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### The Relationship Between Twitter Mentions & Stock Volatility During Trading Hours

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The Relationship Between Twitter Mentions & Stock Volatility During Trading Hours

By

Connor Day

An Undergraduate Thesis Submitted in Partial Fulfillment  
of the Requirements for the  
University Honors Scholars Program  
Honors College  
and the  
College of Business and Technology  
East Tennessee State University

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Connor Day

Date

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Dr. Anca Traian, Thesis Mentor

Date

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Dr. William Trainor, Reader

Date

## **Abstract**

"The Relationship Between Twitter Mentions & Stock Volatility During Trading Hours"

By

Connor Day

A new paradigm in investing has been created where people have easier access than ever to invest in the stock market from the convenience of their phones. Through zero-commission trading apps, like Robinhood, less starting capital is required. This research is used to investigate the relationship between the frequency of social media mentions on Twitter and a particular stock's volatility. This will be done using the qualitative data analyzing tool AtlasTi to calculate the frequency in which a particular stock ticker is mentioned on Twitter during trading hours. The volatility of the stock will be calculated using data from Yahoo! Finance. Using a panel data analysis, our evaluation reveals that there is a statistically significant relationship between the number of Tweets both one and two days before and the volatility of the stock based on percent change. Additionally, there is a statistically significant relationship between the number of Tweets the day before and the volatility of the stock based on volume traded. It is intended that our research will aid future investors when making decisions on how to invest in assets heavily mentioned on social media.

## **I. Introduction**

The rise of social media, retail investing, and zero commission trading has pioneered a new frontier in the investing landscape. Never has the inexperienced investor had such easy access to the markets. This new landscape has opened a new paradigm to traders, smart phone users, or anyone with internet access. It is common for individuals to attempt a quick profit day trading based on the latest online news. However, the retail investor does always go to trusted news sources, but often will simply use the latest social media trend. This means that gone are the days where you need to be a “financially competent” investor who relies on sound financial analysis or a proven trading strategy. Now, if a certain stock is creating buzz, specifically on Twitter, that is sufficient to validate an investor. This new way of trading has caused significant changes in the marketplace.

This research investigates how social media mentions and market sentiment on Twitter impact a stock’s volatility. Twitter was chosen because it is the primary social media platform in which stocks and the stock market are most discussed. Additionally, Twitter is a community driven social media platform and investors commonly go to Twitter for FOMO (Fear of Missing Out) and speculative trading. Through preliminary research, it is found that young investors, specifically those who trade based on social media trends, are likely to sell or buy based primarily on FOMO. This leads to trading based on speculation and herd mentality. This shift from traditional technical trading, based on sound financial analysis, means less justification for a particular trade. This means both a higher panic and higher “FOMO” rate, which means more volatility. Because Twitter is likely to attract a disproportionately higher number of active stock traders when compared to other social media sites, it can be assumed that a high market sentiment on this site would be a

good proxy for all social media platforms. By conducting this research, this paper attempts to discover a relationship between social media market sentiment and stock volatility.

When looking over popular social media sites (Twitter, Facebook, YouTube, etc.) it is easy to see the common theme of influencers affecting many people. There has been much debate about the possibility of large amounts of social media interaction being reprimanded for “market manipulation” regarding small market-cap cryptocurrency projects. For example, when many Twitter influencers issue a “Buy” for a small crypto, the price of the coin can increase dramatically purely based on speculation. While small cap cryptocurrencies certainly are not the same as large publicly traded companies, this is still an interesting proxy to show the impact social media can have on investment decisions and trading sentiment.

## **II. Literature Review**

### **The Role of Media in Stock Market Participation:**

Research suggests that people are more likely to invest based on external factors that influence them over traditional investment methodologies. This can be either through people they know personally, for example close friends and family, or through what they digest using other media sources. These other media sources can include news articles, television, social media outlets, and other similar forms of entertainment and connection.

Based on Tetlock’s 2005 study, it is found that high media pessimism is an excellent proxy for predicting a downward trend in the stock market and overall market prices. Furthermore, when media viewpoints are either very bullish or bearish, the result is a higher market trading volume. Tetlock’s study was done by using the *Wall Street Journal’s* (*WSJ’s*) “Abreast of the Market” column on U.S. stock market returns. This article was given a quantitative metric based on

viewpoint and compared with various market statistics such as price and market trading volume. This study also found that “statistical tests reject the hypothesis that media content contains new information about fundamental asset values”. This shows that the WSJ article does not give any new technical information on the value of the stock, but instead just gives a point of view from the media. It is concluded that people will be quick to react, in terms of both market pricing and trading volume, when new qualitative information is presented. This information does not present new data on the intrinsic value of a stock but only gives a viewpoint on the market.

The hypothesis that people will invest based on media interaction is further explored by Audrino et al. (2019). They explored how various media outlets such as social media, news articles, information consumption, and search engine data impact market volatility. By using a penalized regression framework using sentiment data from the various media sources, and controlling economic and financial predictors, they found that the most impactful predictors were Google searches on financial keywords and the daily volume of company specific messages posted on StockTwits. The attention and sentiment variables they used significantly increased volatility for what was being targeted. However, the changes were marginal in terms of the economy. This research again suggests that behavioral metrics, such as Google searches or StockTwits post, can be a measure to predict market direction and volatility. This was further validated by Lyu et al. (2021) when they researched how different news flow impacted metrics on stocks via analyzing volume traded, volatility, and returns. Using a variety of sources such as professional platforms, blog posts, and stock message boards, they found that an increase in sentiment leads to an increase in both volatility and volume.

