The Journal of Prediction Markets 2022 Vol 16 No 3 pp 67-79

EXPLAINING THE GAMESTOP SHORT SQUEEZE USING INTRADAY DATA AND GOOGLE SEARCHES

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ABSTRACT

This article examines the recent short squeeze of the GameStop (GME) stock in early 2021. This event, although not the only case of short squeeze, has some idiosyncratic features that make it extremely interesting, mainly because it was organized by non-institutional investors through social media like Reddit. Using intraday data during the period January 4, 2021–March 26, 2021, we conclude that volume and Google searches provide useful information, which enables us to explain the GME performance. Moreover, we show that information on volume and Google searches can provide investors with valuable data, but the faster investors have access to this information, the greater the advantages. This analysis could be very useful for scholars and practitioners who examine profitable investment strategies when such conditions emerge in the markets, and it also provides some thoughts for regulators regarding the impact of networks, social or not, on the stability of the financial markets.

Keywords: GameStop; Granger Causality; Short Squeeze; Google Searches

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1 INTRODUCTION

The Coronavirus pandemic significantly influenced the financial markets worldwide, and its economic consequences puzzled scholars, practitioners, and regulators. GameStop (GME) is a new case that attracted the attention of many people who were involved in financial markets because its stock price increased from $18.80 on December 31, 2020 to an intraday $483 on January 28, 2021.

What is the GME? GME is an American video games retailer and consumer electronics in general[1]. It is a company based on its physical stores network and the largest retailer of gaming products with over 5,000 stores worldwide. The profits of the GME have declined mainly due to the increase in online sales. The Coronavirus pandemic drove the price of the stock even lower because in the midst of lockdowns and social distancing measures people turned to online shopping. Based on these negative prospects for the company, hedge funds shorted the stock.

Is shorting something new in financial markets? What makes the GME case special? Short selling is not a new strategy. Many shares are shorted, and the average short positions are around 5% of the outstanding shares. In the GME case, the percentage of shares sold short in relation to the total publicly available shares (percentage of float shorted) has remained close to 100% and in many cases above this threshold since 2019 (Angel, 2021)[2,3]. Thus, the term "short squeeze" describes the GME case better than the term "short sale."

Does something else make the GME case special? The first widely known short squeeze case was that of Volkswagen (Godfrey, 2016). However, the GME is the first widely known case where a large number of small investors, the r/Wallstreetbets community of the Reddit platform (hereafter small investors), went against the big hedge funds. Small investors coordinated to take long positions on the GME price even though the fundamentals were not good and the prospects for the company were not auspicious[4]. The long position on the GME stock price cannot be characterized as rational solely based on the

[1] https://www.sec.gov/Archives/edgar/data/1326380/000132638016000320/a10k-fy15q4.htm

[2] https://www.forbes.com/sites/jonathanponciano/2021/02/10/meme-stock-saga-officially-over-gamestop-short-interest-plunged-70-amid-20-billion-loss/?sh=6832e9e8b213

[3] https://www.bloomberg.com/news/articles/2021-02-01/gamestop-short-interest-plummets-in-a-sign-traders-are-covering

[4] Though difficult to pinpoint, the GME story can be traced back to a video on YouTube by Keith Gill, in which he presents his analysis that GameStop is an undervalued stock price. As he mentioned, he invested in GME at a price around $5 per share and he claimed that GME was the most asymmetric opportunity in the market. He also emphasized that the short interest/adjusted float index is over 100%. This analysis certainly had an impact on how members of the r/Wallstreetbets

fundamentals and the prospects for the company. The coordination of the small investors and the short squeeze conditions made this irrational behavior profitable[5].

Coordinated investments is a crucial issue for the stability of the financial system, and the soaring usage of social media and Internet platforms make coordination easier than ever before in human history. Therefore, we examine whether Google searches (data from the Google Trends tool) can be an important explanatory variable in the analysis of the GME stock. Moreover, we test the role of volume on GME performance. In order to provide empirical evidence for our assumptions, we use intraday data of the GME stock prices for the period January 4, 2021 up to March 26, 2021.

