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The effect of information-sharing within online forums on investor behavior: Evidence from GameStop.

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Abstract:

This dissertation research aims to examine the effect of information sharing within online forums, as well as through meme posts, on trading volume of particular stocks. The focus is on the GameStop short squeeze which led to a price bubble, due to the coordinated action of online investors communicating in a subreddit. An event study model is deployed to test the effect of popular meme posts on stock returns, while an OLS regression is conducted to examine the impact of subreddit activity on trading levels of stocks. The results indicate that there is an effect of meme posts for abnormal stock returns, while the findings of the OLS regression suggest that there is evidence of online activity impacting trading level of stocks. It is argued that misinformation in the discussions of the subreddit led to the mass short selling of online investors, due to the involvement of multiple users and the use of memes posts to share information. The implications of this study are the difficulty to capture all unobserved factors related to the online community of Reddit.

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1. Introduction

In the first months of 2021, the price of GameStop stocks (GME) increased tremendously, going from 17$ per stock in December 2020 to 483$ per stock by 28 January 2021, creating a short squeeze on the stock (Lyócsa et al., 2021). This incident was the result of a coordinated action by retail investors, communicated within a SubReddit forum, known as r/WallStreetBets (r/WSB). The increase in stock price of GME led to the formation of a stock price bubble and, eventually, in the distortion of the financial stock market, making evident that the impact of online communication of investors is not trivial. Communication by interacting in online social networks, such as Reddit, is a contemporary instrument for sharing financial information, compared to more traditional tools such as financial articles or newsletters. Nevertheless, online social networks allow for different users to interact, meaning it is not possible to differentiate between professional traders and 'noise' traders. Noise traders are retail investors whose choices are not guided by fundamental knowledge about stocks but are rather driven by emotional or biased opinions (Gianstefanni et al., 2022).

The fast nature of information sharing makes it difficult to determine its credibility, implying that the identification between actual news and opinionated posts is challenging. Thus, this dissertation paper will examine the effects that online misinformation within the Reddit platform can have on stocks. Furthermore, this research is exploring the impact of meme posts on the stock price of GME. The case of GameStop is currently a prime example of the unforeseeable influence social media platforms can have on financial stock markets, with a number of online investors taking part in mass short selling of certain underrated stocks, namely AMC Entertainment (AMC), BlackBerry (BB), Nokia (NOK) and GameStop (GME) (Lyócsa et al., 2021). The challenging aspect of this research topic is that online platforms are very extensive, and misinformation can be presented in various forms, such as blogs, social media posts etcetera. Hence, long-term forecasts about financial markets are impeded due to the complexity of online platforms.

The study by Sornette (2017) argues that intensified cooperative speculation over a considerable time-period can distort stock markets by generating rapid rises in stock prices, also known as price bubbles. A stock price bubble is created when market participants drive stock prices above their actual value, which implies investments are conducted in an organized manner to keep the stock prices increasing. That said, the constantly increasing user activity the subreddit is associated with

the price bubble created for GME stocks (Pedersen, 2021). This connotes that online information sharing between noise traders can incite significant effects on a financial market mostly controlled by high-value stocks. Thus, examining any possible association between stock trading levels and growing attention in the Subreddit in the form of online activity is relevant for stocks markets, in terms of regulatory measures preventing these kinds of shocks.

The motivation behind the topic chosen derives from the empirical study by Gianstefani et al. (2022), which investigated into social network activity that could impact the stability of the stock market and, with the use of an event study, it analyses the effect of the activity on two meme stocks and two non-meme stocks. The findings suggest differences between meme and non-meme stocks, implying that there is an effect of intensified online activity on discussed stocks. This dissertation is following a similar approach to examining the effect of meme posts on the GME stock by conducting an event analysis.

The choice of examining meme posts will add value to the research, as the simplistic and humorous design of memes causes a difficulty to identify the notion of the information shared. Especially when considering financial information, like in GameStop, meme posts are instruments not frequently used before the emergence of social network platforms. Regarding r/WSB, information-sharing and individual opinions were communicated often through internet meme posts, which lead to a 'viral' information spread across different social media platforms and reach a larger user audience (Pedersen, 2021). Thus, it is difficult to understand whether the information shared within these memes are verifiable, leading to confusion amongst investors in the Subreddit. This information asymmetry would imply that the efficient market hypothesis does not hold, meaning that stock price changes are not reflected from the information available in the market.

Furthermore, it is important to obtain a better understanding of the relation between Subreddit activity and misinformation, considering meme posts as well. The empirical study by Pedersen (2021) examines the propagation and susceptibility to fake news in terms of different types of online investors, while also looking into the case of GameStop. The findings indicate that individuals with fanatic views are more prone to generate fake news, while fake news sharing is on relatively high levels for all categories (Pedersen, 2021). This would imply that the effect of fake news on investor behaviour can be explained by looking into different aspects of fake news related to the GameStop short squeeze. Amplified levels of information-sharing between noise

investors in the Subreddit, as well as the unconventional method of exchanging insights through memes, suggest that the discussions and coordinated actions within the online forum were not entirely driven by knowledge of the stocks, but rather by biased opinions about the financial stock market. Therefore, this research will focus on the effect of misinformation, also through the circulation of internet memes, on investor behaviour and attempt to gain some further insights on the GameStop occurrence. Hence, the Research Question of this dissertation is formulated as following:

Research Question: "How does information-sharing through Subreddit forums, and meme posts, impact investor behaviour towards particular stocks?"

2. Literature Review

In this section, the supporting literature of the dissertation study will be presented, along with the hypotheses that are formulated.

2.1 Background information

In order to understand what the research question examines, it is important to consider some background information on some aspects that could have impacted the GameStop stock price. Note that this section will serve to illustrate the context of this research, thus will not be analysed further.

Firstly, understanding the mechanism behind Reddit's platform will aid to explain better the information-sharing involved. Reddit is a social network consisting of user-generated content and topic-based discussion threads. Content is categorized into subreddits, topic-based communities that users can subscribe to. Users can comment on posts and create discussions and can gain 'upvotes' or 'downvotes'. The score created between the two types of votes decides the post's exposure on the platform, meaning that the higher the popularity of the content, the higher the number of users it is shown to (Gianstefani et al., 2022). r/WallStreetBets is one of the most active Subreddits, with discussion circulating around the financial stock market and trading strategies. What is prevalent in the discussions of this forum are disruptive strategies, as highlighted by the short-squeeze on the GME stock price.

Numerous FinTech companies manage to operate in stock market trading and to alter the regulatory landscape of financial markets, with some growing their organization substantially in a short amount of time (Phillips & McDermid, 2020). GameStop is one of the market leaders in retail of video games and accessories. In 2017, however, the American-based company's decline began, as downloadable versions of many games emerged, and consoles offered additional services. Hence, a significant decrease in stock price was the result of reductions in sales. The COVID-19 pandemic is another factor that severely impacted GameStop's operations, leading to a large number of institutional investors undervaluing GME stocks (Pedersen, 2021).

The empirical research conducted by Cahill et al. (2021) analyses the influence the prolonged lockdowns have had on trading activity, in terms of volatility and volume. The findings connote that investing activity has significantly increased through the use of online trading platforms, most

notably in regions with high percentages of young population and in regions with elevated proportions of individuals not working from home prior to the COVID-19 pandemic (Cahill et al., 2021). This could provide insight to explain the GameStop short squeeze, as the massive price increase in the stock occurred in the beginning of 2021. The subreddit participants have expressed a preference for one particular online trading platform which experienced great success during the pandemic as well, namely Robinhood. The online brokerage company is established on the business objective to provide easier and less costly access to small investors to participate in the retail stock market (Welch, 2020). Mobile-accessible user interface and other small technological innovations lead to mass customer appeal for the company's services, which resulted in 13 million investors engaging in Robinhood by mid-2020 (Welch, 2020). Therefore, it can be understood that online trading platforms give easy access to a large audience, which could provide insight on the increase of the GameStop stock price.

2.2 Memes on investor behavior

2.2.1 Misinformation in meme posts

In order to examine the meme-investor behavior relationship, it is important to consider the extent of information-sharing meme posts can possess. In social media, nowadays, there are numerous ways to share ideas and knowledge, through written posts, videos, memes etc. This would, nevertheless, imply that detection of online misinformation is more complex. Memes are the social media posts that will be examined, due to their simplistic design and fast transmission across all social media. The information shared are easily assimilated by its viewers due to memes' visual component (Ireland, 2018). The rapid spread across social platforms causes difficulties in verifying the true value of the memes posted, which in turn generates misinformation (Qazvinian, 2011). Thus, it is evident that meme posts are designed to transmit short amount of information and are more prone to reach 'viral' attention levels. Furthermore, Mihailidis & Viotty (2017) describe memes as social media instruments that intensify the information shared, as users have the capability to shape and express their own ideologies around an issue. This would imply that memes' user-friendly design and accessibility can be exploited by certain users who intend to share

misinformation to others. The study by Dupuis & Williams (2019) suggests that social media posts, particularly memes, do not generate misinformation because of malicious behavior by certain individuals, but mainly due to ordinary online users who spread misinformation without detecting it. This would imply that fast-paced online exposure of a meme in different social media applications is what makes memes a social media instrument prone to generating misinformation.

Upon inspecting the internet memes shared within the r/WallStreetBets, it is apparent that, regardless of the information shared, the context of the internet memes is humorous. The conception behind the internet memes, however, is one-dimensional; the meme posters either criticize the objective and meaning of r/WSB or are disregarding everyone who criticizes the group. The study by French (2017) examines the presence of memes in online textual communications and how the use of such an unconventional way of conversating can generate certain sentiments to the users. This would imply that user communication through internet memes is an untraditional method and can have an impact on individual behavior. There is some debate on this topic, nevertheless, that argues that there is no notable evidence that investor sentiment could influence the predicted outcomes of stock prices (Kim, 2014).