**The Power of Social Media / Recent Rise due to COVID 19:**

Social Media is extremely prevalent in all aspects of life today. Furthermore, the rise of “herd behavior” and meme stocks within the culture has risen dramatically. According to Meme Stocks and Herd Behavior, this was not restricted to the GameStop (GME) short squeeze, but instead, there is sufficient evidence that this unique trading behavior was not a one-time occurrence. Using hourly data, both pre and post COVID-19, it was found that this new trading style goes beyond the GME short squeeze and has a more lasting impact. Through their research, this behavior was mostly drawn from inexperienced retail investors. Many times, this herd behavior was triggered by social media frenzy, with investment decisions being driven by positive social media momentum. They found that the emergence of the meme stock community and retail traders who follow a herd mentality has gone up significantly since the beginning of COVID. This style of trading was found to lead to higher volatility, greater risk, and a more irrational trading pattern by traders.

Recently, there has been a paradigm shift since the global pandemic of COVID-19. According to Ortmann et al (2020), the stock market and investor trading patterns have experienced a dramatic shift since the outbreak. In their study, they found that weekly trading intensity and new positions both increased significantly. In addition, they found that trading intensity increased by 13.9% as the number of cases of the virus doubled.

Looking again at the work of Lyu et al (2021), evidence indicated that the increase in both herd behavior and market participation by retail investors led to an increase in volatility. This volatility was heightened by the relationship of retail investors with more traditional-institutional investors (hedge funds, large corporations, etc.). The rise of the normalization of investing seemed to trigger a newfound dynamic between institutional investors and the newer retail investors.

## **FOMO / Zero Commission Trading**

Social media led investing, as well as herd mentality, is driven by the fear of retail investors potentially missing a great investing opportunity. This sociological tendency is often referred to as FOMO (fear of missing out). The research by Gupta and Shrivastava (2021) investigated this phenomenon. Their study deployed a survey that collected data from 323 retail investors in the Indian stock market. Their research suggested that investment judgements were significantly impacted by both loss aversion and FOMO. Their researched highlighted that anyone with a bank account can break into the stock market and begin trading with no barrier to entry. The unexperienced and untrained retail investor was most likely to engage in this herd investing behavior.

In an interesting study by Jones of Utah State (2021), the relationship between stock market volatility and Robinhood usership was analyzed. A positive relationship between users and different measures of market volatility was found. They concluded this is likely since retail investors who invest with Robinhood are far more likely to trade on factors such as media coverage, popularity, and company familiarity. This is opposed to trading on fundamental values, such as financial statements, which leads to a much less volatile market.

### **A Trend to Stay?**

Researchers investigated the plausibility of long-term retail trading. Could this indeed be a prolonged trend? Possibly jumpstarted by the infamous short squeeze of GME and AMC, research implies this may be a trend to stay. By looking at hourly data and trading patterns, Aloosh et al (2021) found that this kind of trading is not limited to the short term. This makes sense, as never before have such a high number of “everyday retail traders” made such a difference. Retail



investors are empowered that this is a way to “stick it to the man” and “take back control from Wall Street.” Additionally, for many traders, lifetime financial changes occurred both for the positive and for the negative.

This idea of “taking back control of Wall Street” started with the popular reddit forum WallStreetBets. This forum served as a staple for retail investors looking for investment advice. However, after rising to fame during the GME short squeeze, the effectiveness and validity of the advice was changed. The site shifted from a forum filled with due diligence and solid financial analysis to a site filled only with speculative FOMO investing. This was verified by the research of Bradley et al (2021). This showed that pre-2021, due diligence reports on WSB were a good indicator of market success. However, after the GME short and the increase in popularity of the site, it could no longer predict consistent positive returns.

This is important because it suggests this new paradigm in investment trading is not simply a rare occurrence but an extended aspect of the market. This could open the door to investment opportunities never seen before. The research suggests the days of only trading on technical financial knowledge and sound investment principles are gone. While this is proven to be the most consistent and risk-adverse way to see long time growth, social media and zero commission trading has opened the door to a new paradigm of investing. This research hopes to serve as a guide to those looking at the volatility associated with this way of trading.

### **III. A History of Zero Commission Trading, Market Manipulation, & Social Media's Impact of the Stock Market**

In 1975, the Securities Acts Amendments were signed into law by President Gerald Ford. The legislation represented the first cuts to brokerage commission fees. This is referred to by industry and investment professionals as "May Day." While this is a far cry from today's zero commission landscape, prior to 1975 every brokerage firm charged the same commission fee for the same transaction. It was forbidden by the law from charging a different rate. For example, the cost of buying 100 shares of Coca-Cola was the same regardless of if you went to Fidelity, Merrill Lynch, or TD Ameritrade. However, after the legislation was signed, a new kind of broker was born. This was the discount broker. This allowed for trades to be completed at a discounted rate. For example, Charles Schwab was at the forefront of the new low-cost trading. The company realized that this finally opened the door for individual investors to begin investing their own money in the stock market. Schwab said in 2005, "We probably didn't know it at the time, but May 1, 1975, was a watershed moment for individual investors and the markets...with the sudden arrival of negotiated stock trades that were less than half the cost they had been, a major barrier to investing went away for the average American."

When discounted brokerage firms were first introduced to the market, it was quickly dismissed by industry professionals. In the eyes of Wall Street, only a small number of inexperienced investors would dare trade without the advice of a large, professional firm. However, this number continued to rise over the years. This would lead to commission prices for other firms being driven down due to the lower rates charged by the discounters. Day trading truly took on positive momentum in the 1990s. This was due to the rising tech bubble, which brought with it a new wave of day traders who were able to buy and sell online without the need for an

actual human broker. The commission fees then, while high at the time at around \$40 a trade compared to today, was still a heavy discount compared to what traditional Wall Street was charging. This goes in parallel with Charles Schwab going public in 1987; and TD Ameritrade and E\*Trade coming soon after. These new internet brokers were not much concern to Wall Street at the time, as they were seen as handling the clients that Wall Street had little interest in. However, as the trends changed and investing prices declined, these online brokers collected trillions of dollars in client assets.