The rest of the paper goes as following: Section 2 presents the theoretical framework and Section 3 the descriptive statistics of the study. Section 4 explores the causalities between the basic variables of the study, Section 5 econometrically presents the GME case, and Section 6 concludes the study.

2 THEORETICAL FRAMEWORK

The GME drew the attention of scholars and for this reason a significant number of contributions have already been presented in the financial literature. Various aspects of the event have been examined in these studies, such as the influence of the put-call ratio, the number of tweets, the short sales, and the traditional media on GME performance (Umar et al., 2021); sentiments using textual analysis (Long et al., 2022); increased attention surrounding the GME case as this was reflected by Google Trends and its impact on the price of the share (Lyócsa et al., 2021)[6]; the abnormal returns and the anti-leverage effect that emerges during the GME turmoil and which constitutes a violation of the EMH (Vasileiou, 2021). This note focuses on the GME turbulence period and examines factors and views that have not been

community viewed the GME stock. Was GME an underpriced stock, or did the short squeeze lead to the skyrocketing increase of the price?

[5] The subreddit r/Wallstreetbets investors decided to buy and hold the GME shares in order to increase the GME stock prices because hedge funds, which initially had shorted the stock had to buy these shares back in order to close their short positions. Moreover, the rise in GameStop share price attracted new short sellers who expected its price to fall after the short squeeze, while buying a call option to hedge the risk. Buying a call option from short sellers forces market makers to buy the underlying stock to hedge the risk, further raising the price of the stock. GME is a case that illustrates that demand and supply curves of a stock are not subject to asset price models (Godfrey, 2016). For example, the increase of the GME price from $18.80 on December 31, 2020 to an intraday $483 on January 28, 2021 cannot be rationally justified by significant corporate news regarding GME during this period.

[6] In this study, Google Trends are used as explanatory variables in a panel dataset, in which the GME is included.

explored yet: the impact of volume and Google Trends on the intraday performance of the GME[7], and the significance of the speed of the arrival of information.

The role of volume in financial markets is significant, especially in investment strategies, which work outside the EMH framework, such as technical analysis (Blume et al., 1994). Studies show that there is a positive correlation between volatility and volume (Gallant et al., 1992) and a causal relationship between the trading volume and the returns of an asset (Balcilar et al., 2017). It has also been established that trading volume affects volatility (Bohl & Henke, 2003). Most of the studies regarding GME suggest that this case cannot be considered as a normal case in financial markets and that the coordination issue should be taken into serious consideration by regulators in order to protect the stability of the financial system. Thus, volume should be a significant explanatory variable in the GME case because when a coordinated group of small investors decide not to sell their shares until a high price is offered, the volume should be low (and vice versa). Figure 1 presents GME performance and trading volume between January 4, 2021 and March 26, 2021.

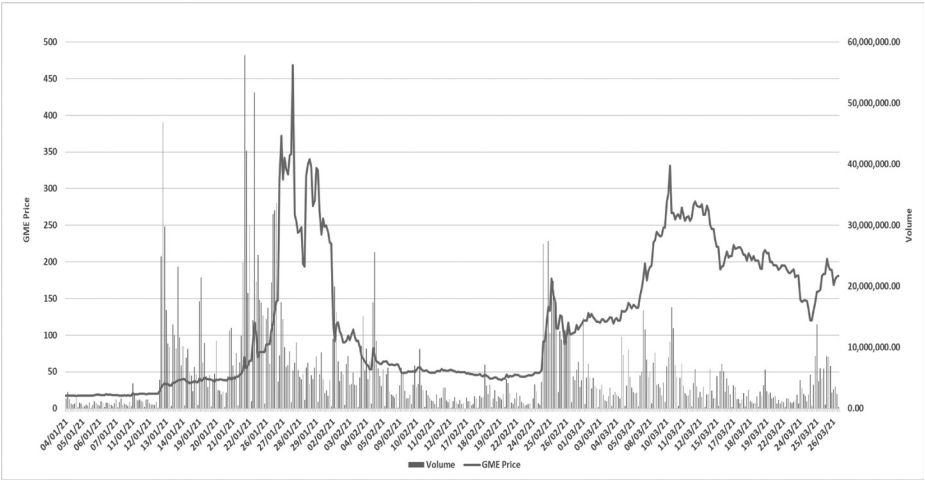

Figure 1. Price performance and volume of GameStop shares

The EMH assumes that stock prices always incorporate all the available information (Fama, 1970). Therefore, the speed at which information spreads is a crucial factor in financial markets. The Internet has a played a crucial role