2.2.2 Meme posts on stock price fluctuations

The empirical study by Corbet et al. (2021) examines distortions in the functionality of stock markets in relation to the increasing use of online forums and internet memes. The results suggest that the emergence of modern methods of expressing ideas, such as memes and sarcastic GIFs, could explain the corporate instability features for some of the mentioned stocks (Corbet et al., 2021). This would connote that comments and shares of internet meme posts could play an important role, as they amplify the information shared within the memes. The research conducted by Behrendt & Schmidt (2018) raises countering arguments against this, claiming that forecasting performance of stocks is not enriched by the inclusion of Twitter sentiments and activity. The argument is that up-to-date investors with access to such data are not affected by intensified spread of information within the social platform. This suggests that experienced investors are less prone to altering their behavior towards the large influx of information, however the recent introduction of trading platforms allow less experienced online investors to also participate in the stock market.

Hence, the influx of meme posts in r/WSB concerning the short-selling action taking place created this sense of optimism, which was further highlighted by inexperienced retail investors.

Moreover, the empirical study by Gianstefani et al. (2022) analyses the intensified Subreddit activity of r/WallStreetBets and the reaction of financial markets. The approach was to regard two stocks that have been heavily discussed within the meme posts and two stocks that have not been discussed in the Subreddit. The discrepancies between meme stocks and non-meme stocks suggest that the coordinated action by online investors can significantly distort the financial market by creating abnormal returns for the meme stocks (Gianstefani et al., 2021). This would imply that meme posts can be used to spread information in accelerated pace and result in an organized attempt to keep the stock prices high to distort the market. There are other studies, nevertheless, that do not find strong evidence associating online platform posts and stock prices. The empirical research by Klaus (2021) explores the effect on stock returns of companies listed in the Chinese stock market by several tweets made by Trump about China, conducted in an event study. The results claim that there is no evidence of a significant impact on the index companies. It is clear that research has not reached defining conclusions on the new approach of communication of financial information via online social platforms, and the effect it may have in the stock market.

The research made by (Lasek, 2016) conducts a sentiment analysis on certain news in relation to the performance of certain stocks. The findings illustrate that investor sentiments are an unobserved aspect which has a prominent impact on stock returns (Lasek, 2016). This would connote that investor sentiments created by exposure to memes posts affect price fluctuations for the GME stock, and therefore impact company returns. Hence, the first hypothesis of this report is formulated as following:

H1: Abnormal returns for the GME stock increase(decrease) in the presence of positive(negative) memes in r/WallStreetBets.

2.3 Subreddit activity on trading volume of stocks

2.3.1 Misinformation in r/WallStreetBets & investor sentiments

There has been research previously conducted on the impact of misinformation on operations of financial markets, and more specifically on the analysis of investor behavior. The empirical paper by Kogan et al. (2018) examines the effect of online publications of financial articles containing fake news. The findings connote that 'fake news' articles mentioning certain stocks result in significant increase in trading levels and high price volatility of the mentioned stocks (Kogan et al., 2018). There is large body of evidence supporting this, as the investor reaction to misinformation is mostly associated with an inconsistent increase in stock prices under irrational optimism (Ahsan et al., 2013; Kogan et al., 2018; Pedersen, 2021). Nevertheless, it is important to examine different aspects of investor behavior. Regardless of the investor sentiment involved, stock prices substantially react to publication of rumors, with abnormal returns being significant in the presence of bullish sentiment (Xu et al., 2020). This would indicate that optimistic notions expressed by online investors play a role in determining stock price fluctuations.

Furthermore, the research conducted by Clarke et al. (2020) makes a comparison between the effect on investor behavior under fake news and under real news. Even though the results propose that online investors are not able to detect misinformation, the comparative analysis argues that the investor reaction, meaning the stock price volatility, is substantially less for fake news, compared to real news (Clarke et al., 2020). The circulation of news between users has certainly been affected by the emergence of online communication platforms. Most current media mechanisms promote information-sharing methods that restrain greater critical thinking (Yoo, 2007). This would indicate that despite the use of social media accelerating distribution of information, it challenges the extent to which this information can be processed. The study by Allcott et al. (2019) examines the spread of misinformation across different social media platforms and argues that since the introduction of a misinformation detection mechanism in Facebook, there has been an increase in online engagement on other platforms, such as Twitter. This would connote that individuals attempting to influence others are likely to switch media platforms in order to continue spreading misinformation. Therefore, the creation of certain sub-groups within some social media, such as 'Subreddits', plays an important role in the way misinformation reaches mainstream media platforms (Zannettou et al., 2018). As discussed, the mass short selling

coordinated by users of r/WallStreetBets who had the intention of disrupting the financial stock market. The magnitude of the mass short selling could have convinced many inexperienced investors to join in search of profitability. Hence, the intentions of the main moderators behind the coordinated move and the intentions of inexperienced investors are not aligned, due to the biased information shared within the subreddit.

2.3.2 r/WallStreetBets activity on trading volume of stocks

Furthermore, it is important to regard the effect subreddit activity can have on trading volume of stocks, implying the number of posts and comments made in r/WSB, regardless of if users being subscribed to the subreddit. The study by Gao et al. (2018) explores the impact of online investor attention on the stock market of China. The findings indicate that online investor attention can speed up the pace of information diffusion, which is found to be a valid determinant of stock markets. This is further supported by the research conducted by Rao et al. (2012), which examines the relation between stock prices and sentiments expressed via discussions in Twitter. The outcomes indicate that the movement of stock prices and indices is substantially impacted by Twitter discussions involving multiple users. This would further support that enhanced online activity in social platforms, as is Reddit, can have an effect on the trading levels of stocks. As mentioned, the most discussed stocks in r/WSB are AMC Entertainment (AMC), BlackBerry (BB), Nokia (NOK) and GameStop (GME), low-rated stocks which the online investors hope to change with their short-selling activity, which increases the stock price (Lyócsa et al., 2021). Hence, we assume that trading volume for discussed stocks has a positive relationship with the online activity in the subreddit in the form of posts and comments. Thus, the following hypothesis is formulated as following:

H2: User activity in r/WallStreetBets is positively related with the trading volume of stocks.

2.3.3 r/WallStreetBets subscriber count on trading volume of stocks

Reddit has a variety of subreddits, as it consists of user-generated content, thus it is sensible to consider the mechanism behind the online platform. One popular metric calculated by Reddit is the subscriber rank, used to draw comparisons between the different subreddits. The higher the

number of subscribers, the lower the rank, and therefore, the higher the popularity of the community (See Appendix). This indicates that the number of users subscribing to a subreddit, the higher the exposure it receives within the Reddit platform, as it is the case for r/WSB. The discussions of this community, nevertheless, involved information sharing about the stock market, with the purpose of coordinating the short selling that retail investors engaged in.

Empirical evidence suggests that there is a positive association between abnormal return of stocks and the growth of online community subscribers, with millennial meme-stocks being of great importance on the disruption of stock market functionality (Corbet et al., 2021). Hence, the creation of sub-groups allows for individuals who share certain values and beliefs to assemble in one platform and communicate their opinions unreservedly. The rapid emergence of the subreddit group in the end of 2020 indicated larger participation for the coordinated attempt the users opted to achieve. This would suggest that the growing number of subscribers could be associated with the significant increase of the trading levels for the discussed stocks. Trading volume for the discussed stocks would be affected by subscriber count since it increases the exposure of the community within the platform. Hence, the last hypothesis is formulated as following:

H3: The number of subscribers in the r/WallStreetBets are positively related with the trading volume of stocks.

3. Methodology

In this section, the formulation of the dataset and the empirical methodology are discussed. First, we elaborate on the steps of the event study and second, we explain the linear regression model approach.

3.1 Data

3.1.1 Financial Data

In order to create the time-series dataset, a series of financial data is collected from online financial datasets, such as CRSP and Compustat. The companies of focus are US-based corporations listed in the S&P500 stock market index, which are intensely discussed in the subreddit in the period 2019-2021. Trading volume, company returns and price per stock were obtained as the variables of focus, while shares outstanding, returns without dividends and returns on the S&P 500 index are used to control for the stock market the stocks are listed on. The stocks selected are the stocks of GameStop (GME), AMC Entertainment (AMC), Nokia (NOK), and BlackBerry (BB), since they are included in the most discussed topics in r/WallStreetBets' posts (Pedersen, 2021). Hence, for the OLS regression model, a panel dataset is formed. For the event study, only the GameStop stock was considered, as the meme posts selected express sentiments mainly about this stock. It also features in the most used keywords within the subreddit (Subredditstats.com). Thus, the second dataset is constructed using the same variables as previously, but only concerning the GME stock.

3.1.2 Subreddit Data

Data collection on meme posts used in r/WSB is done by data-scraping the subreddit, with a number of the memes presented in the appendix. The most popular memes were selected, with popularity measured with number of comments and upvotes. The counterfactual, in this case, implies that there is still information-sharing activity in terms of memes, however the extent of exposure received is not as notable. Other characteristics of the online forum, such as number of participants, posts per day etc. are also gathered using figures from Subredditstats.com, a database with a number of meta-data regarding all subreddits. All the variables considered in this research

are examined on daily data. The pace of information spread on online communication platforms is very fast, thus daily data would allow to capture the effect of the internet memes on the stocks more efficiently. This is the case since they are short intraday market information and were often contracted within a short time frame. The time period considered is 1/1/2019-31/12/2021, as the occurrence of the price bubble of the GME stock was relatively recent (Lyócsa et al., 2021).