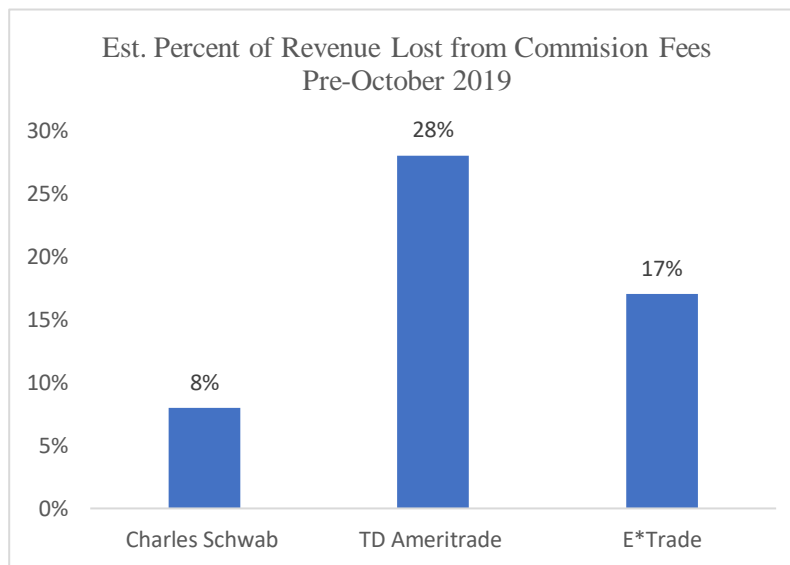
One company that took advantage of the huge shift in the stock market towards zero commission trading was Robinhood. Robinhood is a US based financial services company that specializes as a stock trading for the “everyday investor.” Robinhood is widely known for being a trailblazer in the landscape of zero commission trading of stocks, exchange-traded funds (ETFs), and cryptocurrencies via their user-friendly app. While their trading is commission free, they generate from revenue from: margin lending, interest on cash held in the app, and by selling order information to high-frequency traders. According to their co-founder Vladimir Tenev, the purpose of the company is "provide everyone with access to the financial markets, not just the wealthy." The company has succeeded in their goal, amassing over 22 million users by the end of 2021. Furthermore, when looking at the company demographic, the “millennial” age group made up almost 80 % of total users. The average age of investor was 26. This is a great indicator for the types of traders Robinhood is looking for when growing their customer base. Their marketing and growth strategy reflects this, as well. In 2016, the company started Robinhood Gold, which was a premium subscription plan for users of the app to gain access to additional features. In 2017, the company began offering free stock for referring new users. In late 2017, the company allowed investors to participate in options trading. This high-risk / high-reward style of trading would

appear to appeal more to the younger, more risk-tolerant demographic. Additionally, their commercials and advertising often will only focus on people working more common jobs, such as retail or manual labor, not people in suits or “finance” roles. The mass adoption of Robinhood to the mainstream population has resulted in a shift of investing behavior by retail investors the likes of which have never previously been seen.

Looking again at other major brokerages; it was in February 2017 that the final push towards commission free trading for large brokers was again led by Charles Schwab and Fidelity when they dropped equity commissions for the first time in 10 years. While Robinhood pioneered true commission free trading, on Oct. 1st, 2019, Charles Schwab sent shockwaves through the online broker industry forever when they announced they would be the first major brokerage to drop commissions to zero. Top competitors followed Charles Schwab’s lead quickly. The markets were quick to react. Between Schwab, E\*Trade, and TD. Ameritrade, \$16.4 billion in aggregate market value was lost. However, for these larger online brokers, most revenue did not come from commission fees on stock trades.

<b>Share-Price Performance of Top Online Brokers</b>	
<b>Charles Schwab</b>	<b>-15%</b>
<b>TD Ameritrade</b>	<b>-16%</b>
<b>E*Trade</b>	<b>-29%</b>

	<b>Equity Commission Fees for US Stocks Per Trade</b>		
	<i>2015</i>	<i>2017</i>	<i>2022</i>
<b>Charles Schwab</b>	\$6.95	\$4.95	\$0.00
<b>Fidelity</b>	\$7.95	\$4.95	\$0.00



While the drop to zero commission is no doubt a victory for both consumers and online brokers, now there is even more focus on generating revenue via alternative methods. “Not everyone is going to survive this,” stated Robert Siegel, who is a professor at Stanford University. In addition to cutting costs and laying off workers; heavy M&A activity and integration has been taking place to adapt to the changing industry. Two examples of this were the acquisition of Scottrade by TD Ameritrade in 2017, and E\*Trade buying the parent company of OptionsHouse. Another way online brokers will look for alternative revenue streams is through their banks. Through their banks, they collect revenue by lending the invested money out and collecting the

interest. In addition to their banks, the most prevalent way these firms can overcome the zero commission fees is through a method called “payment for order flow.” In this, the online brokers will send the client orders to high-speed trading firms in exchange for money. This is helpful for the retail investor, as in theory this allows customers to get the lowest available execution price. TD Ameritrade received \$526.59 million in cash for order flow in Q2 of 2020 alone, while Robinhood collected \$271.2 million. However, this method is full of controversy. In December of 2020, Robinhood had to pay a \$65 million dollar fee to the SEC for lack of transparency on how the company made money from payment for order flow. On top of that, they were accused by the SEC of failing to execute orders in the client’s best interest. Finally, as these online brokers give up their commissions, selling financial advice and wealth management becomes ever more important. For example, Charles Schwab recently started providing a financial planning model that is based on a pay-by-subscription method. The company also recently invested further into the wealth management industry by acquiring wealth management operation via USAA. E\*Trade has also integrated further into the advice business, recently purchasing Trust Company of America for their financial advisory services. “Competition is what started the race to (ultimately) \$0 trades,” stated Blain Reinkensmeyer, who is head of research at StockBrokers.com. He continues by saying, “With that chapter coming to a close, the next two major battlegrounds are cash management and investment advice.”