[7] We use hourly data because they enable us to focus only on the turbulence period and they allow us to have a sufficient amount of data for reliable statistical evidence. Other studies that use daily data have to use either a larger sample or panel data in order to increase the number of observations, while the more frequent data cannot be corresponded to the number of Google searches.

in accelerating the sharing of information, so much so that its role with regard to stock prices and information can be perceived as a structural change in the financial markets (Wilhelm, 2001; Drehmann et al., 2005). Google searches are a useful tool that enable scientists to predict several issues of social life (Nuti et al., 2014; O'Leary & Storey, 2020), and in the last years they have become a significant tool for the study of the financial markets (Preis et al., 2013; Hamid & Heiden, 2015; Vasileiou, 2020). For the purpose of our study, we use an hourly index of Google Trends, which includes the terms "GameStop," "Wallstreetbets," "short squeeze," and "Robinhood" because these terms adequately cover the GME topic (GME Google Index). The range of the values of the index is 0–100; the higher the value, the greater the interest regarding the GME in the USA. Figure 2 presents the price performance of GME and the GME Google Index during the examined period.

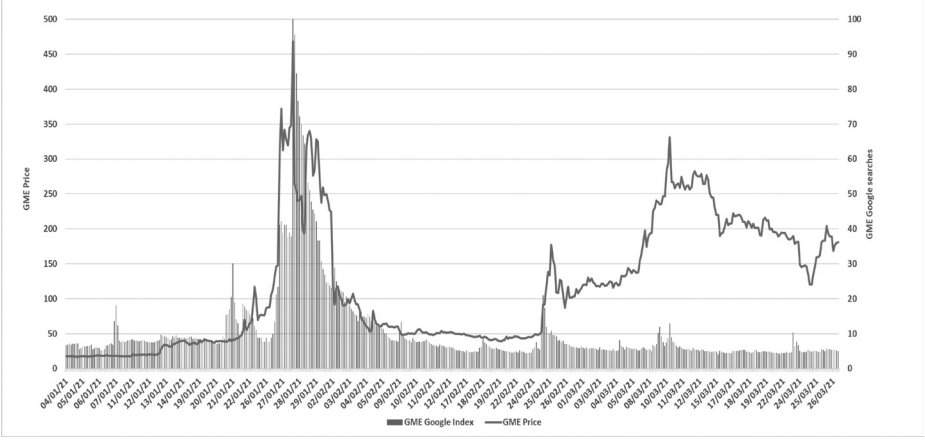

Figure 2. Price performance and GME Google Index

Note: The GME Google Index is an hourly index of Google Trends, which includes the terms "GameStop," "Wallstreetbets," "short squeeze," and "Robinhood" because these terms adequately cover the GME topic. The range of the values of the index is 0–100; the higher the value, the greater the interest regarding the GME in the USA.

3 DESCRIPTIVE STATISTICS

In our study, we use hourly data of the GameStop stock for the period January 4, 2021–March 26, 2021[8], and we calculate the daily returns using the formula:

$$GME_t = \frac{Gamestop\ Price_t}{Gamestop\ Price_{t-1}} - 1 \qquad (1)$$

[8] We obtained our data from the Eikon database.

where GME_t is the GameStop return in time/hour t, and $GameStop\ Price_t$ and $GameStop\ Price_{t-1}$ is the GameStop price in the current and in the previous working hour, respectively. Moreover, in our study we use the first differences of the per hour performance of the GME Google Search Index and the Volume (d_Google_t and d_Volume_t, respectively), in order to (a) resolve stationarity issues, and (b) examine the impact of the growth/decline of the GME Google Search Index and GME trading volume on hour t relative to the previous hour. The descriptive statistics of these variables are reported in Table 1.

