The data cover the period Jan 11, 2021 through Feb 19, 2021, i.e., ten trading days before and ten trading days after the short squeeze period (Jan 26 through Feb 04). The data frequency is on the minute level. Data come from TAQ.

Panel A: All 13 short-squeezed stocks										
	Obs	Mean	Std. Dev.	Min	Max	P1	P25	P50	P75	P99
Spread	139068	.0135	.0685	0	1.9994	.0006	.0025	.0058	.0104	.1138
Volatility	139245	.0046	.0077	0	.3021	.0004	.0014	.0026	.005	.0326
Volume	137305	380203.6	1150062	1	7.14e+07	7	11113	71277	288703	5029116
Bid Size	139937	260717.9	2747024	0	8.76e+08	7	1997	14583	113956	4118764
Ask Size	139937	254819.5	2314940	0	6.43e+08	7	1947	14064	109516	4214086
Buy Volume	66188	400079	1169571	1	5.36e+07	8	12527.5	77365	308205.5	5289480
Sell Volume	70244	362029.1	1119146	1	7.14e+07	10	10793	67504	275588.5	4715238

Panel B: Competitors of the 5 most-impacted short-squeeze stocks										
	Obs	Mean	Std. Dev.	Min	Max	P1	P25	P50	P75	P99
Spread	324803	.0117	.0179	0	1.7086	.0003	.0029	.0066	.0136	.0781
Volatility	313651	.0017	.0021	0	.1042	.0002	.0006	.0011	.002	.0098
Volume	304349	23108.44	173036.9	1	1.96e+07	2	500	2531	10566	304256
Bid Size	324954	12819.95	66278.17	0	1.50e+07	8	234	707	2937	240927
Ask Size	324954	12916.74	58610.79	0	3970577	8	233	696	2918	249240
Buy Volume	147646	21182.55	140571.1	1	1.85e+07	2	500	2481	9831	299829
Sell Volume	144536	25258.65	201575.9	1	1.96e+07	2	515	2628	11529	310662

Panel C: Competitors of all 13 stocks										
	Obs	Mean	Std. Dev.	Min	Max	P1	P25	P50	P75	P99
Spread	781893	.0186	.0311	0	1.8634	.0007	.0048	.0099	.0205	.1412
Volatility	759858	.0034	.0262	0	3.454	.0003	.0007	.0012	.0022	.0158
Volume	721453	11317.41	58344.93	1	8392821	1	242	1232	5238	172124
Bid Size	785484	4783.385	20093.32	0	2560703	2	118	361	1297	85490
Ask Size	785484	4560.967	19211.18	0	3989240	2	118	360	1256	81879
Buy Volume	371280	11609.26	58855.84	1	8392821	1	254	1262	5358	178163
Sell Volume	342410	11244.07	58426.11	1	7388624	1	250	1258	5298	168866

Table 7 Market quality tests for the 13 stocks impacted by the short-squeeze: This table reports the results from the market quality regression estimation described in Equation 3. The dependent variables are defined in Table 6. We present results for all 13 short-squeeze stocks. The data set covers the period Jan 11, 2021 through Feb 19, 2021. The data frequency is on the minute level. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. t-statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from TAQ.

	(1) Spread	(2) Volatility	(3) Volume	(4) Bid Size	(5) Ask Size	(6) Buy Volume	(7) Sell Volume
Post-SSqueeze	0.0077*** (16.061)	-0.0002*** (-4.641)	67,940.5651*** (9.770)	238,307.9847*** (31.424)	216,416.5895*** (15.438)	76,172.8921*** (8.200)	54,497.1581*** (5.664)
SSqueeze	0.0034*** (17.664)	0.0044*** (37.649)	318,691.2496*** (28.589)	219,112.9588*** (8.241)	225,566.2932*** (19.636)	331,204.9559*** (21.055)	289,831.4142*** (24.063)
Pre-SSqueeze	0.0097*** (79.974)	0.0034*** (104.763)	262,802.1087*** (73.268)	111,105.0801*** (70.079)	111,296.0140*** (75.467)	275,150.8104*** (58.831)	258,031.8988*** (58.292)
Observations	139,068	139,245	137,305	139,937	139,937	66,188	70,244
Adjusted R^2	0.002	0.070	0.013	0.002	0.002	0.014	0.012

Table 8 Market quality tests for the competitors: This table reports the results from the market quality regression estimation described in Equation 3. The dependent variables are defined in Table 6. Panels A and B present results for the competitors of the 5 most-impacted short-squeeze stocks (i.e., Gamestop, Koss, Express, AMC, and the Naked Brand Group), and the competitors of all 13 short-squeeze stocks, respectively. The data set covers the period Jan 11, 2021 through Feb 19, 2021. The data frequency is on the minute level. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. t-statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from TAQ.