### **Pump and Dumps, Market Manipulation & Social Media**

Market manipulation is any time there is a purposeful attempt to deceive investors by controlling or artificially affecting the price of a stock. A common scheme that is classified as market manipulation is a “Pump and Dump.” Generally, the idea behind this scheme is an individual or group of people will artificially drive the price of a stock higher than the fair market

value would indicate, is this the “pump.” After the price is inflated, the group behind driving the scheme will sell of their own shares for a large profit, this is the “dump.” This is obviously unethical and illegal. As once the original group sells their shares, the price of the stock will drop and leave the new investors owning a stock worth significantly less than they paid for it. In the past, the orchestrators of this would have to depend on cold calling, newsletters, and fake press releases. Often, these groups will gather momentum by claiming to have “insider information” on the newest hot stock. A famous example of this is the infamous case of the penny-stock brokerage firm Stratton Oakmont and Jordan Belfort, which was turned into an Academy Award nominated film in 2013. While Pump and Dump schemes have been in existence for many years, the internet and zero commission trading has allowed for a much more efficient and cheap way of influencing many unsuspecting investors with less resistance.

At 15 years old, Jonathan Lebed began using the internet, online message boards, chat rooms and emails to run-up the prices of various penny stock. Lebed purchased relatively large amounts of low-priced stocks, radically increased internet sentiments, and then sold off his shares once the price rose. Most notably, Lebed would post multiple messages on Yahoo Finance under the guise of various fake names inflating his already purchased stocks. Lebed did this on eleven separate occasions from the end of 1999 to the beginning of 2000. On an average day with the stocks Lebed dealt in, the companies would experience trading volume of around 60,000 shares. On the days Lebed would pump, the small companies he would discuss would experience daily volume of over a million shares traded. On his most profitable day Lebed made over \$70,000 at the age of fifteen. In total, after his approximately six-months of trading, the kid had profited nearly \$800,000. On September 20h, 2000 the SEC settled its case against the high school student. Lebed would be the first minor ever to be accused of stock-market fraud and market manipulation. In the

settlement, Lebed agreed to pay back a small amount of his total accumulated gains and agreed to not tamper with securities moving forward. He would end up keeping over \$500,000 in profit after paying back what was dictated by the SEC.

Interestingly, the young stock trader never admitted to any wrongdoing in the incident. This is symbolic, as opinions are divided as to whether the young man did anything wrong. For some, Lebed became a symbol of creative thinking and “overcoming the man” and “taking back Wall Street.” For others, he became an example of greed and, in the eyes of the SEC, market manipulation and fraud. Young Lebed would be an interesting sign of things to come. While zero commission fees and social media had not yet truly come to light, Lebed served as an excellent proxy of what can happen when internet sentiment towards a particular stock is fully charged in a particular direction.

Now, with the rise of social media, it's never been easier to shift the sentiment of a stock by influencing a large group of people. Popular social media sites such as Facebook, Twitter, and Reddit have created the perfect ecosystem for traders to share ideas and build on one another. This can be both a positive and a negative. On one hand, it allows for like-minded traders to have intelligent conversations and provide educated advice to yield better investments. This can be very positive, as many people who have never had exposure to the markets or how to invest their money can learn valuable skills for free. On the other hand, it can be a powerful and dangerous tool that encourages a herd mentality. Social media influencers can take advantage of inexperienced traders looking to make a quick profit, and herd-mentality behavior can help encourage poor decision making that otherwise could have been avoided. “Herding... is when we behave as we believe others like us are behaving. Instead of finding out what's really happening in the market or what the value, risk or opportunity of an investment is, we take the easy choice of doing what it seems

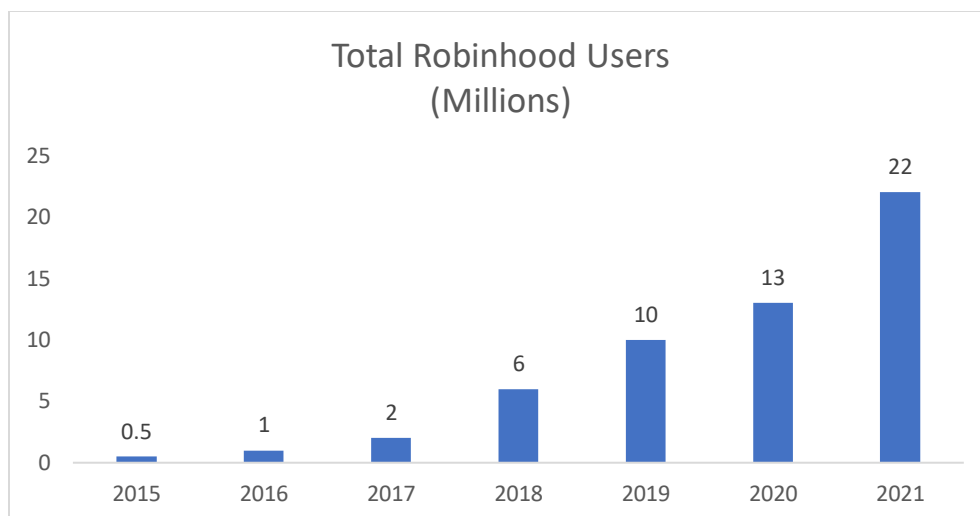


like everyone else is doing,” stated by Jeff Kreisler, who is the Head of Behavioral Science at J.P. Morgan Private Bank. This is particularly dangerous, as stock popularity on Twitter, Facebook or Reddit is not related to how sound of an investment the stock is. This cultivates an online culture of trading purely based on speculation and popularity, not well-constructed investment strategies. In addition to this, social media often promotes day-trading, swing-trading, and short-term gains over steady returns. These kind of investing strategies are far riskier and promote higher levels of volatility than investing in index funds, mutual funds, or the S&P 500.