3.2 Descriptive Statistics & Correlation Matrix

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
DataDateDividends	3028	22098.531	316.668	21551	22645
CashDividendsDaily	8	.165	.115	.03	.38
SharesOutstanding	3028	1.619e+09	2.339e+09	51744000	5.675e+09
TradingVolumeDaily	3028	24400289	60410028	545961	1.217e+09
CurrentEPS	2720	-5.35	8.934	-39.15	.91
PriceCloseDaily	3028	22.127	48.144	1.98	347.51
PriceOpenDaily	3028	22.25	48.673	1.99	379.71
StockExchangeCode	3028	11	0	11	11
WSBsubscribers	2772	4124715.5	4525768.2	458375	11409790
Commentsday	2640	23372.808	34993.707	37	394280
Postsday	2412	782.484	3271.348	3	68250
ReturnontheSP500In~x	3028	.001	.014	-.12	.094
ShareVolume	3028	24617491	61521524	545961	1.253e+09
ReturnswithoutDivi~s	3028	.004	.093	-.6	3.012
compid	3028	2.5	1.118	1	4

Table 1: Panel dataset summary of statistics

As shown in Table 1, there are 3,028 statistical observations in the dataset on a daily level. When drawing a comparison between the minimum and the maximum values of the variables concerning r/WallStreetBets, the magnitude of the changes taking place in the time period considered are apparent. For instance, *Postsday* has a minimum of 3 daily posts, while the maximum is at around 68.000 daily posts, which illustrates the influx of users communicating in the subreddit, assuming that the minimum was dated in the beginning of the time period. The same comparison for some of the financial data, such as *ReturnswithoutDividends* and *PriceCloseDaily*, further supports the research focus of this analysis. There is a difference in the number of observations between the financial data and the subreddit data, which can be attributed to the different availability of data when selecting these variables. In addition, it is observed that for several variables the standard

deviation is larger than the mean, implying a high within variation and a non-normal distribution of the data across time. This supports further the association examined in this research between trading volume of the stocks and r/WSB user activity.

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) TradingVolumeD~y	1.000					
(2) Commentsday	0.540	1.000				
(3) Postsday	0.562	0.774	1.000			
(4) PriceCloseDaily	0.014	0.166	0.145	1.000		
(5) WSBsubscribers	0.290	0.358	0.181	0.473	1.000	
(6) Returnswithout~s	0.376	0.231	0.485	0.070	0.023	1.000

Table 2: Correlation Matrix between variables

In order to further examine the dataset selected, it is relevant to explore the correlations between the variables of interest, to check for any relationship that could skew the outcomes of the models selected. As shown in Figure 2, the correlation between the independent and the dependent variable is positive, implying that all variables selected can explain the variation in trading levels of stocks. Daily comments (*Commentsday*) and posts (*Postsday*) indicate to have a strong correlation with trading volume (*TradingVolumeDaily*), which can be evidence of an effect of the subreddit activity on stock trading levels. It is evident, however, that the correlation between *Commentsday* and *Postsday* is very strong, signifying a serial correlation between the two variables, which could endanger the accuracy of the empirical results later on. Therefore, I decided to create an interaction variable between the two, which would represent the amount of online activity r/WallStreetBets receives over time (*WSBactivity*). Additionally, *PriceCloseDaily* is stronger related with *Commentsday* and *Postsday* rather than *TradingVolumeDaily* or *ReturnswithoutDividends*, implying that subreddit activity could explain the price fluctuations experienced for the stocks selected. *WSBsubscribers* illustrates also a strong correlation with the dependent variable, but not as strong as the correlation of *Commentsday* and *Postsday*.

3.3 Event Study

An event study measures the economic impact of an event on a certain value of a firm (MacKinlay, 1997). In this study, the research is whether a popular meme post influences the stock prices of GameStop, and therefore affect the company's returns. With the event study we analyse whether there is an abnormal return. The abnormal return can be defined as the difference between the actual return and the approximate return without the presence of an event (MacKinlay, 1997). Hence, the variables selected for this model are the events and cumulative abnormal returns, calculated using company returns without dividends computed below (Section 3.3.3). In this dissertation we will use the 7 steps which researchers Fama et al. (1969) have composed for executing an event study, these steps are depicted in Figure 1.
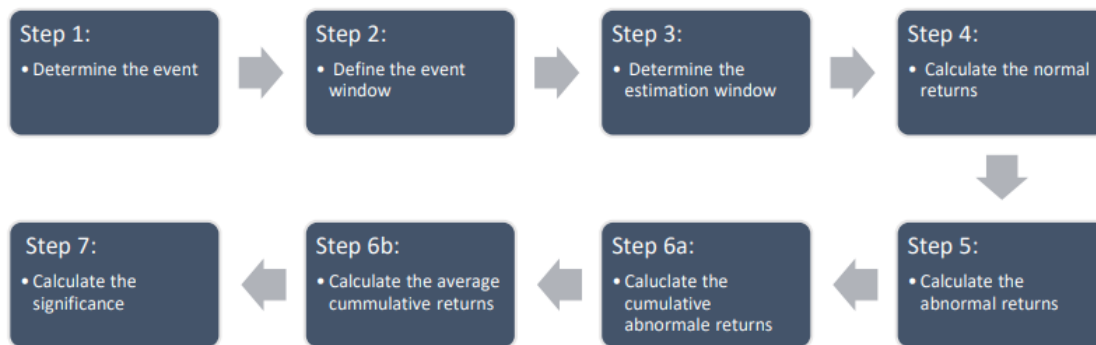

Figure 1: The 7 steps of an event study Fama et al. (1969)

3.3.1 Meme Events

The first step would be to determine the events. As this research focuses on the impact of meme posts of r/WallStreetBets on stock prices, the events would be the subreddit posts with the memes that managed to get the biggest exposure in the subreddit. The popularity of these posts is measured with regards to the number of comments and upvotes each meme received since its original posting date. The more comments and votes a meme post receives, the greater the exposure within the platform, which is one of the most common metrics used by social networks. I proceeded by selecting the meme posts that would have the most prevalent association with the GME stock. Since I did not have access to a keyword tool which would allow to extract the main context of each post, I will make use of my own judgement to define the notion expressed by these memes.

Future research can use a keyword tool to avoid biased interpretations; however, a keyword tool was beyond the scope of this research dissertation. Visualization of the meme posts and their comments is available in the Appendix.

The classification will be binary, meaning that the meme posts and comments will either express a positive or a negative sentiment towards the GME stock. Positive sentiments are perceived as optimism about price fluctuations of the stock, while negative sentiments are perceived as pessimism towards the price stability of the stock. The first meme post is perceived to express a positive sentiment regarding the rising stock prices, as it portrays a movie scene from the popular "The Matrix" movie franchise, edited so that the short video is related to the stock price bubble incident. The short video together with the editing illustrates a sense of teamwork and unity amongst all investors involved, while displaying heroism against Wall Street (Appendix 8.1). The second meme post, however, is perceived to have negative sentiments towards the coordinated action of the subreddit. The post, again, is a combination of a short movie scene and editing, indicating the prevalent price fluctuations of the GME stock and the panic of inexperienced investors. This connotes a feeling of pessimism towards the outcomes of the price bubble, while the majority of the discussion taking place in the comments raised doubts about the judgement of the movement (Appendix 8.2).

The third meme, posted after the stock price of GameStop decreased significantly, illustrates an image of a very luxurious car with r/WallStreetBets stickers on it. This would suggest that one investor involved in the Subreddit has managed to acquire wealth, thus expressing a positive sentiment. The comments imply a sense of optimism about the stock price of GME and the objective of the Subreddit (Appendix 8.3). Lastly, the last meme post is perceived to express a negative opinion regarding the GameStop stock, as it intends to illustrate the magnitude of losses incurred by the decrease in price. The comments involve humorous and non-humorous content mainly providing criticism regarding the coordinated action in r/WallStreetBets (Appendix 8.4).

3.3.2 Event Windows

The second step is to define the right event window for our study. Brooks (2019) claims there are several different approaches when considering the event window. Specifically, for daily observations his suggestion would be an event window range between 100 to 300 days, while for instance yearly data could cover a longer event horizon. Due to the nature of my events being a subject of internet information spread, it is difficult to capture the surprise factor of the memes. Hence, I will follow a similar approach to Klaus (2021) by deploying two variations for comparison of the potential surprise factor within the Subreddit. This would imply that initially a 10-day pre-event and post-event window would be considered (Mac Kinlay, 1997), which would result in 84 observations per meme. Afterwards, I will re-run the analysis by adjusting the window to 5-day pre-/post-event window. This will reduce the sample considered to 42 observations to compute returns.

The idea behind deploying two different event windows is that the vast majority of event studies are conducted on known financial events (i.e. dividend days, realized earnings announcement). Since Subreddit posts are created without pre-announcement and spontaneously shared in the platform, it is appropriate to test for a degree of 'surprise' effect from a meme (Klaus, 2021).