Panel A: Competitors of the 5 most-impacted short-squeeze stocks							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Spread	Volatility	Volume	Bid Size	Ask Size	Buy Volume	Sell Volume
Post-SSqueeze	0.0015*** (13.192)	0.0001*** (3.775)	-3,729.7096*** (-2.593)	1,881.1858*** (7.555)	1,789.3363*** (8.640)	-2,334.7802** (-2.141)	-6,301.0240*** (-2.813)
SSqueeze	0.0025*** (19.434)	0.0004*** (19.591)	2,620.7329 (1.580)	2,123.3342*** (8.006)	2,055.1338*** (8.519)	6,143.0181*** (4.118)	-1,316.6519 (-0.554)
Pre-SSqueeze	0.0104*** (120.715)	0.0016*** (134.515)	23,777.7430*** (19.016)	11,536.8675*** (83.256)	11,686.1218*** (84.589)	20,239.7407*** (27.264)	27,899.3511*** (13.662)
Observations	324,803	313,651	304,349	324,954	324,954	147,646	144,536
Adjusted R^2	0.003	0.007	0.000	0.000	0.000	0.001	0.000
Panel B: Competitors of all 13 stocks							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Spread	Volatility	Volume	Bid Size	Ask Size	Buy Volume	Sell Volume
Post-SSqueeze	0.0040*** (25.081)	0.0004*** (5.340)	3,682.7520*** (9.350)	-29.5316 (-0.440)	-274.2468*** (-4.361)	3,621.6986*** (8.434)	3,744.1006*** (8.011)
SSqueeze	0.0047*** (27.108)	0.0011*** (15.731)	763.9278* (1.922)	172.7080** (2.553)	112.3005* (1.728)	887.6724** (2.009)	546.9383 (1.213)
Constant	0.0158*** (142.248)	0.0030*** (61.714)	9,790.0170*** (34.801)	4,744.0872*** (102.554)	4,626.0829*** (107.502)	10,072.0092*** (33.799)	9,748.5040*** (30.732)
Observations	781,893	759,858	721,453	785,484	785,484	371,280	342,410
Adjusted R^2	0.005	0.000	0.001	0.000	0.000	0.001	0.001

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Internet Appendix

Squeezing Shorts Through Social Media Platforms

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A.1. Price and order imbalance charts.

This section describes the evolution of price and order imbalance for the 13 stocks initially banned by retail brokers, including Robinhood and impacted by short squeezes for the period Jan 01, 2021 – Feb 19, 2021.

Fig. A1 Evolution of price and order imbalance for the remaining initially banned 12 stocks: Jan 01, 2021 – Feb 19, 2021: This figure depicts the evolution of close price (lhs) and the evolution of the number of times a company was mentioned in the social media (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.