The perfect example of social media investing, and herd-behavior exemplified in its extreme form was in 2021 during the GameStop Short Squeeze. In early 2021, led by GameStop, fifty “meme stocks” added an incredible combined \$276 billion in value. This was done by using the popular trading forum r/WallStreetBets on reddit. On the forum, millions of users got together and began artificially raising the prices of various stocks, particularly GameStop, by posting “buy” recommendations. This countered many large institutions “short” position on the stock. As a result of the artificial rise in prices, many of the large hedge funds had to buy shares to cover their position, which caused the price to soar even higher. For context on the reach of this global phenomenon, it was tracked that approximately 1.5 million tweets, 1,400 videos on YouTube, and over 80,000 reddit posts mentioned Gamestop in one week between January 20<sup>th</sup> and January 27<sup>th</sup>. On the other side of this event, \$167 billion in total value had been completely removed. This shows the kind of insane volatility that can occur when enough people get together behind an idea. This also created a split in public perception on what was justified and right. One group believed this was a way of the common trader taking back control from large, corporate institutions. The other group believed this high level of trading volume based exclusively on social media sentiment was too like a pump-and-dump scheme. This led to many online brokers making it stricter to

purchase stocks on margin; particularly after Robinhood had to raise over a billion dollars in emergency funds to help satisfy the margin calls. The CEO of Robinhood went on record stating, "Robinhood Markets would not have been able to meet the \$3 billion deposit call that Depository Trust & Clearing Corp. made against Robinhood on Jan. 28." Many online brokers, most notably Robinhood, had to temporarily pause all trading of meme stocks due to unprecedented levels of risk and volatility. This style of high risk, lottery-style, behavior of trading meme stocks has inexperienced traders guided only by the very apparent financial rewards without fully perceiving the associated risks of their actions.





Good or bad, it is clear that social media is here to stay and has a permanent place in the state of the stock market. A combination of a global pandemic and stimulus checks, commission free trading, and social media has triggered a historic boom in the world of retail investing. Ever since 2013, when the SEC started to allow public companies to post earnings and news on social media, the relationship between investing and social media has only grown. As of 2021, almost 80% of institutional investors have admitted to using social media as part of their daily workflow. Additionally, approximately 30% of that group stated that social media postings have directly altered or contributed to an investment decision. It was found that 34% of retail investors have directly changed an investment decision based on a posting read on social media. Furthermore, as of 2021 it was found that retail traders make-up as much as one-fifth of the total market volume per day. This is double the number of retail traders present in 2019. The influx in volume of retail investors after the GameStop short squeeze; combined with the rise of social media's prevalence in stock investing and zero commission fees, have paved the way for retail investors to have the power to move the markets like never before.

#### **IV. Methodology / Data**

The data was collected using the qualitative data analysis and research software AtlasTi. To collect the data for the number of times a stock was mentioned on Twitter, the stock ticker was inserted into the research software following a "\$" symbol. This is the most common way a stock is mentioned on Twitter, so this gives the most accurate representation of overall Twitter activity. After entering the information, the software would provide the total number of times the stock was mentioned over the previous four hours. This was done twice a day during trading days. The data collected presented the number of mentions between 9 am-12 pm, and 12 pm-4pm respectively. Data was collected for 20 trading days, or approximately one month. Data was collected for 25 individual stocks, ranging from traditional well-known "blue-chip" stocks to more unknown stocks. The data points collected were added together to get the overall Twitter mentions for each given day.

During the same time periods, the volatility of the stock was calculated using stock data collected from Yahoo! Finance. The respective stock ticker was entered; and the opening price, closing price, daily highs and lows, and overall trading volume was collected. Daily percent change of the stock, percent difference in daily highs and lows, and overall volume were used to show volatility. The two variables, Twitter mentions and stock volatility, will then be examined under the same period to evaluate their relationship using a panel data analysis.

A Panel Data Analysis was used because it allows for a more detailed analysis of the multiple variables within the different stock observations. Specifically, the Panel Data Analysis was able to analyze the behavior of each companies' number of Tweets in comparison to that stock's volatility. A Panel Data was chosen because it allows the analysis on multiple data points

across time; compared to a time series analysis which focuses only on a single data point at multiple time intervals. The equation used was:

$$Volatility_{it} = \alpha_0 + \beta_1 * NumbeOfTweets_{it} + \beta_2 * NoOfTweets_{n-1_{it}} + \beta_3 * NumberOfTweets_{n-2_{it}} + \epsilon_{it}$$

The dependent variable used in our model was the volatility of the stock, indicated by percent change and volume, respectively. The independent variables used in our model are the number of tweets on the day the volatility was being measured, Number of tweets – 1 Day, Number of tweets – 2 Day.

	Average Number of Tweets per Day Over Research Periods	Ranking
<b>AAPL</b>	1180	High
<b>AMZN</b>	1114	High
<b>NFLX</b>	865	High
<b>WMT</b>	704	High
<b>PTON</b>	595	High
<b>NVDA</b>	568	High
<b>DWAC</b>	554	High
<b>DIS</b>	442	High
<b>AAL</b>	170	Medium
<b>JNJ</b>	103	Medium
<b>KO</b>	66	Medium
<b>ACB</b>	61	Medium
<b>ATVI</b>	46	Medium
<b>ELY</b>	34	Medium
<b>EXPO</b>	32	Medium
<b>PZZA</b>	32	Medium
<b>BTG</b>	25	Medium
<b>CFX</b>	12	Low
<b>IIVI</b>	9	Low
<b>LITE</b>	9	Low
<b>LCID</b>	7	Low
<b>BRK.A</b>	6	Low
<b>TRGP</b>	6	Low
<b>MOMO</b>	6	Low
<b>VGR</b>	4	Low

*Figure 4*

For additional analysis, the number of Twitter mentions were averaged together for each stock over the time of the research. The stocks were then distributed evenly according to three categories (High, Medium & Low). The three categories were then compared using volatility measurements of daily high / low of each stock and opening / closing price of each stock. The “High” group reported the highest average of volatility by both percent change and volume. The

stocks selected were a combination of large blue-chip stocks, penny stocks, and mid cap stock across multiple industries. Additionally, stocks were selected by looking at the most discussed stocks on Twitter each day and selecting the ones that occurred most often.