Table 1. Descriptive Statistics of the Returns of GameStop, and the First Differences of Trading Volume Google Search Index and Trading Volume from Jan 4, 2021 to Feb 4, 2021

Statistic	GME_t	d_Google_t	d_Volume_t
Mean	1.013%	0.00	–2,840.96
Median	0.040%	–0.08	–148,154.00
Maximum	109.954%	62.22	37,225,492.00
Minimum	–48.889%	–11.13	–30,961,480.00
Std. Dev.	10.807%	3.55	5,912,830.00
Skewness	3.479	11.89	0.27
Kurtosis	34.540	206.63	13.69
Jarque-Bera	20,125.390 (0.0000)*	810,861.20 (0.0000)*	2,209.90 (0.0000)*
Augmented Dickey-Fuller Test (ADF)	–20.497 (0.0000)*	–21.337 (0.0000)*	–10.318 (0.0000)*

Note: This table shows the descriptive statistics of the variables of our sample. GME_t is the GameStop return in time/hour t. We use the first differences of the other variables in order to resolve stationarity issues. d_Google_t and d_Volume_t indicate the growth/decline of the GME Google Search Index and GME trading volume relative to the previous hour.

* indicates statistical significance at 1% level. p-values are presented in parentheses.

The descriptive statistics of our sample show that the variables:

- do not follow the normal distribution, according to the Jarque-Bera (JB) test, therefore a linear model is not appropriate for our dataset, and
- are stationary, according to the Augmented Dickey-Fuller Test (ADF), which means that we can use the variables without any further adjustment.

4 THE ROLE OF VOLUME AND GOOGLE SEARCHES ON GME PERFORMANCE: THE GRANGER CAUSALITY TEST

We employ a linear Granger causality test (Granger, 1969) following Shen et al. (2019) using the following equations:

$$GME\ Returns_t = c_0 + \sum_{i=1}^{n} c_{1i} GME\ Returns_{t-i} + \sum_{i=1}^{m} c_{2i} X_{t-i} + \varepsilon_{1t} \qquad (2)$$

$$X_t = d_0 + \sum_{i=1}^{n} d_{1i} GME\ Returns_{t-i} + \sum_{i=1}^{m} d_{2i} X_{t-i} + \varepsilon_{2t}$$

where $X = d\_Google$ (and *d_Volume*), and the lag length is determined by the Schwarz information criterion. The optimal lag period is 1. The results are presented in Table 2.

The Granger causality shows a bidirectional causality between *GME Returns* and *d_Volume*, which means that these two variables Granger cause each other. However, there is a one direction causality from *d_Google* to *GME Returns* and this indicates that the changes in peoples' interest in the GME case during the examined period, as this was expressed by the number of searches via Google, Granger cause the returns, but the vice versa causality does not exist.

Table 2. Granger Causality between *GME Returns* and *d_Google/d_Volume*

Null Hypothesis	***F*-Statistic**
d_Volume does not Granger Cause *GME Returns*	27.256 (0.000)*
GME Returns do not Granger Cause *d_Volume*	13.046 (0.000)*
d_Google does not Granger Cause *GME Returns*	9.739 (0.001)*
GME Returns do not Granger Cause *d_Google*	0.020 (0.889)

Note: * indicates statistical significance at 1% confidence levels. Number of observations 463, Optimal number of Lags 1.

5 MODELING THE GAMESTOP CASE

In order to model the GameStop performance, we employ a GARCH family model because, as we presented in the descriptive statistics section, a linear model is not appropriate for the specific dataset[9]. Among several examined

[9] We have run linear models and we observed that these models suffer from autocorrelation and ARCH-LM issues.

GARCH family models (EGARCH, TGARCH, IGARCH), we finally concluded that the GARCH(1,1) model, which follows the *t*-distribution in the error term, is the most appropriate model for our dataset because: (i) it resolves the autocorrelation and ARCH-LM issues, and (ii) presents the lowest values of the Akaike and of the Schwarz Information Criteria among the examined models[10]. The model has the following architecture:

$$GME\ Returns_t = a_0 + a_1 \times d_{Google_t} + a_2 \times d_{Volume_t} + \varepsilon_t \quad (3)$$

$$\sigma_t^2 = c + \alpha \times \varepsilon_{t-1}^2 + \beta \times \sigma_{t-1}^2 \quad (4)$$

where d_Google_t and d_Volume_t are the growth Google Index and the number of volume from hour-to hour, and ε_t is the error term, which follows the *t*-distribution. For the variance equation, α and β are the coefficients of the ARCH (ε_{t-1}^2) and GARCH (σ_{t-1}^2) terms, respectively, which should be positive ($\alpha, \beta > 0$) and their sum lower than 1 ($\alpha + \beta < 1$). Term *c* represents the long-term average value of volatility. The results are presented in Table 3.

