

# Online Appendix

## We Reddit in a Forum: The Influence of Message Boards on Firm Stability

Shaen Corbet<sup>a,b</sup>, Yang (Greg) Hou<sup>b</sup>, Yang Hu<sup>b</sup>, Les Oxley<sup>b\*</sup>

<sup>a</sup>*DCU Business School, Dublin City University, Dublin 9, Ireland*

<sup>b</sup>*School of Accounting, Finance and Economics, University of Waikato, New Zealand*

*\*Corresponding Author: les.oxley@waikato.ac.nz*

---

### Abstract

The use of messaging boards to instigate coordinated manipulation of stock prices is not a novel phenomenon. However, the growing breadth and sophistication of social media, the widespread availability of technological cloaking techniques, and the ready accessibility of leveraged derivatives have all significantly contributed to the growth of the infamous Reddit forum r/wallstreetbets. Using a lexicon of terminology designed to identify explicit and implicit manipulation attempts, this research presents several novel findings. The results indicate significantly positive, pronounced, and persistent abnormal returns in the aftermath of manipulative events, with the results being robust across several testing procedures. These abnormal returns have increased significantly in line with the growth of forum users and the reach of manipulation-related comments. Significant effects on market liquidity and analyst recommendations are further identified across tests. Such continued predatory headwinds are certainly of interest to market-makers, regulators, and policymakers alike, as the irrational exuberance incited by millennial meme stocks and sarcastic GIFs is found to have played a significant role in disrupting market functionality. The desired outcome of some of these five million monthly forum users is to create enough momentum to trigger algorithmic responses to move out-of-the-money options into a profitable state. Our results present evidence that this potential threat to corporate stability is concrete.

*Keywords:* Market Activity; Liquidity; Volatility; Pump-and-Dump; Manipulation; Messaging Boards.

---

## Section A: Can we deem the behaviour of r/wallstreetbets traders to be cross-jurisdictionally illegal?

The key tools that r/WallStreetBets investors have been using include the trading accounts provided by Robinhood<sup>1</sup>, a company based in the US with assets under management of approximately \$50 billion and thirteen million registered users. The company advertises itself as providing free trades to investors, with a variety of leverage rates, associated ease of usage and borrowing capabilities. Further, in quite a remarkable error, one r/WallStreetBets user, u/ControlTheNarrative, found a bug in Robinhood's trading platform. In a related social media release, the user presented evidence as to how he exploited this error to leverage his original deposit of \$2,000 up to approximately \$50,000, resulting in a leverage ratio of approximately 25:1. Next, the trader sold covered calls, thus exploiting this glitch, and the credit that he received then appeared as investable assets. The trade led to a loss of \$46,000, which was enormous relative to his initial deposit of only \$2,000. Further leverage glitches were taken advantage of by Robinhood Gold Service users, who are traders that pay \$5 per month to trade at increased margin levels. These incidents were in contrast to SEC and FINRA regulations, which give these organizations the option of penalizing brokerages for failing to safeguard client and firm funds. The above mentioned error was unfortunately not an isolated incident. Among several high-profile mistakes, Robinhood was [reported](#) to have failed to add the `isleap()` code to their Python module, therefore leading to a complete system error on Feb 29, 2020, during the recent leap year.

The growth in interest in the r/WallStreetBets forum surrounds several high-profile pieces of 'evidence' that have been presented in posts, such as screenshots of positions or statements by high-profile contributors, some of which have been reported across several broadsheet media outlets. Regarding the attempt to use such evidence of the growth of profits to incentivize new entrants to add further trading capital, there has been a growing amount of evidence to support claims through the exceptional volume traded and, in some cases, through independent verification by media sources in exceptional circumstances. This further contributes to the above claim that such traders may possess the ability to move markets in a sophisticated manner through relatively unsophisticated mechanisms. In July 2020, Reddit trader u/mori226 [claimed](#) to have turned \$35,000 from retirement savings into \$1.25 million during the chaos caused by the COVID-19 pandemic. The post contained a detailed outline of all trades made, both winners and losers, while establishing a set of self-imposed