*Descriptive Statistics*

<i>Stock Tested</i>	<i>Mean</i> <i>(NumberOfTweets)</i>	<i>Standard Deviation</i> <i>(NumberOfTweets)</i>	<i>Max</i> <i>(NumberOfTweets)</i>	<i>Min</i> <i>(NumberOfTweets)</i>
AMZN	1114	276.9962274	1718	549
NFLX	865	324.7098551	1563	273
NVDA	568	185.7906516	1045	129
AAPL	1180	317.807721	1636	322
WMT	704	495.8339919	2000	59
DIS	442	208.3950335	1006	126
DWAC	554	139.9082199	772	258
PTON	595	243.7036058	1003	216
BRK.A	6	3.057368149	11	1
LITE	9	5.985607739	22	1
TRGP	6	3.407345007	12	1
IIVI	9	6.672892926	22	0
LCID	7	4.910193479	19	1
VGR	4	3.04097024	12	1
CFX	12	8.0000000	39	3
MOMO	6	3.861346915	16	1
JNJ	103	37.01658412	181	27
EXPO	32	11.16187708	57	17
PZZA	32	25.40920109	97	2
ATVI	46	19.22361829	81	18
KO	66	16.98940847	98	42
ELY	34	4.393176527	18	0
AAL	170	45.17787069	237	71
BTG	25	10.57768878	54	11
ACB	61	35.30948881	117	10

*Figure 5*

The table above is descriptive statistics on the number of tweets per day. Included in the table above is the mean, standard deviation, minimum and maximum for the number of tweets paired with each respective stock. When looking at the table above, it can be found there is a large discrepancy in the average amount of tweets posted for each of the different companies. The highest being AAPL at 1180 average tweets a day and the lowest being VGR at 4 tweets a day. Furthermore, this table also shows the large variation in the number of tweets posted within each individual stock. As an example, for AAPL the highest number of tweets in a day is found to be 1636 while the lowest is 322. Being able to look at how much each stock's number of tweets vary per day shows how much sentiment can shift on a day-to-day basis.



<b>Stock Tested</b>	<b>Average Number of Tweets per Day Over Research Period</b>	<b>Stock Price</b>	<b>Mean Percent Change</b>
<b>AMZN</b>	1114	\$ 2,965.92	1.94%
<b>NFLX</b>	865	\$ 218.22	2.48%
<b>NVDA</b>	568	\$ 201.83	3.42%
<b>AAPL</b>	1180	\$ 166.42	1.35%
<b>WMT</b>	704	\$ 159.87	0.98%
<b>DIS</b>	442	\$ 121.66	1.46%
<b>DWAC</b>	554	\$ 37.96	3.26%
<b>PTON</b>	595	\$ 20.46	5.02%
<b>BRK.A</b>	6	\$ 515,815.00	0.77%
<b>LITE</b>	9	\$ 85.60	2.12%
<b>TRGP</b>	6	\$ 78.63	1.25%
<b>IIVI</b>	9	\$ 62.97	2.43%
<b>LCID</b>	7	\$ 19.55	4.32%
<b>VGR</b>	4	\$ 13.22	0.98%
<b>CFX</b>	12	\$ 5.08	1.42%
<b>MOMO</b>	6	\$ 4.42	2.91%
<b>JNJ</b>	103	\$ 183.36	0.70%
<b>EXPO</b>	32	\$ 109.44	1.51%
<b>PZZA</b>	32	\$ 104.68	1.46%
<b>ATVI</b>	46	\$ 78.90	0.37%
<b>KO</b>	66	\$ 66.21	0.99%
<b>ELY</b>	34	\$ 23.02	2.35%
<b>AAL</b>	170	\$ 20.22	2.44%
<b>BTG</b>	25	\$ 4.68	2.05%
<b>ACB</b>	61	\$ 3.12	4.09%

*Figure 6*

The figure above shows the average number of tweets per day, the stock price, and the mean percent change for each stock. This is interesting, as it shows the relationship between the number of tweets and how expensive a stock is, compared to the average percent change for the stock. By looking at the data, in general the more expensive stocks are subject to less volatility than stocks that are cheap, regardless of average amount of daily tweets. This makes sense, as it is harder for a retail investor to buy a more expensive stock as often they have a smaller portfolio size.

## V. Results

The Panel Data Analysis was performed using three different models: a fixed effect (FE), random effect (RE), and ordinary least squares (OLS). The three separate approaches each analyze  $\alpha_0$ . The OLS approach assumes that  $\alpha_0$  does not vary across companies. For the fixed effect model, this model specifies  $\alpha_0$  vary across companies but remains constant for each company over time. Finally, for the random effect test, this approach defines  $\alpha_0$  different for each company, but also allows  $\alpha_0$  to vary within each company.

To determine which model should be used, various tests were performed. This was done using percent change as the measure for volatility. First an F-test was used when comparing fixed effect and ordinary least squares. When looking at the F test, the Prob > F = 0.9846. Due to the high value, we fail to reject the null. Thus, ordinary least squares is used over fixed effect. When deciding between fixed effect and random effect, a Hausman test was used. When the Hausman test was performed, the results were Prob>chi2=0.9529. Thus, the random effect is better.