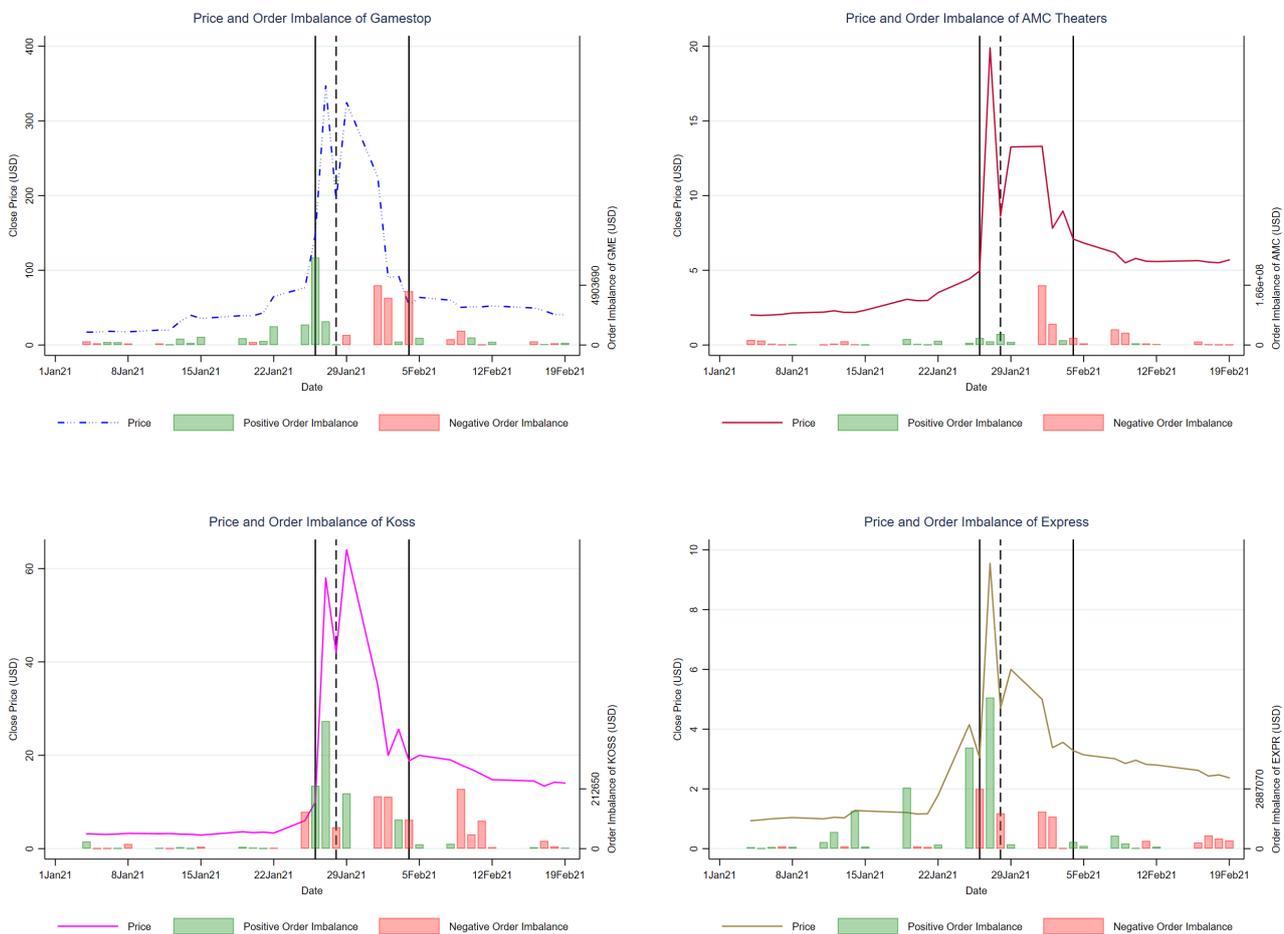


Fig. A2 Evolution of price and order imbalance for the remaining initially banned 12 stocks: Jan 01, 2021 – Feb 19, 2021 (cont'd): This figure depicts the evolution of close price (lhs) and the evolution of the number of times a company was mentioned in the social media (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.