---

<sup>1</sup>Robinhood is an FINRA regulated broker-dealer registered with the US Securities and Exchange Commission and is a member of the Securities Investor Protection Corporation. The company's main source of revenue comes from interest earned on customers' cash balances, selling order information to high-frequency traders and margin lending.

trading rules that surrounded maintaining at least 50% of cash reserves while focusing exposure on trades that did not possess 12-month levels near peak IV. This scenario presents an example of the variety of traders that exist and, indeed, the sophistication of each, where some provide detailed outlines, while others present a meme and state, with no amount of educated opinion, that the stock must go up or down. Such interest in these uneducated views has led to the success in the virality of the presented meme. A May 2019 Forbes [article](#) discussed the behavior of a New York trader, who, although seeking anonymity, was responsible for 50% of the top r/WallStreetBets posts that month by simply combining footage from video content with inserted text mocking a variety of economic circumstances. For each of the success stories, there are a great number of those who have lost all of their savings on individual trades, but such posts appear to be met with repeated sarcastic comments and further reference to terms such as ‘ROPE’ and ‘YOLO’. In essence, it would appear that the vague collection of success stories has inspired prospective r/WallStreetBets traders, instead of the inherent warnings contained within such loss stories, somewhat representative of a market driven by compulsive gamblers or high-stakes-seeking adrenaline junkies, very much akin to the scenarios observed in trading conditions defined as euphoric. Examples of such scenarios can be found in a variety of markets, such as stock markets [[Ljungqvist and Wilhelm Jr, 2003](#), [Brueckner et al., 2012](#)], housing price markets [[Brueckner et al., 2016](#), [Corbet, 2016](#)], and cryptocurrency markets [[Corbet et al., 2018, 2020](#)].

As we continue to quantify and debate as to what the ideal relationship should be between social media and stock markets [[Luo et al., 2013](#), [Sun et al., 2016](#)], in recent years, there have been several high-profile incidents. Mr. Elon Musk used Twitter ([@elonmusk](#)) to [state](#), on May 1, 2020, that the ‘Tesla stock price is too high imo.’ Within minutes, the share price had fallen from \$761 to \$686. Mr Musk is the CEO of Tesla, and this statement reduced the market capitalization of his own company by approximately \$14 billion. Does this constitute market manipulation? While r/WallStreetBets users aspire to perhaps have such market-moving capability, the specific illicit nature of which has received third-party scrutiny surrounding conflicts of interest and [duel ownership](#) of companies. In April 2020, it was [reported](#) that a r/WallStreetBets user had been awarded \$2 million for whistleblowing on a company that had been breaching US law through the simultaneous ownership of several small companies while being accused of using the forum in an attempt to generate interest to boost its respective share price. This was a breach of both SEC and FBI regulatory stances, which forbid the following: 1) buying or selling a security, in breach of a fiduciary duty or other relationship of trust and confidence, based on material nonpublic information about the security and 2) manipulation being considered as representative of increased trading volume, generated by inducing unwitting investors into purchasing shares of the targeted security through false or

deceptive sales practices and/or public information releases. Considering both statements, without the verification of the users that are making these posts regarding companies throughout the world, it is exceptionally easy for issues of moral hazard and informational asymmetry to potentially become significant. The above situation and accusations are not in isolation and represent just one relatively famous example among many from which to select. In 2017, a [post](#) on the forum led to a developing, moderated discussion as to what the SEC was doing. This post was subsequently moved behind a firewall and onto another sub-Reddit, with the leaking of insider information being the key concern of forum users.

## Section B: Calculating ARs and CARs

Abnormal returns are calculated as the sum of the target company less the returns of the domestic exchange on which the company trades. We calculate the natural logarithm of returns  $\left(R_{i,t} = \ln \frac{P_{i,t}}{P_{i,t-1}}\right)$  for each target company and develop a model of the following form to estimate abnormal returns:

$$AR_{i,t} = R_{i,t} - \alpha_i - \beta_i(R_{m,t}) \quad (1)$$

where, on day  $t$ ,  $AR_{i,t}$  is the abnormal return,  $R_{i,t}$  is the daily return for company  $i$ , and  $R_{m,t}$  is the domestic index on which each company trades<sup>2</sup>. For each company  $i$ , the CAR for an event interval  $[T_1, T_2]$  is computed as follows:

$$CAR_{i,T_1,T_2} = \sum_{t=T_1}^{T_2} AR_{it} \quad (2)$$

The abnormal and cumulative returns averaged over all firms ( $N$ ) are given by the following:

$$AR_t = \frac{\sum_{i=1}^N AR_{i,t}}{N} \quad (3)$$

$$CAR_{T_1,T_2} = \frac{\sum_{i=1}^N CAR_{i,T_1,T_2}}{N} \quad (4)$$

We next match target firms with a set of control peers by using propensity score matching for the random assignment of firms. We match firms subject to r/WallStreetBets' forum attention (target)

---

<sup>2</sup>We also computed abnormal returns using the MSCI world index and a number of European and worldwide indices; however, the results remained unchanged compared to those obtained using domestic market indices.

with at least two (at most five) nearest neighbor firms in the sample using firm characteristics, such as firm size, Tobin’s Q, and operating profits. Both target and control firms are sampled from the same four-digit SIC industry code to ensure that both types of firms operate in the same industry, which results in a total sample of 1,474 firms, consisting of 329 target firms and 1,145 control firms, examined within the framework of 859 algorithmically identified individual events. We first use the target and control firms to examine the relationship between security breaches and the cumulative abnormal returns conditional on firm characteristics. More specifically, we run the following regression analyses:

$$CAR_T = \alpha + \beta_0 C_i + \beta' z_i + \epsilon_i \quad (5)$$

where  $CAR_t$  represents the cumulative abnormal returns of the target company, firm  $i$  over a given event window,  $z_i$  represents a vector of firm characteristics calculated over the year prior to the event, and  $C_t$  is a dummy variable that takes a value of one for target firms and zero otherwise.

### Section C: Further Discussion of Key Results

Considering the clarity of the results provided, we can clearly identify that for the algorithmically selected events found to indicate manipulative behavior, significant abnormal effects are generated. To briefly discuss some additional evidence, we present two specific cases of interest that were found to have occurred in February 2020. The hourly price performance, volatility and volume traded for each of the companies, Lumber Liquidators and Virgin Galactic, are presented in Figure 1. In each case, we observe the substantial elevation of price returns and volume traded in the period immediately after each identified manipulative period; however, the same effects are clearly not observed with the same veracity in either sectorally or geographically comparative companies. Even when using various higher frequencies of data, similar evidence of both sudden and largely irregular levels of elevated trading activity can be clearly observed. Such repeated observations, when observed in coordination with the methodologically robust results provided earlier, present substantial evidence to verify that the coordinated manipulation of the r/WallStreetBets forum have not only significant effects on unsuspecting stocks but also both pronounced and persistent effects.

**Figure 1**

There is much that separates the influence of r/WallStreetBets from that of other previously used message boards on stock returns. First, the outreach of r/WallStreetBets is particularly extensive,

considering that 1.5 million registered members are associated with the forum, with further weight being added by the almost 4 million unique monthly users that visit the forum. Second, when considering the previous role of message boards and their use for potential manipulation and broad malpractice during the dot-com collapse, the speed of information transfer is now exceptionally more pronounced. Further, through the use of photos and videos that ‘disappear,’ the presence and ease of the availability of virtual private networks, and the ease and lack of verification through which an individual can obtain a digital presence while cloaking his/her true identity, the conditions through which legal enforcement attempts to mitigate and apprehend those responsible for such potential malpractice are quite exceptional. Third, the availability and speed of technology is exponentially larger than that of the late 1990s. Fourth, the broad availability of derivative trading accounts, including those with margin availability and instantaneous documentation acceptance, is now comparably abundant. Fifth, we can identify substantial differences through the presence of algorithm trading and the volatility generated from the presence of day traders. Further differences can also be identified and are not limited to advanced technological proficiency and substantial intergeneration characteristics observed through the tone and usage of gifs and memes to proliferate information on such forums. Technological progression has generated an environment through which long-standing regulatory counteraction finds itself tracking rather than leading such advancement.