The third step is determining the estimation window. The estimation window is used to make an approximation of the returns under the assumption that there would not have been a surprise announcement. The study by Hall & Weiss (1967) concluded that any estimation window longer than 100 days will be a good benchmark since this length of time captures all the information. However, due to the event dates selected being in close proximity of each other, I decided to use a shorter estimation window of 60 days. In Figure 2, the timeline is depicted which will be used in this paper.
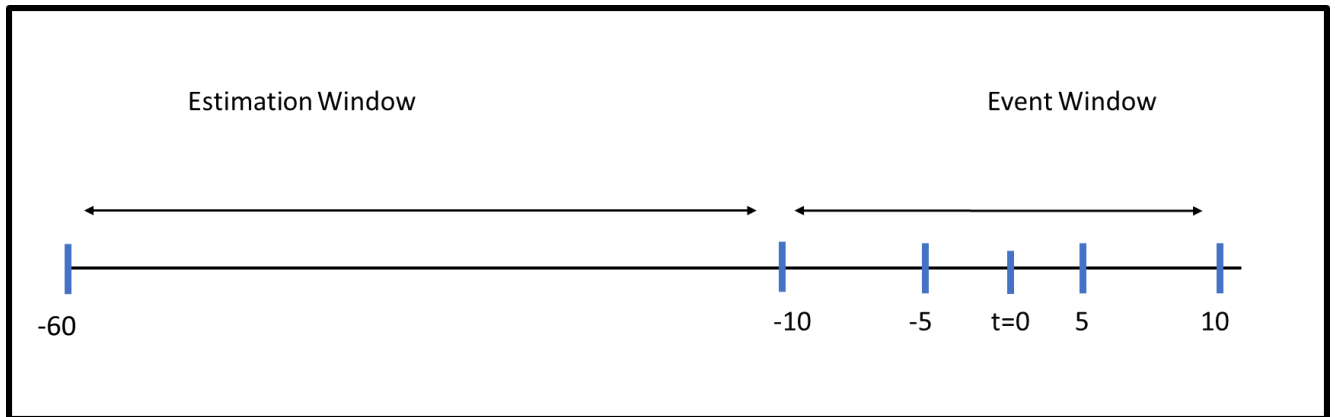
Figure 2: Timeline of the event window

3.3.3 Estimation of the AR and the CAR

The fourth step is to calculate the normal returns. Normal returns are computed using the market model, as it includes the assumption that the relationship between the security and the market return is linear (MacKinlay, 1997). Hence, the market model is formulated as follows:

$$R_{it} = \alpha_i + \beta_i * R_{mt} + \varepsilon_i \quad\quad (1)$$

Where

R_{it} = the normal returns of a security i on time t

α_i = the constant of effect i

β_i = the sensitivity of the stock relative to the market.

R_{mt} = the return on the market index S&P500 on time t

ε_{it} = the error term of security i on time t

Since all data considered are on a daily level, we calculate the daily returns of the individual stock as follows:

$$Daily\ return_t = \frac{closing\ price_t - closing\ price_{t-1}}{closing\ price_{t-1}} \quad\quad (2)$$

We continue to the next step by calculating the abnormal returns. The standard approach is the actual returns minus the normal returns (MacKinlay, 1997)(3). We are using, however, the market model, so the formula has to be altercated to stock returns minus the return to the index (4). Stock returns are defined as the realized returns of the stock and the index return as the realized return on the S&P500 market index. Parameter β represents the sensitivity of the stock compared to the market portfolio.

$$Abnormal\ returns = actual\ returns - normal\ returns \tag{3}$$

$$Abnormal\ return\ market\ model = Stock\ return - indexreturn * \beta \tag{4}$$

The sixth step is to calculate the cumulative abnormal returns (CAR), which implies the sum of the abnormal returns over the whole time period (5). In addition, the average cumulative abnormal returns (CAAR) can be estimated, as shown in Model 6. It would be expected that the emotional valence associated with the set of memes would match with company returns (Sul et al., 2017), meaning for a meme post with a positive sentiment we would expect an increase in CAR.

$$CAR = \sum_{i=1}^{N}(AR) \tag{5}$$

$$CAAR = \frac{1}{N}\sum_{i=1}^{N}(AR) \tag{6}$$

The final step is to use a statistical t-test. In this way, we can test the null hypothesis and determine whether CAAR differs significantly from zero. A 95% confidence interval is used with a critical value of 1.96 (Kwok & Brooks ,1990).

$$T - statistic = \frac{CAR_t}{V_t} \tag{7}$$

3.4 Linear Regression model

In order to examine Hypotheses 2 and 3, we use the ordinary least square regression (OLS) to estimate the impact user activity in r/WallStreetBets has on the trading volume of the aforementioned stocks. Subreddit activity is difficult to apprehend, thus daily posts and comments are used as a proxy, with number of subscribers accounted as well to control for confounding effects that may be associated with the subreddit group. After checking the correlation between daily comments and daily posts in r/WallStreetBets, it is observed that the two variables are highly

correlated between them. Thus, it would be sensible to create an interaction between the two (*WSBactivity*), in order to eliminate bias. Moreover, the logarithmic transformation of both the dependent and independent variables is considered, as it is effective with normalizing the data and with removing exponential variance in the panel dataset. Theory suggests that the logarithmic return has preferred statistical properties (i.e. mean reversion). It is expected that there would be a positive association between the two variables. Hence, the first model is formulated as following:

$$\log(Trading\ Volume) = \beta_0 + \beta_1 \log(WSBactivity) + \varepsilon_\iota \qquad (8)$$

Furthermore, several other control variables are added in the context of the stock market the companies are listed in, so that the precision of the analysis is improved. Close price per stock and returns on the S&P500 index for each company are considered as major determinants when analyzing financial stock markets, as they can indicate the magnitude of firm operations (Shafi, 2014).

$$\log(Trading\ Volume) = \beta_0 + \beta_1 \log(WSBactivity) + \beta_2(Return\ on\ the\ S\&P500\ index) +$$
$$\beta_3(Close\ Price\ per\ stock) + \varepsilon_\iota \qquad (9)$$

In addition, number of Subreddit subscribers is included to test Hypothesis 3, as well as returns without dividends and shares outstanding, which denote valuable characteristics for firms in the stock market, as it could possibly explain trading patterns for their respective stocks (Shafi, 2014). With the inclusion of the control variables, I would expect the relationship between trading volume and r/WSB activity to remain positive, but possibly less strong, due to other variables explaining the stock market environment. Regarding the number of subscribers, a positive effect on trading levels of stocks is expected. Hence, the final empirical model is formulated as follows:

$$\log(Trading\ Volume) = \beta_0 + \beta_1 \log(WSBactivity) + \beta_2(WSBsubscribers) + \beta_3(Shares\ Outstanding) +$$
$$\beta_4 \log(Returns\ without\ dividends) + \beta_5(Return\ on\ the\ S\&P500\ index) + \beta_6(Close\ Price\ per\ stock) + \varepsilon_\iota$$
$$(10)$$

3.5 Robustness Checks for OLS

To ensure robustness of the models, the OLS regression is analyzed in terms of omitted variables and heteroskedasticity, as statistical theory suggests that homoskedasticity and no perfect collinearity are two fundamental assumptions that need to hold for OLS validity. Both tests are conducted using STATA.

Ramsey RESET test using powers of the fitted values of lnTrading
    Ho: model has no omitted variables
        $F(3, 791) =$ 31.64
         Prob $> F =$ 0.0000
Table 3: RESET test on Model 10

The Ramsey RESET test is used to account for model misspecifications by testing for patterns in the residuals. The RESET test is a functional form test which has proven to be a useful tool for detecting for linear regression specification errors (Wooldridge, 2014). The results of Table 3 indicate that the test rejects the null hypothesis with a F-statistic of 31.64, meaning that the model suffers from omitted variable bias. This implies that unobserved characteristics could explain the variation within the estimates. The nature of social networks as information-sharing tools is arguable to this day, thus is it understandable that the model cannot control for all variables in the platform. Lack of data availability on Reddit could explain the omitted variable bias shown. Future research can try to assemble more factors that could have a relation with the Reddit social network.

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
    Ho: Constant variance
    Variables: fitted values of lnTrading
    chi2(1)   =   31.90
    Prob $>$ chi2 = 0.0000
Table 4: Cook-Weisberg test for heteroskedasticity on Model 10

For heteroskedasticity, the Breusch-Pagan / Cook-Weisberg test is selected. The test examines the variance of the dependent variable (*lnTrading*) on Model 7. The null hypothesis implies that there is constant variance for the dependent variable, therefore there is homoskedasticity. If variance is homoscedastic, the variance of each observation is approximately the same fitted value, hence there would be uniform variance (Wooldridge, 2019). As displayed in Table 4, the test rejected the

null hypothesis with a F-statistic of 31.90, meaning that there is heteroskedasticity in our regression model. This challenges the variation captured within our model, thus the precision of the estimates. A method to fix heteroskedasticity is to use a weighted regression or fitting a GARCH model. This would assign a weight to each data observation based on the variance of its fitted value (Wooldridge, 2019). Nevertheless, the weighted regression model is beyond the scope of this dissertation research. A GARCH model is not appropriate, as the GME model results in a too flat log-likelihood. Future research should consider the possibility of adopting the weighted regression model to ensure more robust estimates.

4. Results

In this section, the results obtained from the empirical analysis are discussed. Two event study models were used with different event windows, since the events considered are not by nature conventional financial events, but rather online activity. The comparison between the results of the two models will allow for further understanding of the effect on the prices per stock in the presence of memes. In addition, a linear regression model is conducted in order to examine the relationship between subreddit activity and trading volume of the stocks, as well as the effect of r/WallStreetBets subscriber count.

4.1 Event Study

In the following section, the results of the Event study models will be analysed. The meme event set remains unchanged while deploying two different event windows, which will help to draw comparisons for the discussion section. The event study is conducted in the form of a panel data analysis in STATA. The code used for programming the model follows the event study methodology of Ullah et al. (2021). Abnormal as well as cumulative abnormal returns are estimated for the stock of GameStop.

4.1.1 Subreddit meme mapping

Memes are utilized as means to express elicit humour about relevant topics of discussion, which would result in information being spread as well (Mihailidis & Viotty, 2017). Therefore, it is necessary to identify the sentiment expressed in each of the chosen meme events in order to observe each effect on the CAR of the stock. Since the most popular and shared memes are all posted in 2021, I decided to examine the most popular meme of each quarter, in order to understand better the sentiment involved. As explained in the section 3.3.1, I distinguished each meme's content as either expressing a positive or negative sentiment, by using my own judgement, as shown in Table 5.