Table 3. GameStop GARCH Model

GARCH(1,1) Estimation		
Mean Equation		
	Mean Equation (without lag) (Eq. 3)	**Mean Equation (in which 1-hour lag values are included) (Eq. 5)**
a_0	0.001824 [0.001618]	0.001788 [0.001620]
a_1	0.003856* [0.000842]	0.003664 [0.000794]*
b_1		–0.002452* [0.000823]
a_2	2.84E-09* [4.03E-10]	2.90E-09* [4.19E-10]
b_2		–4.78E-10* [4.52E-10]

[10] The second-best model according to the Akaike and the Schwarz Information Criteria was again the GARCH(1,1) model with generalised error distribution. The empirical evidence was similar to those reported in Table 3.

Table 3. (*Continued*)

Variance Equation		
c	0.000165* [1.56E-10]	0.000182* [1.42E-10]
α	0.134421* [0.026552]	0.135724* [0.027684]
β	0.849389* [0.029538]	0.846018* [0.031288]
***Q*-Statistics and ARCH LM Tests**		
Q_1	0.7642 (0.382)	1.1253 (0.289)
Q_2	1.7219 (0.423)	1.9201 (0.383)
Q_3	3.3916 (0.335)	3.5658 (0.312)
LM_1	0.030271 (0.862)	0.026426 (0.871)
LM_2	0.017632 (0.983)	0.017841 (0.982)
LM_3	0.024439 (0.995)	0.025805 (0.994)

Note: * indicates statistical significance at 1% level. Standard deviations are reported in brackets and *p*-values in parentheses. The values of LM test are the *F*-statistic.

The second column shows the GARCH(1,1) version, which includes the contemporaneous explanatory variables:

$$GME\ Returns_t = a_0 + a_1 \times d\_Google_t + a_2 \times d\_Volume_t + \varepsilon_t \quad (3)$$

$$\sigma_t^2 = c + \alpha \times \varepsilon_{t-1}^2 + \beta \times \sigma_{t-1}^2 \quad (4)$$

and the third column shows an additional version of the model in which the 1-hour lagged variables are included

$$GME\ Returns_t = a_0 + a_1 \times d_{Google_t} + b_1 \times d_{Google_{t-1}} + a_2 \times d\_Volume_t + b_2 \times d\_Volume_{t-1} + \varepsilon_t \quad (5)$$

while the mean conditional variance equation is the same as Equation 4. The on-time arrival of the information regarding the peoples' interest in GME has a positive impact on GME performance (a_1 positive and statistically significant), but when the information arrives with 1-hour lag the impact is negative (a_2, negative and statistically significant). The role of volume is positive and statistically significant on the contemporaneous information (b_1, positive and statistically significant in both versions), but when obtained with a 1-hour lag the information about the changes in trading volume is not beneficial for more accurate estimations of the GME performance.

With regard to econometrics, the model satisfies the requirements $\alpha, \beta > 0$ and $\alpha + \beta < 1$, while the Q-statistics and the ARCH-LM tests show that the models do not present autocorrelation and LM issues. The results of the mean equation indicate that: (i) when Google Searches increase, the returns of GameStop's stock increase (and vice versa) because a_1 is positive and statistically significant at the 1% confidence level, and (ii) when the volume increases, the stock prices increase because a_2 is positive and statistically significant at the 1% confidence level. These results are consistent with previous studies that suggest that Internet publications/searches regarding GME are positively linked to the GME returns. Moreover, in accordance with previous studies regarding the role of volume, when the volume increases the GME price increases too (and vice versa).