However, some similarities with previous experiences exist. There is largely a technologically driven focus on stock selection, similar to that observed during the dot-com collapse. One such company, Tesla, is the source of multiple significant events with regard to aggressive manipulative or crowd-coordinated sentiment provocation. Such targets present quite obscure and cloaked internal mechanics, to which rumors, misinformation, and even disinformation can prevail quite easily with little evidence available in the public forum to contradict such disinformation, particularly with regards to potential product and technological development and advancement, or in the case of Tesla, quite ethically challenging social media behavior by those in senior management positions. Such ambiguity and random acts are particularly beneficial for proponents of message forums such as those similar to r/WallStreetBets, not only providing regulatory and investigatory shelter against the use of illicit manipulative techniques but also generating substantial natural price volatility, which increases the probability that significant out-of-the-money options can become in-the-money options in quite a short period of time.

When considering the broad availability of options to all traders, where in the past, such products were only available institutionally, the broad availability of leveraged options has amplified the probability of significant financial market influence with fewer available financial resources. Therefore, through the use of leverage and coordinated action, groups of small traders can theoretically

generate profound effects, such as those clearly identified within this research. Smaller corporations or, indeed, stocks that trade with relative illiquidity, will thereby be considered exceptionally vulnerable if placed under a sustained and aggressive attack within the same circumstances, as a relatively small amount of trading capital can engender substantial instability. While under the remit of both monetary policy authorities and financial regulatory bodies to monitor and defend, the threat of sustained and repeated attacks by such traders on stock markets will generate substantial unease among corporate institutions, as periods of instability and irrational exuberance are particularly hostile conditions to which institutions can provide assurances of stability and rational growth to shareholders.

One further overarching point surrounds the knowledge presented by the users of r/WallStreetBets. Beyond juvenile memes, crude language and proclaimed innocence in the case of regulatory scrutiny is an underlying knowledge of market conditions. Among the millions of comments and opinions analyzed were far more than singular mentions of the presence of algorithm trading. It is entirely possible that informed traders are attempting to utilize the aspirations of uninformed traders, but such behavioral observation is outside the scope of this research. Tactically, the approach of these traders is structurally similar to those of the 1990s and 2000s dot-com message board traders. However, the propellant is somewhat distinctive. While dot-com traders aspired to trigger the attention of institutional investors to add further weight and support to their position, r/WallStreetBets traders hope that the presence of algorithmic trading will identify momentum and generate substantial deviation, presenting a situation through which long-range, out-of-the-money options can generate substantial profits. Such traders will then close their positions, as evident in the significant volatility effects not only on the day of the identified manipulative situations but also in the following one-, two- and three-month periods thereafter as derivative positions are settled. The augmentation of such behavior is in and of itself self-fulfilling, as evidence of larger profits and news of exceptional victories (or ‘tendies’) spreads, increasing interest and available investable capital become available. Therefore, the described situation can manifest into an issue that will be of deep concern to the corporations, regulatory authorities and exchanges tasked with the provision of orderly and stable financial markets.

## References

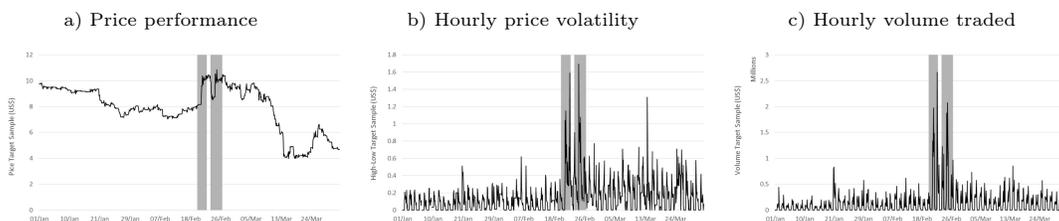
- Brueckner, J. K., P. S. Calem, and L. I. Nakamura (2012). Subprime mortgages and the housing bubble. *Journal of Urban Economics* 71(2), 230–243.
- Brueckner, J. K., P. S. Calem, and L. I. Nakamura (2016). House-price expectations, alternative mortgage products, and default. *Journal of Money, Credit and Banking* 48(1), 81–112.