Meme Events

Events(Memes)	Sentiment	Company.
29/01/2021	Positive	GameStop
10/03/2021	Negative	GameStop
09/10/2021	Positive	GameStop
28/12/2021	Negative	GameStop

Table 5: Meme Events

The first meme event considered was posted on end of January of 2021, a period where the price per stock of the portfolio increased at tremendous levels (Cahill et al., 2021). The sentiment of the meme post is positive, expressing the unity of the subreddit against the 'big players' of the stock market, also indicated by the comments. The second meme was posted in March, when the price bubble of the GME stock burst, also indicated by the price fluctuation of the stock during that period (Long et al., 2021). The post and the comments expressed a sense of pessimism towards the mass short selling and raised doubts about the credibility of the information shared in r/WSB. The third post was shared in late October, displaying a photo of a luxury item with the logo of the subreddit, thus expressing a sense of optimism towards the coordinated action of online investors, Lastly, the sentiment of the last post shared end of 2021 is perceived as negative, indicated by the humorous connotation that the poster's trading wallet in Robinhood is empty. An illustration of all the meme posts selected, including comments, is shown in the Appendix. The stock of GameStop was the one considered, as I wanted to investigate the effect solely on one stock and GameStop is one of the most used keywords in the subreddit (Subredditstats.com).

4.1.2 Event Window [-10,10]

Event Study T-statistic

Events(Memes)	Sentiment	Company.	Coef.	T-test
29/01/2021	Positive	GME	2.183749	2.062374
10/03/2021	Negative	GME	-.2485394	-4.482774
09/10/2021	Positive	GME	-.085045	-.6558471
28/12/2021	Negative	GME	.0868008	.1436979

Table 6: Event Window= [-10,10]

Table 6 demonstrates the cumulative abnormal returns (CAR) estimates for the GameStop stock on the event dates when the most popular memes are posted in r/WallStreetBets. A graphical

representation of CAR over time is provided in Figure 3, see below. The results suggest abnormal returns are positive for the first event and negative for the following meme postings. This is not entirely as expected from the sentiments included on each event, however not all findings are robust. For the first meme post, which is also the most popular one in the subreddit, there is a positive CAR estimate for the GME stock, which is in line with the sentiment attached to the meme. The T-statistic is higher than the critical value, thus we can reject the null hypothesis that the CAR is different from zero and this finding is robust.
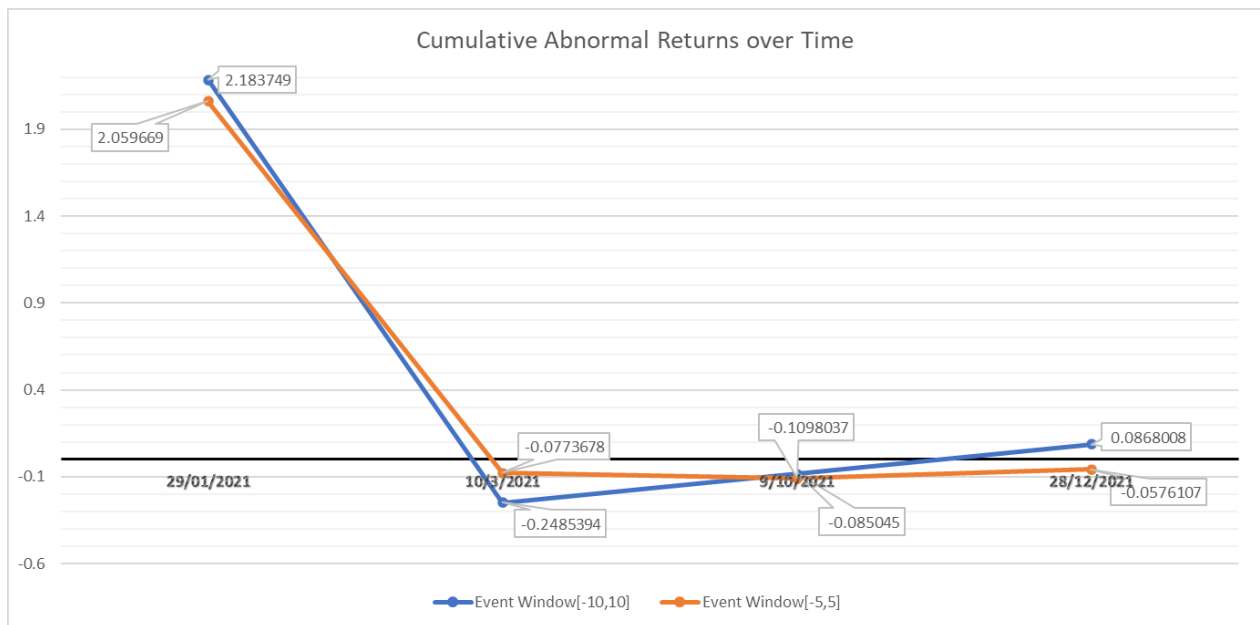
Figure 3: Time-Series Cumulative Abnormal Returns (CAR) of the two Event models

The second event, which is perceived as a meme post containing pessimism, shows a negative CAR significantly decreased compared to the first estimate. The T-statistic is larger than the critical value (in absolute terms), so it can be claimed that this finding is robust. Moreover, for the third event, which is perceived to contain positive sentiments, there is indeed an increase in CAR, but it is still negative. This would be in accordance with my expectations, as the CAR has increased significantly, compared to the previous event. The T-statistic indicates that this result fails to reject the null hypothesis, hence the finding is not robust. Finally, the last meme post considered contains a sense of pessimism, the CAR estimate is positive. This is not in line with my expectations, as

CAR increased compared to the last event. This finding, however, is not robust, as observed by the T-statistic in Figure 4.
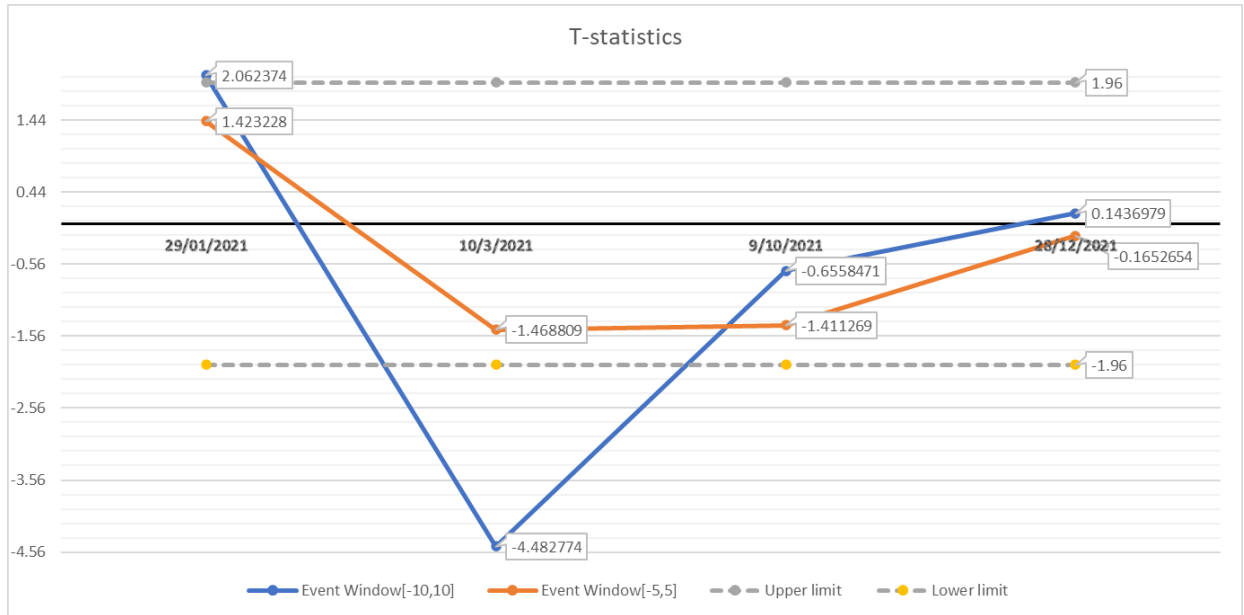

Figure 4: T-statistics for the CAR coefficients of Figure 3

As in most social online platforms, the dissemination of news within the Subreddit is of very fast nature, thus a number of memes posts gained attention. Therefore, it is difficult to translate the relation to the GameStop stock on daily data, as it also experienced several price fluctuations during the period of 2021. It is interesting to examine the results of the next section with a 5-day event window.

4.1.3 Event Window [-5,5]

Event Study T-statistic

Events(Memes)	Sentiment	Company.	Coef.	T-test
29/01/2021	Positive	GME	2.059669	1.423228
10/03/2021	Negative	GME	-.0773678	-1.468809
09/10/2021	Positive	GME	-.1098037	-1.411269
28/12/2021	Negative	GME	-.0576107	-.1652654

Table 7: Event Window= [-5,5]

The results of this model draw a similarity to the findings of Table 6, however none of these findings is robust. For the first event, there is a positive CAR for the GME stock, with a similar estimate to the results of the 10-day event model. This would suggest that indeed the sense of optimism and speculation within the Subreddit during the beginning of 2021 can be associated with significantly increased abnormal returns for GameStop, which would be in accordance with Pedersen et al. (2021). The following post memes considered shows a substantial decrease in the CAR, similar to the decrease for the 10-day window model. In the next meme post, however, a further decrease in CAR is observed, as shown in Figure 4. This observation is contrary with the previous findings of the 10-day window model, which would indicate that deploying a shorter event window could display more variation in the estimates and be more difficult to examine. This finding is not in accordance with the research by Oler et al. (2008), which claims that shorter event windows can provide better estimations for event study models on daily data. However, both these coefficients of CAR for that event are not of significant value. Finally, for the last event the CAR has somewhat increased compared to the previous event. Like the 10-day window model, this is not in line with my expectations. T-statistic values of the coefficients are large in absolute terms, but still insufficient to make any of these findings robust.