The last model selected was between ordinary least squares and random effect. This test was done using a Lagrangian multiplier test. This resulted in Prob > chibar2 = 1.0000, which

means the null cannot be rejected. Therefore, random effect is selected. Having evaluated the different tests, the results indicated that using random effect was best. These same steps were taken when testing for volume. In this case, there was not a clear indication of which test to use. However, based on the Hausman test pointing towards random effect and wanting to use the same test for both dependent variables of percent change and volume, random effect was used when looking at volume as well.

<b>Analysis for Percent Change (RE)</b>			
<b>Percent Change</b>	<b>Coefficients</b>	<b>Std. Error</b>	<b>P &gt;  Z </b>
<b>Number of Tweets_n</b>	.0000113	7.31e-06	0.123
<b>Number of Tweets_n-1</b>	-.0000208	7.60e-06	0.006
<b>Number of Tweets_n-2</b>	.0000141	6.95e-06	0.043
<b>Industry Control</b>	-.0020055	.0026518	0.449
<b>_cons</b>	-.0015375	.0019501	0.430

*Figure 7*

In *Figure 7*, the panel data analysis was run using the percent change between the opening and closing stock price as the measure for volatility. This was the dependent variable. Random Effect was chosen for the panel data analysis based on the Hausman Test. The results show that the “Number of Tweets n-1” and “Number of Tweets n-2” yielded a statistically significant result. However, the coefficients are very small which indicates a relatively weak correlation between the variables. Interesting, for Number of Tweets\_n-1, the coefficient was negative. This indicates there is an inverse relationship between the variables. This would indicate that the amount of people who tweet about the stock on the previous day increases, the volatility goes down. An explanation for this could be that when a stock is talked about by more people on the previous day retail traders could start to be more conservative with their buying and selling. This would cause percent change to go down as number of tweets go up. Additionally, if stocks were talked about on Twitter and the overall sentiment is a “hold” or a “do nothing” mentality, this would cause percent change to be less for each respective stock relative to number of tweets the day before. The number of tweets on the day the volatility was measured did not lead to a statistically significant result. This makes sense, as Twitter behavior from the previous day would be more likely to lead to statistically significant results as it gives retail traders time to process what is happening.

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**Analysis for Volume (RE)**

<b>Volume</b>	<b>Coefficients</b>	<b>Std. Error</b>	<b>P &gt;  Z </b>
<b>Number of Tweets_n</b>	-4283.362	3974.202	0.281
<b>Number of Tweets_n-1</b>	17539.09	3934.94	0.001
<b>Number of Tweets_n-2</b>	1609.637	3608.666	0.656
<b>Industry Control</b>	7303326	7700096	0.343
<b>_cons</b>	6511276	5419949	0.23

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Figure 8

In *Figure 8*, the panel data analysis was run again looking at volatility. This time, with volatility being measured by overall volume traded as the dependent variable. Random Effect was chosen for the panel data analysis again based on the Hausman Test. The results show that the “Number of Tweets n-1” yielded a statistically significant result. Again, this makes sense, as the number of Twitter mentions the previous day give traders time to digest the information and sentiment they read on Twitter. Similarly to the results of *Figure 7*, the number of tweets on the day the volatility was measured did not lead to a statistically significant result.

<b>Endogeneity</b>			
<b>Percent Change</b>	<b>Coefficients</b>	<b>Std. Err.</b>	<b>P &gt;  Z </b>
<b>Number of Tweets_n</b>	.0014525	.0014525	0.564
<b>Number of Tweets_n-1</b>	.0007902	.0007902	0.552
<b>Number of Tweets_n-2</b>	.0005273	.0005273	0.589
<b>Industry Control</b>	.0026414	.0026414	0.271
<b>_cons</b>	.0318785	.0318785	0.559

Figure 9

A variable is defined as endogenous when dependent variable Y causes independent variable X, instead of just X causing Y. For solving the problem of endogeneity, two simultaneous regressions were run using percent change as the measure of volatility. It could be a problem that the percent change of a stock is not actually determined by the number of tweets, but instead the number of tweets is generated by intense / volatile trading. The two regressions were run to identify

if percent change was a byproduct of a high number of tweets or vice versa. The equations used were:

$$PercentChange_{it} = \alpha_0 + \beta_1 * NumbeOfTweets_{it} + \beta_2 * NoOfTweetsn-1_{it} + \beta_3 * NumberOfTweetsn-2_{it} + \varepsilon_{it}$$

$$NumberOfTweets_{it} = \alpha_0 + \beta_1 * HighLow_{it} + \beta_2 * NoOfTweetsn-1_{it} + \beta_3 * NumberOfTweetsn-2_{it} + \varepsilon_{it}$$

In the second equation, daily high / low of the stock priced was used as a proxy for volatility. The table above represents the results. The results of this analysis produced no statistically significant coefficients, which indicates that a feedback loop may be present within the data.

## VI. Conclusions

Based on the research performed, it was determined there was a statistically significant relationship between the number of tweets both previous day and two days before, and the volatility of a given stock based on percent change. Additionally, the relationship between the number of tweets the day before and the volatility of the stock based on volume was found to be statistically significant, as well. Based on the results of the panel data analysis, it could be concluded that an increase in Twitter mentions the day before will lead to an increase in stock volatility for the following days to come. This makes sense, as it gives investors time to think about the increase sentiment around the stock and act the following day by either buying or selling the respective stock. When the data was broken into stocks with high mentions, medium mentions, and low mentions, the group of stock with the highest number of mentions were found to be the most volatile based on percent change and daily high / low. When interpreting these results, it seems that higher twitter activity in general seems to lead to more overall volatility based on metrics of volatility chosen. However, when trying to solve the problem of endogeneity, two

simultaneous regressions were run to identify if percent change was a byproduct of a high number of tweets or vice versa. The results of this analysis produced no statistically significant coefficients, which indicates that a feedback loop is present within the data.