However, we examine another version of the mean equation of the GARCH(1,1) model in which we add the explanatory variables with 1-hour lag. The reason is that the Google searches index can be available to the user with 1-hour lag. The information of the changes in trading volume is easily drawn in time immediately, but some adjustments to the variable should be made. Therefore, the second version of the GARCH(1,1) has the following mean equation:

$$GME\ \ Returns_t = a_0 + a_1 \times d\_Google_t + b_1 \times d\_Google_{t-1}$$

$$+ a_2 \times d_{Volume_t} + b_2 \times d_{Volume_{t-1}} + \varepsilon_t \qquad (5)$$

while the mean conditional variance equation is the same as Equation 4.

The results of the second version are reported in last column of Table 3. The empirical evidence of the second version shows that the *d_Google* information, which is instantly available has a positive relationship with the GME price, but when this information comes with a 1-hour lag, it has a negative influence. This is another indication of how important the speed of information is. If the investors can have instant access to the latest information via Google searches, they can have/get reasonable returns. Information on volume obtained with a 1-hour lag does not have a statistically significant influence on the GME returns.

6 CONCLUSIONS

Using intraday hourly data for the period January 4, 2021–March 26, 2021, we examine the short squeeze of the GameStop stock. We present the role of volume and the interest of investors to gather information regarding the GME. In order to quantitatively present interest in the GME, we use a Google Trends index with terms relative to the GME case. The empirical evidence shows that there is strong bidirectional causality between GME trading volume and GME

performance, and a strong one-way causality, which runs from Google searches to GME returns.

Moreover, we employ a GARCH(1,1) model and we provide empirical evidence that increases in trading volume and in GME Google searches has a positive and statistically significant impact on GME prices (and vice versa). However, we further examine our dataset, and we highlight the importance of the speed of the arrival of the information as far as the Google searches. The Google index with a 1-hour lag has a negative impact on GME performance. Contrarily, the fact that information on trading volume is easily and instantly available for all investors may be the reason why the 1-hour lag does not have an impact on the GME stock price, but the contemporaneous variable does.

Thus, the 1-hour lag is important for investment decisions, especially for short-term investors. Most people have the Google Trends information with a 1-hour lag; therefore instant access to Google Trends information[11] would be a very useful tool for investors. Our findings suggest that increased interest in the GME, as quantitatively depicted by Google Trends contemporaneous indices during the short squeeze period, has a positive influence on the GME price and this conclusion is consistent with the findings of previous studies (Umar et al., 2021; Long et al., 2022). However, we stress that it is very important to have the information about peoples' interest in GME contemporaneously because when the information arrives with a 1-hour lag the stock price has already incorporated the increased interest.

If we assume that increased interest is a significant piece of information for the asset pricing process, this highlights what the EMH suggests, i.e., that information is instantly incorporated in asset prices, and anyone who has this information in time has a better chance of predicting asset prices more accurately. Several questions for future discussion emerge: does anybody have the Google Trends information in time? Should the contemporaneous Google trend information be available to anyone who is interested in it, e.g., by using an online tool? Should the contemporaneous information be free of charge?

Generally, the GME case is a lesson, which is worth examining further. Coordination via platforms may cause instability in financial markets. Given the right conditions, such as the short squeeze in the GME case, a group of coordinated investors may lead a stock to an irrational skyrocketing price. The regulators should examine how the financial stability of the system could be protected. We can argue that the short sale is not unusual in stock markets. In many cases, short selling is not irrational, and it is a market discipline tool (Massa et al., 2015). What about the naked short squeeze? Is it rational?

The short sellers in this case bear a significant risk; therefore, either they should accept their losses or the rules regarding the short sales should be revised. Should the regulators monitor investment groups in social platforms

[11] And/or any other tool for social network analysis, which provides information on what interests people/investors.

as proposed in recent studies (Umar et al., 2021)? The reply is positive because coordination may destabilize financial markets. Moreover, regulators should revise what constitutes coordination. For example, could an extremely high short interest be the outcome of a non-social network coordination? Thus, the GME case is a lesson for anyone who is involved in financial markets, and policymakers should examine this issue in great depth in order to create the conditions for a more stable, transparent, and reliable financial system. Finally, the social media era in which we live shows us that further research should be done in search of contemporary tools that draw information from Twitter, Wikipedia, Google Searches, etc. and which can contribute to more accurate estimations.

Conflicts of Interest: The authors declare no conflict of interest.

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