4.2 OLS Regression model

In this section, the results of the OLS regression models are examined. The first regression model accounts for the effect of subreddit activity on trading volume, isolating the effect to observe the relation between the two variables. Regression model 8 builds up by adding two control variables, to make the estimates more precise. Lastly, the complete regression model is examined, including all control variables related to firm characteristics and number of subscribers to investigate Hypotheses 2 and 3. This allows us to examine how strong the relationship between trading volume of stocks and subreddit activity is, as more related variables are added in the regression. As mentioned, the stocks considered for the OLS models are AMC, BB, NOK and GME stocks. The results are presented in Table 8. It is worth mentioning at this point that we had to include four decimal places for all the variables for the purpose of this analysis, as all the coefficients were very small.

Linear regression Model 8

lnTrading	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lnactivity	.314	.011	29.74	0	.294	.335	***
Constant	11.322	.161	70.34	0	11.007	11.638	***
Mean dependent var		16.061	SD dependent var			1.316	
R-squared		0.269	Number of obs			2408	
F-test		884.409	Prob > F			0.000	
Akaike crit. (AIC)		7405.785	Bayesian crit. (BIC)			7417.358	

*** p<.01, ** p<.05, * p<.1

Table 8: OLS Regression between subreddit activity and trading volume for the stocks

As it can be seen in Table 8, the results of the OLS regression in the first model suggest that a 1% increase in the user activity in the subreddit would result in a 0.31% increase in the trading volume of the stocks considered, ceteris paribus. This effect is statistically significant at a 1% confidence interval, which is evidence of the relationship between the two variables of interest. Compared to the coefficient of the constant term, the effect of subreddit activity on trading volume is not as notable, but it still illustrates evidence of a relationship. The low R-squared of the model would suggest that there is unexplained variation not captured in the regression, understandable as there are only two variables considered. The following step would be to include some of the financial data considered to observe the change in effects.

Linear regression Model 9

lnTrading	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lnactivity	.325	.016	20.56	0	.294	.356	***
PriceCloseDaily	-.005	.001	-7.59	0	-.007	-.004	***
lnReturns	.219	.028	7.96	0	.165	.273	***
ReturnontheSP500 ln~x	-17.881	3.54	-5.05	0	-24.826	-10.936	***
Constant	12.277	.295	41.58	0	11.697	12.856	***
Mean dependent var		16.141	SD dependent var			1.385	
R-squared		0.381	Number of obs			1140	
F-test		174.669	Prob > F			0.000	
Akaike crit. (AIC)		3439.365	Bayesian crit. (BIC)			3464.559	

*** p<.01, ** p<.05, * p<.1
Table 9: OLS Regression model with inclusion of control variables – PriceCloseDaily, lnReturns, ReturnontheSP500.

The outcomes in Table 9 suggest that a 1% increase in r/WSB activity increases trading volume by 0.33%, ceteris paribus. This effect is statistically significant at a 1% confidence interval. We can also observe negative effects from close price per stock and returns on the S&P500 index, with one additional monetary unit of stock returns to the S&P500 index decreases trading stock levels by - 99.9%[1], ceteris paribus. An additional monetary unit of close stock price decreases trading stock levels by 0.50%, ceteris paribus. Both these effects are statistically significant at a 1% confidence interval. This connotes that the change in coefficient for the effect of online activity can be attributed to controlling for these financial data. The R-squared has improved slightly due to the added variables but is still insufficient for the empirical model to be accurate.

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[1] $100 * [exp(-0.005) - 1]\%$
$100 * [exp(-17.881) - 1]\%$

Linear regression Model 10

lnTrading	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
lnactivity	.277	.013	21.80	0	.252	.301	***
SharesOutstanding	0	0	25.86	0	0	0	***
PriceCloseDaily	-.002	.001	-3.82	0	-.003	-.001	***
WSBsubscribers	0	0	12.50	0	0	0	***
lnReturns	.375	.023	16.57	0	.331	.42	***
ReturnontheSP500	-21.617	2.813	-7.69	0	-27.135	-16.099	***
ln~x							
Constant	13.087	.236	55.36	0	12.623	13.551	***
Mean dependent var		16.141	SD dependent var			1.385	
R-squared		0.611	Number of obs			1140	
F-test		355.631	Prob > F			0.000	
Akaike crit. (AIC)		2911.029	Bayesian crit. (BIC)			2936.223	

*** p<.01, ** p<.05, * p<.1*

Table 10: Final model of OLS Regression of Subreddit activity effect on the trading volume of the portfolio.

The complete model is constructed with the addition of several other variables, such as number of subscribers in r/WallStreetBets and shares outstanding. Hence, the results of Table 10 indicate that a 1% increase in the subreddit activity would result in a 0.28% increase in trading volume, ceteris paribus. The coefficients of the control variables denote that their relationship with the dependent variable is as suggested by Shafi (2014), thus are good indicators of the financial stock market. All estimates of this model are statistically significant at a 1% confidence interval. For the number of Subreddit subscribers, it is denoted that there is no evidence of an effect on trading volume of stocks. This effect is statistically significant at a 1% confidence interval. Hence, it cannot be claimed that there is evidence of an effect of the subreddit subscriber count on the trading levels of stocks.

Moreover, the outcomes suggest that a 1% increase in returns without dividends increases trading levels by approximately 0.38%, ceteris paribus. These findings would imply that there is evidence of an effect of stock returns on trading volume, indicating that it explains part of the variation not accounted for in the two previous OLS models. This is in accordance with the research by Shafi (2014), suggesting it is a good determinant of the stock market. For shares outstanding, the results illustrate there is no evidence of an effect on trading volume of stocks, ceteris paribus. The inclusion of this variable has improved with the variation of the model by improving the R-squared but shows no effect on the dependent variable. It is sensible to account for shares outstanding, as the focus is on trading volume of stocks, thus the inclusion of the variable helps with the improvement by accounting for additional variance in the model. Also, for one additional monetary

unit of stock returns to the S&P500 index decreases trading levels by 99.4%[2], ceteris paribus. Both these effects are statistically significant at a 1% confidence interval. The R-squared value is relatively high, which illustrates that the independent variables explain 61.11% of the variation in trading volume of the stocks. The standard error also indicates the precision of the estimates obtained. As discussed, the omitted variable bias observed has to be considered when analyzing the R-squared, meaning that there is variation in terms of the subreddit.

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[2] $100 * [exp(-21.617) - 1]\%$

5. Discussion

In this section, the findings of both the OLS regression models and of the event study models will be further discussed, while also considering supporting studies from the literature.

5.1 Meme posts on CAR

The findings of Tables 6 and 7 display the effect of popular meme posts on the cumulative abnormal returns of GameStop, deployed for two event study models with a 10-day and 5-day event window respectively. The results of both models illustrated initially a significant increase in CAR, followed by continuous decrease until the end of 2021, where there was a trivial increase in CAR. The results only of the 10-day window model, however, were robust. This would not be in line with the study by Oler et al. (2008), stating that having a shorter event window would show more significant outcomes on CAR. Therefore, for the first meme post considered, we can draw conclusions that following the post there was an increase in abnormal returns for GameStop. This finding would be in accordance with the study by Long et al. (2021), stating that abnormal return movement can be explained by a coordinated action by Subreddit users.

The findings of the second event (meme) post, which contained negative sentiments, show that there was a substantial decline in CAR following the posting date, which would be in accordance with the study by Gianstefani et al. (2022). This connotes that certain users might actively strive to create coordinated actions in order to influence the stock market by creating a number of opinionated posts. As discussed, the unconventional and humorous nature of memes makes it hard to identify them as carriers of information relatively to publicized financial articles, implying there is difficulty in determining the authenticity of information (Kogan et al., 2021). The following two events (memes) suggest a minor increase in CAR compared to the second meme post, as shown in Figure 6. This would not be as expected, as the negative sentiment of the fourth meme post did not decrease CAR but could be explained by the emergence of a new international lockdown in the end of 2021 (Cahill et al., 2021). Both findings of the last two meme events are not robust, so it can be argued that the estimates are not precise. The Subreddit includes other forms of posts not regarded in this analysis, such as daily discussion posts and earnings thread. Thus, it is not sensible to claim that the effect of meme posts on company returns can be isolated in an efficient manner.

Following the discussion of Hypothesis 1, this dissertation research answers the Research Question as follows:

The use of memes as means to share financial information creates a sense of exaggerated optimism/pessimism for online investors, due to their humorous design. This implies that users can make use of memes to share biased information and coordinate actions that would distort the financial market. Therefore. investor sentiments are enhanced in the presence of meme posts, which shows the effect on investor behavior, explaining the significant impact on stock returns (Lasek, 2016).

5.2 Subreddit activity on Trading volume

The findings from Table 8 illustrate a positive relation between trading volume for the portfolio of stocks and user activity in the subreddit. This outcome is in line with the study by Corbet et al. (2021), therefore, it can be argued that fluctuations in the trading volume across the time-period could be explained by the amplified online expression of opinions and information. The rapid nature of online activity makes it challenging for users to distinguish between unbiased news about the stock market and opinionated posts that intend to further support the mass short selling.

In addition, the complete model outcome shown in Table 10 illustrates a weaker effect on trading volume, but the R-squared would suggest that it is a more robust finding. Hence, the argument raised is that intense online activity and discussions about stock market information can attribute to changes in the trading volume of stocks. This finding would be in line with the supporting literature claiming that stock price fluctuations and trading activity can be explained by online discussions involving multiple users (Rao et al., 2012). Interestingly, the involvement of r/WSB in the GameStop stock price bubble was not solely done for profitability purposes, rather more aimed to cause disruptions in the stock market for the 'big players', meaning the stock market leaders (i.e., Apple). Hence, the ambiguous intentions of the multiple users sharing information in the subreddit illustrate that misinformation and over-optimism is the true cause of the mass short selling of the discussed stocks.