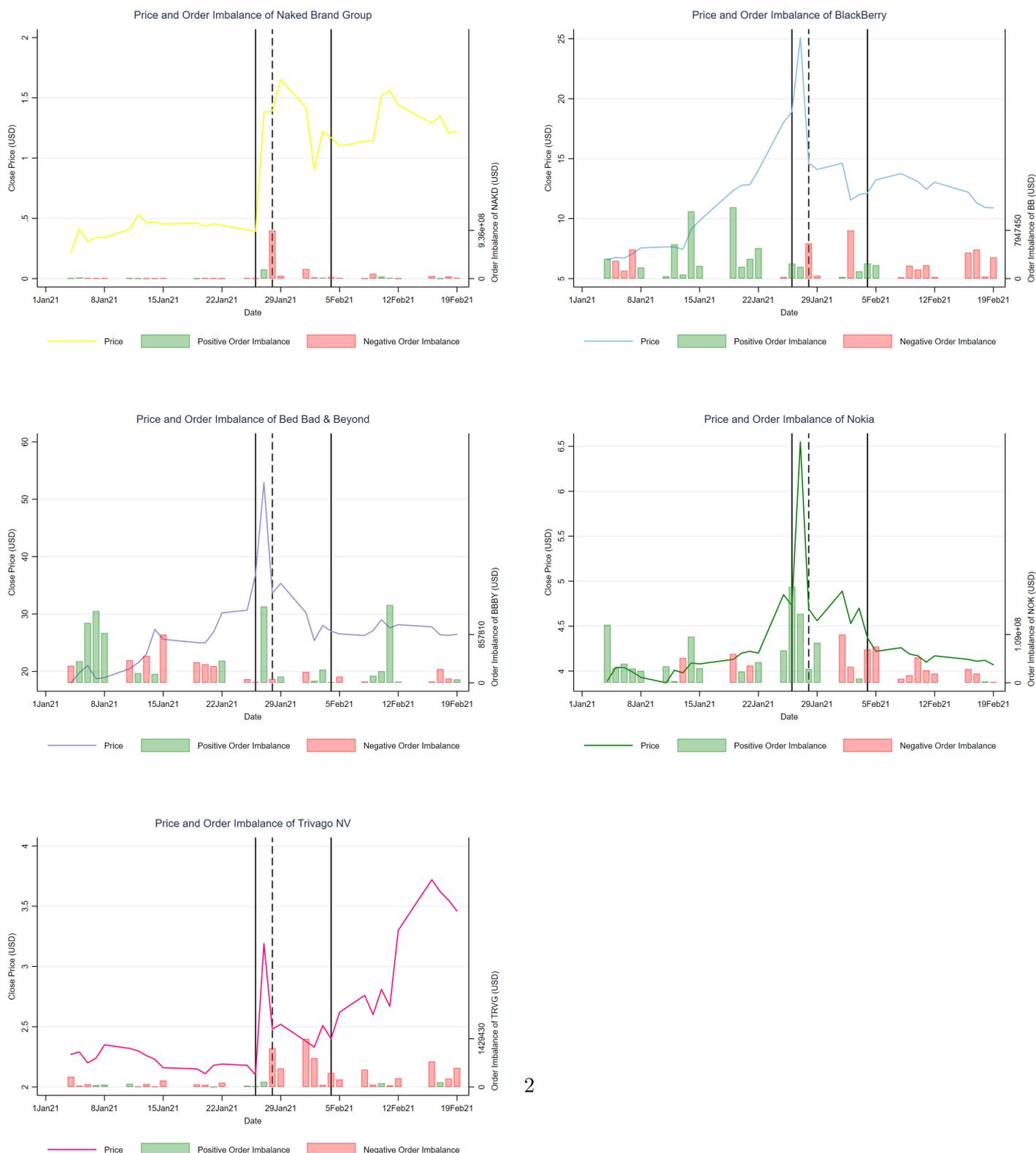
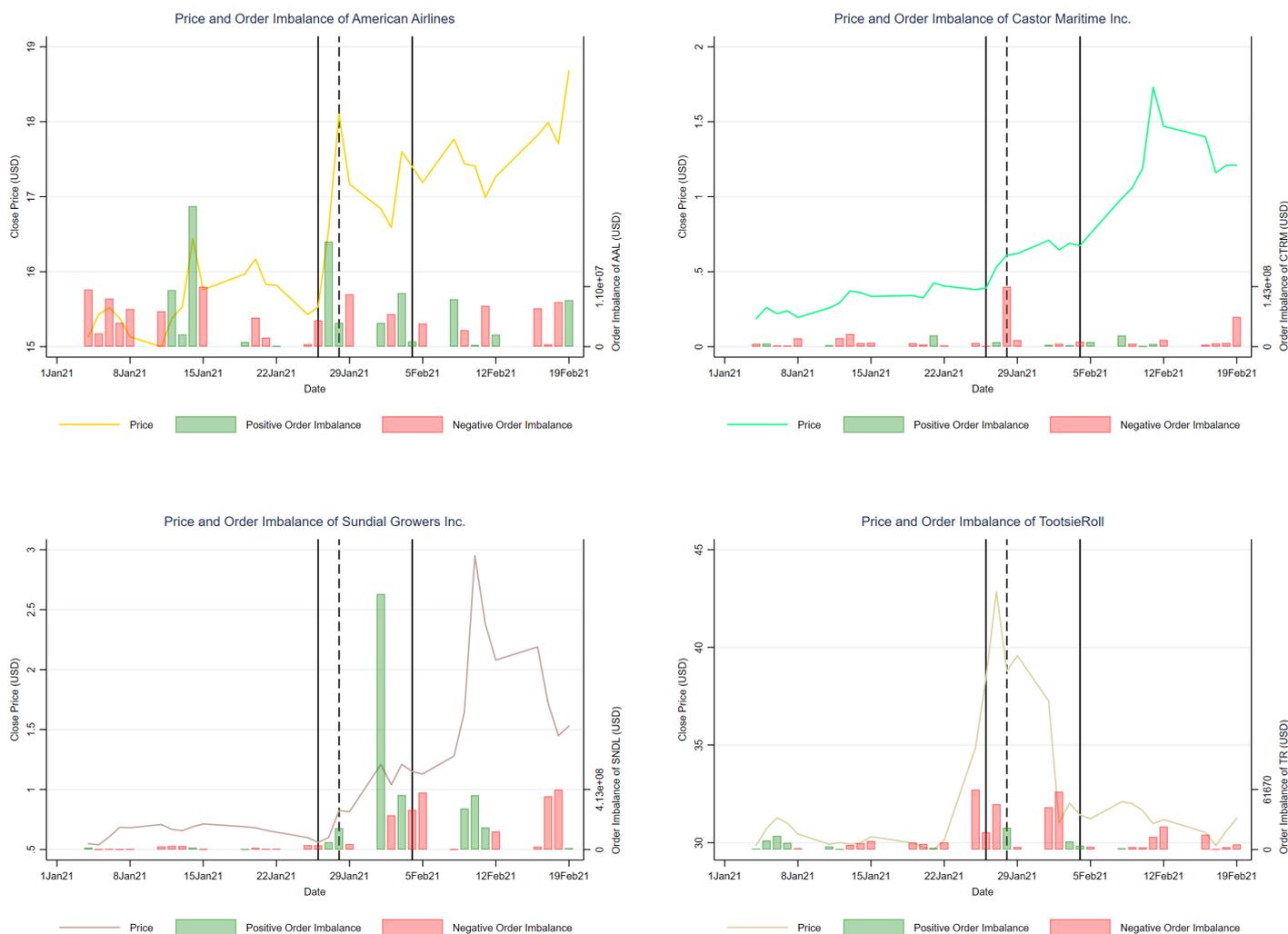


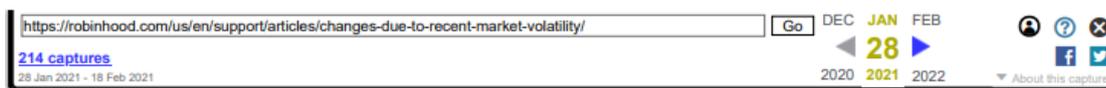
Fig. A3 Evolution of price and order imbalance for the remaining initially banned 12 stocks: Jan 01, 2021 – Feb 19, 2021 (cont'd): This figure depicts the evolution of close price (lhs) and the evolution of the number of times a company was mentioned in the social media (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.



A.2. Relevant public announcements of brokers.

This section presents relevant public announcements made by brokers.

Fig. A4 Announcement made by Robinhood on January 28, 2021: This announcement illustrates that Robinhood, among other brokers, restricted 13 stocks from purchasing.