- Corbet, S. (2016). Turning tigers into PIIGS: The role of leverage in the irish economic collapse. In *Lessons from the Great Recession: At the Crossroads of Sustainability and Recovery*. Emerald Group Publishing Limited.
- Corbet, S., C. Larkin, B. Lucey, and L. Yarovaya (2020). Kodakcoin: a blockchain revolution or exploiting a potential cryptocurrency bubble? *Applied Economics Letters* 27(7), 518–524.
- Corbet, S., B. Lucey, and L. Yarovaya (2018). Datestamping the bitcoin and ethereum bubbles. *Finance Research Letters* 26, 81–88.
- Ljungqvist, A. and W. J. Wilhelm Jr (2003). Ipo pricing in the dot-com bubble. *The Journal of Finance* 58(2), 723–752.
- Luo, X., J. Zhang, and W. Duan (2013). Social media and firm equity value. *Information Systems Research* 24(1), 146–163.
- Sun, A., M. Lachanski, and F. J. Fabozzi (2016). Trade the tweet: Social media text mining and sparse matrix factorization for stock market prediction. *International Review of Financial Analysis* 48, 272–281.

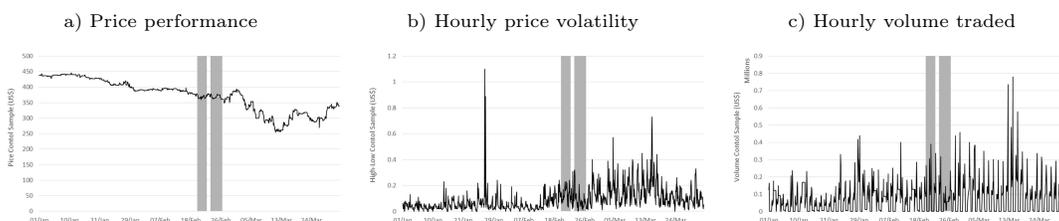
Figure 1: Specific cases of interest, hourly data, January through March 2021

*i) Lumber Liquidators*

*Target Sample Performance*

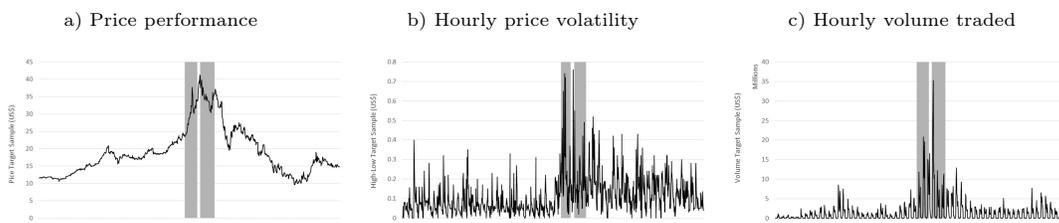


*Control Sample Performance*

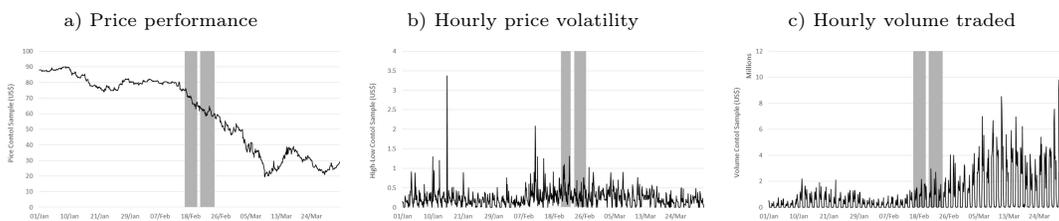


*ii) Virgin Galactic*

*Target Sample Performance*



*Control Sample Performance*



Note: The above figure presents the hourly data of specific cases of interest. The gray shaded regions represent the algorithmically identified estimation of actions to either 'pump' or 'dump' respective stocks within each sample. Data were obtained from Thomson Reuters Eikon. The target sample is first presented to be compared with the average data of the comparable control sample. Further examples of such scenarios are available for each case from the authors upon request.