Furthermore, the findings of the model connote that there is no evidence of an effect of subscriber count of r/WSB on the trading volume of stocks. This would mean that the results are inconclusive and are not in line with the study by Corbet et al. (2021), which argued the positive association between forum participation and abnormal stock returns. The implication is that number of subscribed users does not show a significant impact on trading levels of stocks, compared to other online components, such as posts and comments. Hence, increase in subscribers can gain more exposure for a subreddit, but the online activity by already existing members of the community is what influences stock trading levels. In addition, the coefficient of returns to the S&P500 index suggest that there was a strong effect on trading levels of stock, which would further support that it is a good determinant of the stock market. This difference in outcomes could be credited on the significant growth of the Subreddit that I was not able to capture to its full extent. The accelerated influx of different posts placed in r/WallStreetBets makes it hard to capture the extent to which information has been assimilated.

Following the discussion of Hypotheses 2 and 3, this dissertation research answers the Research Question as follows:

The resilient postings and comments made by multiple users in r/WallStreetBets highlighted the coordinated action of the subreddit and led more investors to participate. Thus, the trading levels of the discussed stocks are impacted by the continuous user activity in the subreddit, which would explain the prominent increase in stock prices (Lyócsa et al., 2021). This would connote that particular stocks which could be the focus of online discussions in subreddit forums, would experience changes in trading volume and price, hence information-sharing through online forums should be considered as a determining factor for trading levels of stocks.

5.3 Limitations of the study

The main findings of this Master dissertation research concern the impact of Subreddit activity on the trading volume of a mentioned stock portfolio, as well as the impact of most commented memes on stock prices. The findings of the OLS model suggest that when information spread within the online platform was highly intensified, trading levels for the stock portfolio are positively affected. However, the robustness checks in the OLS regression challenge the precision of the estimates. The RESET test in Section 3.5 shows that there is evidence of model misspecification due to omitted variable bias. This would mean that the regression model does not account for all unobserved heterogeneity. Hence, it is sensible to assume that including more variables concerning the subreddit could provide more accurate estimates. Number of website visitors, for example, could lend better understanding of the information reach from the Subreddit, while also financial data such as dividends paid, and number of employees could further support the robustness of the results. However, certain data was not available on a daily level, thus not considered in the time-series. In addition, the Breusch-Pagan / Cook-Weisberg test shows that the variance of the dependent variable (*lnTrading*) is heteroskedastic, implying that the variation that the OLS model captures is not large. A possible solution to this problem is to use a weighted regression, with each observation being assigned a weight based on the variance of its fitted value. This model would, however, be beyond the scope of this research, so future research should consider using the weighted regression model. The choice of using daily data could be argued as well, as daily data have high variance due to intra-day variation. However, since the focus is on meme posts, which are frequently posted in online platforms, daily observations must be selected.

Another limitation of this study is that I made only use of meme posts for my research, whereas there are many different types of posts encountered in r/WallStreetBets. The other posts not considered in the event study could explain the variation of the outcomes, and thus challenge the accuracy of the estimates. Moreover, for the choice of the memes in the event study, I chose several of the most popular meme posts, in terms of upvotes and comments. The choice of the counterfactual would be dissemination of information in terms of memes, however the extent of exposure received is not as notable. This would mean that there still are memes being posted, but do not receive as many likes or comments. This is not a strong argument, as information diffusion for less popular posts is up for debate, since it cannot be easily observed. The use of more meme posts as events could identify more suitably an effect of meme posts on stock returns. Moreover,

the findings suggest that there is no evidence of an effect between trading volume of stocks and subscriber count of the subreddit. Inclusion of other types of users could capture better online activity in the subreddit. For instance, users visiting the platform without subscribing, posting, or commenting, still are exposed to the information shared, but are not easily detected. Future research should try to include more types of online users that visit the subreddit to better capture the exposure to information.

Another limitation faced in the study is the difficulty in estimating the attention some of the meme posts gained. Usually posts that contain visual content are re-shared within the platform, resulting in an echo-chamber effect of information within the subreddit. Hence, the memes selected could include more comments and information in other re-shared posts that are not as popular as the original post. Also, other social network platforms were not considered, such as Facebook, Instagram etc., where these memes could be re-shared. Reddit was only considered due to its division of topics into different forums. Future research could consider more social networks to capture the attention gained by posts more efficiently. Furthermore, what could help interpreting misinformation better would be to conduct a sentiment analysis. A sentiment analysis would illustrate the sense of optimism or pessimism expressed by the users' posts, meaning that it would be possible to examine the impact of user sentiments on the stocks discussed. Conducting this, nevertheless, would require me to switch programming languages and completely reshape my dataset, which is beyond the scope of this dissertation research. Thus, I opted to not to continue to that direction with my research. Future research could consider a sentiment analysis to provide further understanding on the topic. Another limitation of my research would be that the sentiment involved in the memes chosen was defined with regards to my own judgement. The use of a tool that can create key words from images could have been utilized to have a less biased sentiment. However, there was no access to such a tool that would be suitable for memes, thus I chose to use my own interpretation.

6. Conclusion

Reddit, and generally social media, nowadays is a powerful way to disseminate information and share opinions, without having to worry about the credibility of that information. This research yields empirical evidence that online activity in such platforms has an effect on trading levels of discussed stocks. This connotes that the vast amount of information being shared in a short period of time does not allow for online investors to distinguish between real news about the stocks and biased opinionated posts from users who strive to manipulate the stock market. Future research should examine different online social platforms sharing information about other stocks in order to gain further insights about online behavior of investors.

In addition, the OLS model illustrates the relation between trading levels of stocks and number of subscribers on r/WallStreetBets. The findings, nevertheless, are inconclusive so there is no evidence of an effect on trading volume in relation with the increased subscription. Instead, the number of online visitors on the platform could be considered for future studies in order to further investigate the actual information spread deriving from the Subreddit. With the use of the event study, I managed to examine the abnormal returns of the stock in the presence of several popular meme posts which included a certain opinion. Findings suggest that meme posts that expressed positive sentiments towards the rise in stock prices show to have a positive effect on abnormal returns. This would imply that the information- and opinion-sharing that took place in these meme posts could have created an exaggerated sense of optimism amongst online investors, who in turn chose to believe on the maintenance of the high price of the stock. Hence, this could explain to a greater extent the magnitude of this coordinated action within r/WallStreetBets and the relation with abnormal returns for the stocks considered. Future research could account for the use of a tool that identifies the mention of the company names and the nature of the opinion expressed about the company.

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8. Appendix

8.1 Meme Event 1

Post Date: 29/01/2021

Sentiment: Positive

Link:
https://www.reddit.com/r/wallstreetbets/comments/l7feld/its_power_to_the_traders_now/?utm_source=share&utm_medium=web2x&context=3

Comments for Meme post 1

opanaooonana · 1 yr. ago

"But honey, I know it could technically result in INFINITE losses but only a total retard would buy GME these days"- Gabriel Plotkin last month

592   Reply   Give Award   Share   Report   Save   Follow

DTX41 · 1 yr. ago

BITCH IM RETARDED

85   Reply   Give Award   Share   Report   Save   Follow

3 more replies

Nodder420 · 1 yr. ago   3   2   5

game stonk , power to the trader

12.5k   Reply   Give Award   Share   Report   Save   Follow

cesiumbathbomb · 1 yr. ago

WE LIKE THE STOCK

205   Reply   Give Award   Share   Report   Save   Follow

5 more replies

_jukmifgguggh · 1 yr. ago

trader is just retard mixed up

167   Reply   Give Award   Share   Report   Save   Follow

a_doom_squirrel · 1 yr. ago

You just added a fold to each of these apes brains

54   Reply   Give Award   Share   Report   Save   Follow

12 more replies

imti_space · 1 yr. ago   2

I've never traded stock. No idea where to begin. Somebody tell me how I can help bring down the fat pigs please

---

Sidebar

Tight-Station-8270   7
iDoctorBob   6
JUSTSAYING_5541   5
anotherspiff   3
Aggravating-Recipe66   3
TradeIdeas2020   3
madtendie   2

See All Heroes

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4. No Pump & Dump, Crypto Discussions, Schemes or Scams
5. Political Bullshit
6. No Advertisement, Self-Promotion, Fundraising, or Begging
7. No Bullshitting
8. Bad Positions Screenshot
9. No Brigading
10. No Social Media Posts
11. Don't Shit on the Community

DaTimeTravelersWharf · 1 yr. ago   2   3

Buy gme.

Not advice, just like the stonk

5.3k   Reply   Give Award   Share   Report   Save   Follow

Holybolognabatman   +1 · 1 yr. ago

This is a good stonk

2.5k   Reply   Give Award   Share   Report   Save   Follow

Bozdemshitz · 1 yr. ago

I Like This STONK

1.9k   Reply   Give Award   Share   Report   Save   Follow

WoodsAreHome · 1 yr. ago

You know what, I was looking at that stonk and I quite like it, so I bought some shares.

1.3k   Reply   Give Award   Share   Report   Save   Follow

dogeteapot · 1 yr. ago · edited 1 yr. ago   2

Ireland here proudly hodling my 0.82 stonks (on revolut) until I REACH URANUS/DIE

Disclaimer: I AM NEITHER THE WHOLE OF IRELAND NOR IS THIS ANY FORM OF FINANCIAL ADVICE I AM NOT A PROFESSIONAL BUT I AM A FULL BLOWN RETARD WITH DIAMOND HANDS

Edit: refrain from idolisation via rewards and inject said funds into the rocket booster system within the stonkery thamkemuverymuch

2.1k   Reply   Give Award   Share   Report   Save   Follow

fuzzybooks · 1 yr. ago   2   2   2

Aye. Top of the market to ya.