< Investing

Changes due to ongoing market volatility

Due to ongoing market volatility, the following securities are currently set to position-closing only:

- AAL
- AMC
- BB
- BBBY
- CTRM
- EXPR
- GME
- KOSS
- NAKD
- NOK
- SNDL
- TR
- TRVG

This means you can sell and close your positions, but you can't open new positions.

Any open orders (such as market orders and limit orders) for these securities were canceled, since they would have resulted in a new open position. If you hold any of the listed securities, you can only close your positions at this time.

For more background about how to be an informed investor, read our [blog post](#) from this morning.

Reference No. 1500807

Still have questions? [Contact Robinhood Support](#)

A.3. Price and open interest charts for the impacted stocks.

This section presents additional price and open interest graphs for the impacted stocks.

Fig. A5 Evolution of price and open interest: Jan 01, 2021 – Feb 19, 2021:

This figure depicts the evolution of close price (lhs) and the evolution of open interest separately for call and put options (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.

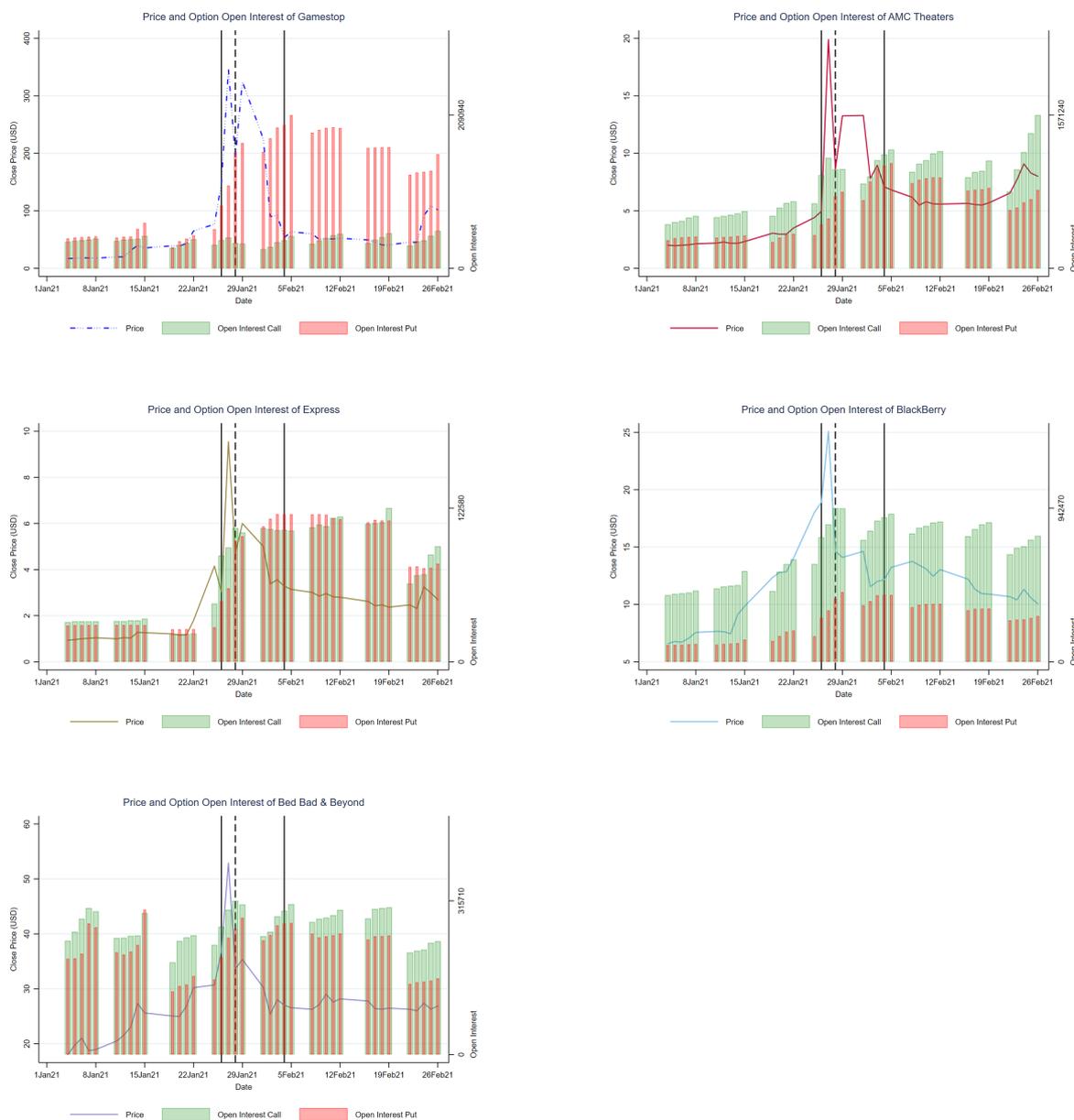
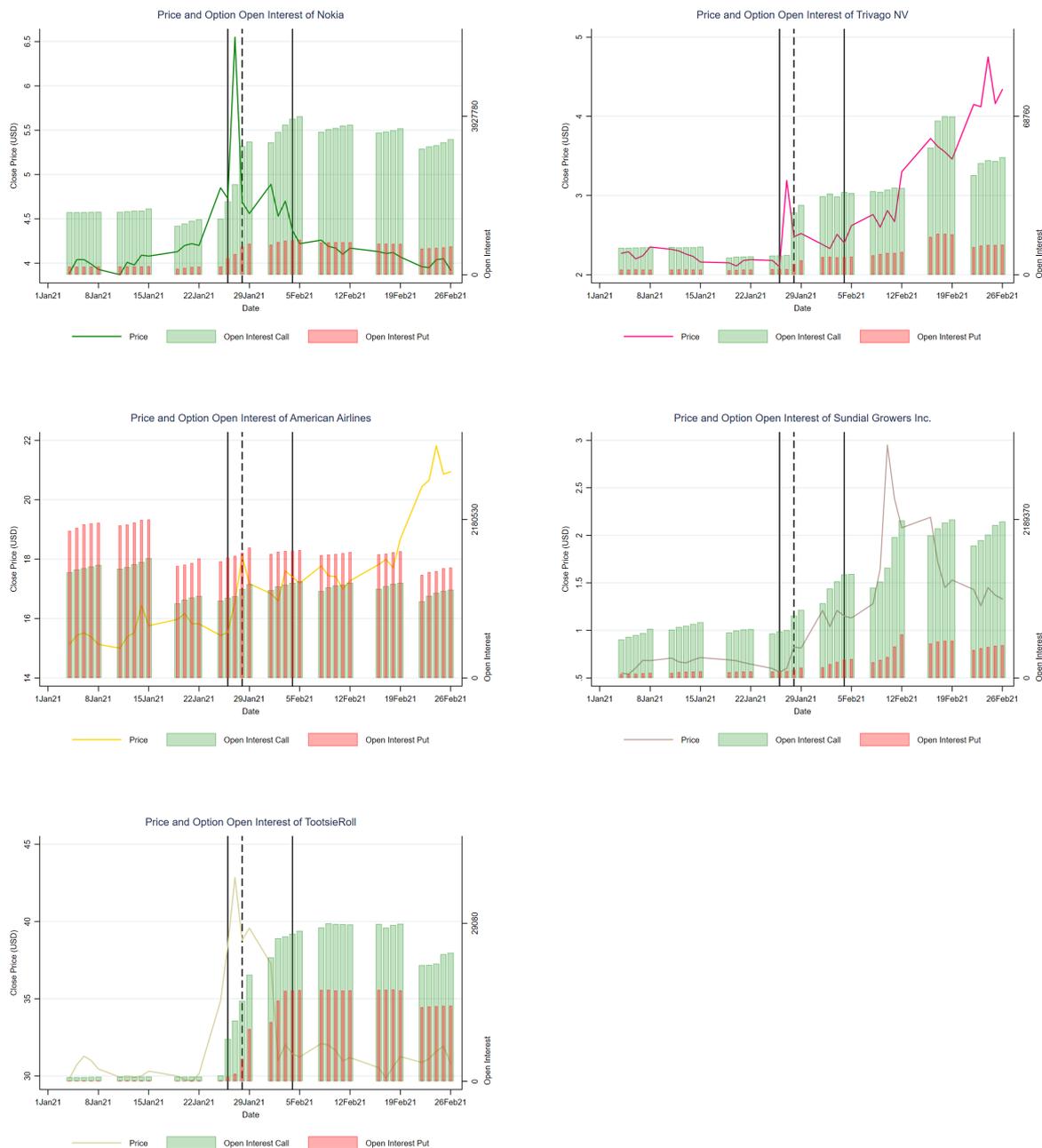