This research proved to be very informative. While attempting to correct for endogeneity, the results show that a feedback loop is present in the data. The research also showed that an increased twitter sentiment either the previous day or previous two days is an indicator of increased stock volatility. Hopefully, this will be helpful to future retail traders who invest mostly based on FOMO and social media sentiment. Moving forward, this research hopes to serve as a baseline for further work investigating the relationship between social media mentions and stock volatility. An important data point not considered or collected in this research is the amount of influence garnered by each respective tweet. For example, this research treats all tweets as if they have the same audience, which obviously is not true.

If additional research were to be pursued, it would be focused on groups over a longer time (month-to month) to evaluate the effect of macro-economic indicators within the data. This would be interesting, as the effects of global macroeconomic shifting events on stock volatility and social media sentiment could be evaluated. Furthermore, it would be interesting to look at the most discussed stocks each month and calculate the average volatility of that changing group of stocks. This calculated volatility could then be compared to the volatility of the S&P 500 to evaluate the relationship between the two groups. Doing this, as opposed to tracking the same stocks over time, would show the relationship in volatility between consistently heavily mentioned stocks on Twitter and the whole market.

## References

- ABC News Network. (n.d.). *Teen Stock Broker Profits from Manipulation*. ABC News. Retrieved April 28, 2022, from <https://abcnews.go.com/Business/story?id=88547&page=1>
- Aloosh, A., Choi, H.-E., & Ouzan, S. (2021, August 27). *Meme stocks and herd behavior*. by Arash Aloosh, Hyung-Eun Choi, Samuel Ouzan :: SSRN. Retrieved April 28, 2022, from <http://dx.doi.org/10.2139/ssrn.3909945>
- Audrino, F., Sigrist, F., & Ballinari, D. (2019, October 9). *The impact of sentiment and attention measures on stock market volatility*. International Journal of Forecasting. Retrieved April 28, 2022, from <https://www.sciencedirect.com/science/article/pii/S0169207019301645>
- Beilfuss, L., & Osipovich, A. (2019, October 5). *The race to Zero commissions*. The Wall Street Journal. Retrieved April 28, 2022, from <https://www.wsj.com/articles/the-race-to-zero-commissions-11570267802>
- Bradley, D., Hanousek Jr., J., Jame, R., & Xiao, Z. (2021, March 22). *Place your bets? the market consequences of investment research on Reddit's Wallstreetbets*. SSRN. Retrieved from [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3806065](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3806065)
- Curry, D. (2022, January 11). *Robinhood revenue and Usage Statistics (2022)*. Business of Apps. Retrieved April 28, 2022, from <https://www.businessofapps.com/data/robinhood-statistics/>
- Duré, E. (2021, September 13). *Social Media's influence on the Investing Community*. Credit Card, Mortgage, Banking, Auto. Retrieved April 28, 2022, from <https://www.chase.com/personal/investments/learning-and-insights/article/social-medias-influence-on-the-investing-community>
- Farley, A. (2022, February 7). *Is there a catch to free stock trading?* Investopedia. Retrieved April 28, 2022, from <https://www.investopedia.com/investing/free-stock-trading-whats-catch/>
- Gupta, S., & Shrivastava, M. (2021, November 30). *Herding and loss aversion in stock markets: Mediating role of fear of missing out (FOMO) in retail investors*. International Journal of Emerging Markets. Retrieved April 28, 2022, from <https://doi.org/10.1108/IJOEM-08-2020-0933>
- Heilner, J. (n.d.). *The history of Zero commissions*. WT Wealth Management. Retrieved April 28, 2022, from <https://wtwealthmanagement.com/whitepapers/2020-07/>
- Jones, C. (2021, May). *Retail trading and stock volatility: The case of robinhood*. DigitalCommons@USU. Retrieved April 28, 2022, from <https://digitalcommons.usu.edu/gradreports/1534>



- Khan, R. (2021, June 28). *Social media fueled stock market trading: The unsuspecting need to be protected*. Forbes. Retrieved April 28, 2022, from <https://www.forbes.com/sites/roomykhan/2021/03/08/social-media-fueled-stock-market-trading-the-unsuspecting-need-to-be-protected/>
- Lewis, M. (2001, February 25). *Jonathan Lebed's extracurricular activities*. The New York Times. Retrieved April 28, 2022, from <https://www.nytimes.com/2001/02/25/magazine/jonathan-lebed-s-extracurricular-activities.html>
- Lyu, S., Wang, Y., & Zhang, M. (2021, December 15). *Heightened herd behavior in financial market under covid-19*. Heightened Herd Behavior in Financial Market Under Covid-19 | Atlantis Press. Retrieved April 28, 2022, from <https://www.atlantispress.com/proceedings/icemci-21/125965809>
- Ortmann, R., Pelster, M., & Wengerek, S. T. (2020, August 8). *Covid-19 and investor behavior*. Finance Research Letters. Retrieved April 28, 2022, from <https://www.sciencedirect.com/science/article/pii/S1544612320307959>
- Silver, C. (2021, September 14). *Chuck Schwab on Zero commissions*. Investopedia. Retrieved April 28, 2022, from <https://www.investopedia.com/charles-schwab-discount-broker-zero-commissions-4776572#:~:text=When%20Charles%20Schwab%20announced%20it,source%20of%20pr ofits%20for%20centuries.>
- Tetlock, P. C. (2005, March 21). *Giving content to investor sentiment: The role of media in the stock market*. by Paul C. Tetlock :: SSRN. Retrieved April 28, 2022, from <https://doi.org/10.2139/ssrn.685145>
- Wenk, J. (2019, October 16). *How does commission free trading work?* Grow with Altruist. Retrieved April 28, 2022, from <https://grow.altruist.com/the-real-story-behind-commission-free-trading>
- Yahoo! (n.d.). *Yahoo Finance - Stock Market Live, quotes, Business & Finance News*. Yahoo! Finance. Retrieved April 28, 2022, from <https://finance.yahoo.com/>