Moderators

Moderators

Message the mods

u/OPINION_IS_UNPOPULAR Rated 161660
u/CHAINSAW_VASECTOMY Get off my lawn
u/WallStreetBot BOT - Automod support
u/bawse1   Creator of WSBkid/Fuckboy ...
u/notmikjaash ususus
u/Plechazunga_ Help Computer
u/HellzAngelz His Royal Highness Sir Doctor Rev...
u/Stylux got his law degree at the good walm...
u/ThetaGang_wsb Lehman Brothers: Risk Mana...
u/Grumpy-james somethingbright

VIEW ALL MODERATORS

8.2 Meme Event 2

Post Date: 10/03/2021

Sentiment: Negative

Link:
https://www.reddit.com/r/wallstreetbets/comments/m27xop/gme_today/?utm_source=share&utm_medium=web2x&context=3

Comments for Meme post 2

mateotrujillowheeler OP · 1 yr. ago · *edited 1 yr. ago* 🐸

MEME CREDIT : u/positionsorban

OG MOD but banned with all the drama lately..

BIG THANKS FOR THE JUICY MEME ⭐

Twitter: wsbmod

2.3k   Reply   Give Award   Share   Report   Save   Follow

> **Alt_Panic** · 1 yr. ago
>
> Exit what who now?
>
> 428   Reply   Give Award   Share   Report   Save   Follow
>
>> **23x3** 🏅 +1 · 1 yr. ago
>>
>> Exit you do when done. This ride only begun.
>>
>> 263   Reply   Give Award   Share   Report   Save   Follow
>>
>>> **Thinkspeed_YT** · 1 yr. ago 🐸
>>>
>>> Your right on that, bought just before the dip like a true retard
>>>
>>> 134   Reply   Give Award   Share   Report   Save   Follow
>>>
>>>> **[deleted]** · 1 yr. ago
>>>>
>>>> Bought when I realized you retarded bastards were gonna do this shit again. Starting to realize this isn't just an investment anymore. Ready to milk these mfs for billions 💎🙌
>>>>
>>>> 144   Reply   Share   Report   Save   Follow
>>>>
>>>>> **highplainsdrifter__** 🏅 +1 · 1 yr. ago 🙈🙈
>>>>>
>>>>> took you long enough. now strap in, the stewardess will be around shortly with crayons to enjoy for the flight
>>>>>
>>>>> 124   Reply   Give Award   Share   Report   Save   Follow
>>>>>
>>>>> 6 more replies
>>>>
>>>> 3 more replies

---

therestruth · 1 yr. ago 💲

Dips in GME are just flash sales for a different level of idiots to hop aboard.

1.1k   Reply   Give Award   Share   Report   Save   Follow

> **OshQosh** · 1 yr. ago · *edited 1 yr. ago*
>
> Like this idiot who bought two more shares on the dip, *increasing* my share cost average, lol, after a month of trying to decrease it.
>
> 368   Reply   Give Award   Share   Report   Save   Follow
>
>> **therestruth** · 1 yr. ago · *edited 1 yr. ago* 💲
>>
>> I'm an idiot at multiple levels. I bought high, bought low, sold high, bought higher. Eventually I might sell it all super high but I still don't know what an exit strategy is until someone with deep fucking value let's me know.
>>
>> 201   Reply   Give Award   Share   Report   Save   Follow
>>
>>> **yzdaskullmonkey** 🏅 +1 · 1 yr. ago
>>>
>>> Are you me? Am I you?
>>>
>>> 27   Reply   Give Award   Share   Report   Save   Follow
>>>
>>> 1 more reply
>>
>> 37 more replies

> **[deleted]** · 1 yr. ago
>
> Same here lmao
>
> but the profits will be greater so fuck the old average
>
> 25   Reply   Share   Report   Save   Follow
>
> 1 more reply

9 more replies

Back to Top

8.3 Meme Event 3

Post Date: 09/10/2021

Sentiment: Positive

Link:
https://www.reddit.com/r/wallstreetbets/comments/q4p7zf/which_one_of_you_picked_up_my_wife_in_this/?utm_source=share&utm_medium=web2x&context=3

Comments for Meme post 3

zjz **MOD** +4 · 7 mo. ago · Stickied comment 2 & 2 More

There are people in this comment section that are mad at OP for (allegedly) realizing gains and buying a car.

If you're not here to (at least attempt to) make money then get out. This isn't the place for you.

Vote   Give Award   Share   Report   Save   Follow

Powellwx +3 · 7 mo. ago 2

So this is the WSB equivalent of being a top seller for Mary Kay.

3.2k   Reply   Give Award   Share   Report   Save   Follow

DancepantsX · 7 mo. ago

This is what you get if you convince enough people to buy WISH or CLOV

615   Reply   Give Award   Share   Report   Save   Follow

[deleted] · 7 mo. ago

Lol, but painfully.

136   Reply   Share   Report   Save   Follow

2 more replies

10 more replies

CanAlwaysBeBetter · 7 mo. ago

Which group has lower median returns: Mary Kay or WSB?

236   Reply   Give Award   Share   Report   Save   Follow

---

ninjadude4535 · 7 mo. ago

Fuck that's a tough one

74   Reply   Give Award   Share   Report   Save   Follow

2 more replies

---

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5. Political Bullshit
6. No Advertisement, Self-Promotion, Fundraising, or Begging
7. No Bullshitting
8. Bad Positions Screenshot
9. No Brigading
10. No Social Media Posts
11. Don't Shit on the Community

ProcyonHabilis · 7 mo. ago

I think this is the WSB equivalent of buying a couple of cheap vinyl decals and borrowing a top Mary Kay seller's car for a photo while they aren't looking.

108   Reply   Give Award   Share   Report   Save   Follow

Tibernite · 7 mo. ago

Bro $WISH is gonna squeeze like GME and AMC bro it isn't like $CLOV bro the DD is legit bro it's gonna squeeze please bro

64   Reply   Give Award   Share   Report   Save   Follow

Pied_Piper_ · 7 mo. ago

Squeeze me daddy

36   Reply   Give Award   Share   Report   Save   Follow

4 more replies

1 more reply

---

regoapps · 7 mo. ago

And bottom buyer and middle HODLER

9   Reply   Give Award   Share   Report   Save   Follow

10 more replies

---

apolloandbackk +3 · 7 mo. ago

I got it as a rental so I could bring her back to my mansion of an apartment sitting at 500sqft

5.6k   Reply   Give Award   Share   Report   Save   Follow

---

tmime1 · 7 mo. ago

A $WISH ape for sure.

1.4k   Reply   Give Award   Share   Report   Save   Follow

---

apolloandbackk +3 · 7 mo. ago

Im just a PLTR bro strung out on stimulants that hasn't seen the sun since last year

---

8.4 Meme Event 4

Post Date: 28/12/2021

Sentiment: Negative

Link:
https://www.reddit.com/r/wallstreetbets/comments/rqo284/catch_me_if_you_can/?utm_source=share&utm_medium=web2x&context=3

Comments for Meme post 4

breakevencloud +2 · 4 mo. ago
PAPER TRADING COMPETITION WINNER

Does this work on the IRS when you've lost everything before paying your taxes?

7.4k   Reply   Give Award   Share   Report   Save   Follow

Bright-Reflection-61 · 4 mo. ago · 2 · 2 · 3 ·

Just delete your IRS app. Should work.

10.0k   Reply   Give Award   Share   Report   Save   Follow

breakevencloud +2 · 4 mo. ago
PAPER TRADING COMPETITION WINNER

What about just removing my mailbox? That's the same thing, right?

1.9k   Reply   Give Award   Share   Report   Save   Follow

passthegrass4201 · 4 mo. ago

Some teenagers with a baseball bat removed mine and I haven't gotten a bill in the mail since. It totally works.

2.0k   Reply   Give Award   Share   Report   Save   Follow

Comment deleted by user · 4 mo. ago

11 more replies

JohannReddit +1 · 4 mo. ago

And when they come to serve an arrest warrant, you just plug your ears and scream "na na na boo boo, I can't hear you!!".

129   Reply   Give Award   Share   Report   Save   Follow

8 more replies

Bright-Reflection-61 · 4 mo. ago

Wife wasn't happy Xmas Eve when I drank to much at family Xmas party and ran over mailbox when I got home. She'll be sucking me off come tax season.

213   Reply   Give Award   Share   Report   Save   Follow

northernlad2000 · 4 mo. ago

Bog-EA · 4 mo. ago

Sounds like Robinhood got Robinhooded.

5.6k   Reply   Give Award   Share   Report   Save   Follow

Ok_Government_8865 · 4 mo. ago · edited 3 mo. ago

Contacted Robinhood to delete and close my account. They said they would get back to me in a couple of days. That was October 28th

Got contacted by Robinhood that my account was deactivated and cannot be used for transactions. I can restart it if I wish. I guess I'm not yet used to online transacting. I'll need to become more comfortable with it as time passes.

2.0k   Reply   Give Award   Share   Report   Save   Follow

Mr_Prolapsed_Anus +3 · 4 mo. ago
phhbt

I'm in the process of getting out, and I heard some horror stories.

What if, I just withdraw all cash at and ATM. Wouldn't that be faster than waiting for a transfer?

772   Reply   Give Award   Share   Report   Save   Follow

honestly_Im_lying · 4 mo. ago

I withdrew after the original GME fiasco. It took ~3 weeks. I sent 14 support tickets; all went unanswered.

528   Reply   Give Award   Share   Report   Save   Follow

PreventerWind +1 · 4 mo. ago

Cant unsubscribe if they never respond!

308   Reply   Give Award   Share   Report   Save   Follow

Meltingteeth · 4 mo. ago

That business model is what Moviepass built itself on. Dudes even removed the cancel subscription button from the app.

246   Reply   Give Award   Share   Report   Save   Follow

honestly_Im_lying · 4 mo. ago