Fig. A6 Evolution of price and open interest: Jan 01, 2021 – Feb 19, 2021 (cont'd): This figure depicts the evolution of close price (lhs) and the evolution of open interest separately for call and put options (rhs). The start of the short squeeze is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations.



A.4. Separate market quality tests for the 13 stocks.

This section presents market quality tests separately for GME and the remaining 12 stocks impacted by trading bans.

Table A1 Market quality tests for the 13 stocks impacted by the short-squeeze:

This table reports the results from the market quality regression estimation described in Equation 3. The dependent variables are defined in Table 6. We present results for GME and the remaining 12 short-squeeze stocks in panels A and B, respectively. The data set covers the period Jan 11, 2021 through Feb 19, 2021. The data frequency is on the minute level. We define the period before the short squeeze (Pre-SSqueeze) as the two weeks (10 trading days) preceding Jan 26, 2021. We define the short squeeze period (SSqueeze) as Jan 26, 2021 through Feb 19, 2021. We define the period after the short squeeze (Post-SSqueeze) as the two weeks (10 trading days) after Feb 04, 2021. t-statistics are based on HAC standard errors and are reported in parentheses below the coefficient estimates. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Data come from TAQ.

Panel A: Gamestop							
	(1) Spread	(2) Volatility	(3) Volume	(4) Bid Size	(5) Ask Size	(6) Buy Volume	(7) Sell Volume
Post-SSqueeze	0.0818*** (13.764)	-0.0018*** (-12.771)	-150009.7093*** (-29.857)	-4,571.3059*** (-9.649)	-5,982.4977*** (-13.548)	-177705.6302*** (-23.303)	-119399.9609*** (-19.860)
SSqueeze	0.0096*** (6.031)	0.0104*** (23.462)	-36,583.5850*** (-6.110)	7,499.4345*** (6.113)	4,138.5914*** (5.307)	-58,451.5859*** (-6.418)	-15,700.7529** (-2.127)
Pre-SSqueeze	0.0129*** (35.941)	0.0068*** (57.078)	211,845.4835*** (45.434)	9,995.3410*** (24.543)	11,284.9408*** (28.414)	245,764.6161*** (34.677)	174,134.0625*** (30.726)
Observations	10,692	10,817	10,760	10,815	10,815	5,002	5,696
Adjusted R^2	0.026	0.125	0.085	0.015	0.025	0.098	0.080
Panel B: Remaining 12 short-squeezed stocks							
	(1) Spread	(2) Volatility	(3) Volume	(4) Bid Size	(5) Ask Size	(6) Buy Volume	(7) Sell Volume
Post-SSqueeze	0.0015*** (10.097)	-0.0001 (-1.163)	85,886.1265*** (11.494)	258,221.8038*** (31.448)	234,629.7412*** (15.453)	95,454.2527*** (9.588)	69,711.5972*** (6.691)
SSqueeze	0.0029*** (18.900)	0.0039*** (37.004)	347,295.3001*** (29.024)	235,944.3227*** (8.207)	243,203.9090*** (19.582)	362,468.1781*** (21.472)	313,284.4009*** (24.224)
Constant	0.0094*** (74.885)	0.0031*** (110.224)	267,357.3329*** (70.189)	119,809.3411*** (69.832)	119,905.6938*** (75.202)	277,720.3084*** (55.692)	265,890.0767*** (55.863)
Observations	128,376	128,428	126,545	129,122	129,122	61,186	64,548
Adjusted R^2	0.003	0.072	0.014	0.002	0.002	0.015	0.012

A.5. Posting patterns for the 13 stocks

This section presents Benford's Law and hourly posting patterns for the 13 stocks.

Fig. A7 Benford's Law of count of social media mentions of each of the 13 stocks for new and old users: Short squeeze period: This figure shows the probability of the first digit of the count of social media mentions for each of the 13 stocks by social media platform and for just the short squeeze period. The start of the short squeeze period is set to Jan 26, 2021. Users are split into two groups: users that already had an account with one of the three platforms before January 26 (Old users), and users that opened an account during the short squeeze period after January 26 (New users). The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.

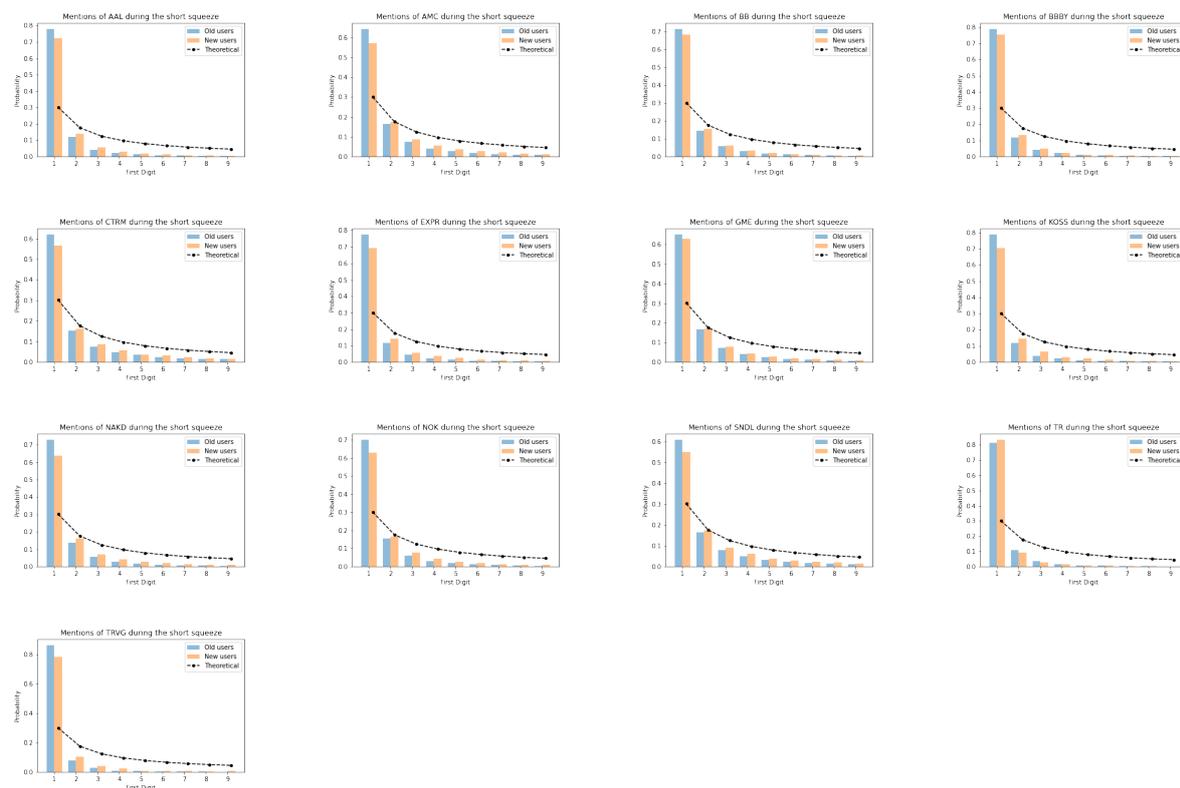
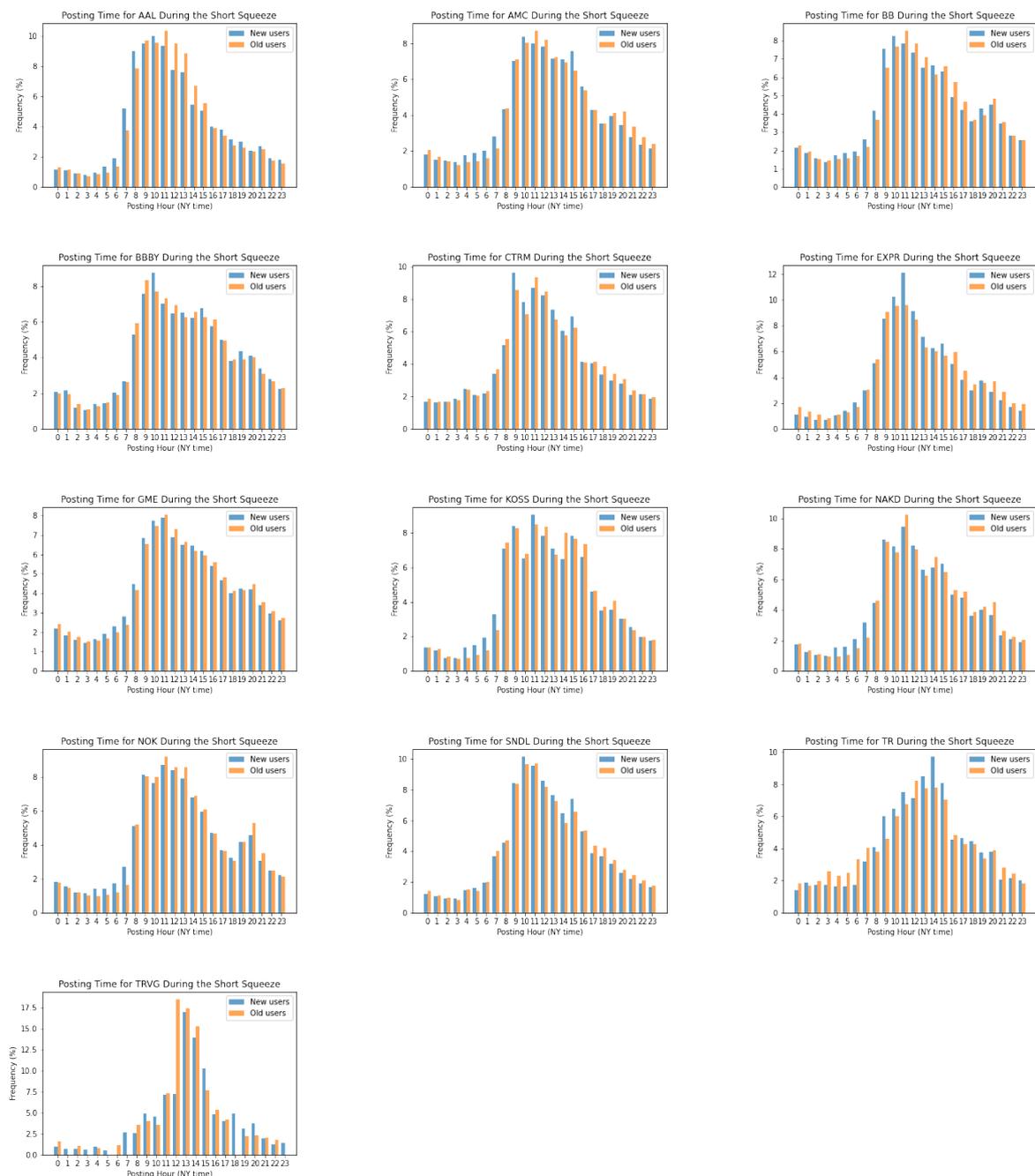


Fig. A8 Hourly posting patterns of social media mentions for the 13 stocks for new and experienced users: Short squeeze period: This figure shows the hourly posting pattern in NY time for social media mentions for the 13 stocks by social media platform and for just the short squeeze period. Users are split into two groups: users that already had an account with one of the three platforms before January 26 (Old users), and users that opened an account during the short squeeze period after January 26 (New users). The start of the short squeeze period is set to Jan 26, 2021. The end of the short squeeze is set to Feb 4, 2021. On Jan 28, 2021 Robinhood, among other brokers, implemented the trading limitations. Mentions have been collected from posts and comments published on Reddit, Stocktwits, and Twitter.



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