Self-induced consensus formation among Reddit users on the GameStop short squeeze

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The GameStop short squeeze of January 2021, primarily orchestrated by amateur investors on the Reddit r/wallstreetbets (WSB) community, represents an unprecedented example of a collective coordination action on online social media, with tangible impact on the stock market. A theoretical knowledge of the microscopic dynamics that led to this event is still lacking, but empirical evidence suggests that a fundamental understanding of the GME case study requires an endogenous self-reinforcing mechanism able to trigger consensus formation. In this work [1] we characterize the structure and time evolution of WSB conversations, identifying early signs of collective action that can be associated to an increasing level of user commitment towards the short squeeze operation.

The first variable we looked at is the occurrence of stock tickers in the text of posts and comments. As Figure 1A shows, peaks in the Z-scores for "GME" occurrences correspond to all major events of the GameStop saga, and they become more frequent in time, signaling a growth in interest towards GME. It is also noteworthy that peaks of GME occurrences and trading volume of the stock mostly coincide, pointing to a strong relation between the two variables. Another variable of interest is the *sentiment* of comments, that has been analyzed using VADER (*Valence Aware Dictionary and sEntiment Reasoner*)[2]. Figure 1B shows the average sentiment of all daily posts/comments that mention GME. We see that as early as the beginning of December the trend starts to grow significantly (with respect to the baseline which refers to the whole conversation). We can interpret this empirical evidence as a growing commitment towards the GME operation, representing an early sign of consensus formation in the community.

In light of these results, we worked out a model in which user engagement can influence collective behavior and foster the emergence of consensus. We build on the *voter model*, following an approach formally similar to [3]. There are two opinions in the population, ± 1, which in our context can be

associated with participation or not to the short squeeze operation. At each time step a user is selected at random; with probability $1-\lambda$ she copies the state of a random neighbor j, whereas, with probability λ she follows a global field given by a random variable $e(t) = \pm 1$, depending on a control parameter $c \geq 1$ associated with the level of user engagement. Studying the analytical mean-field solution of the model, in Figure 1C we can see how the system exhibits a classic second order phase transition at the critical value $c = e^2$: below this threshold no opinion prevails, whereas, above the threshold the dynamics quickly reaches a stable equilibrium point $|m^*| \neq 0$ that becomes closer to full consensus as c grows. We proceeded on studying how the model behaves on user-user interaction networks extracted from WSB conversation data, by building a user network for each month, from October 2020 to January 2021. Since the success of the short squeeze required a large number of investors who bought and held GME shares, we introduce an extensive order parameter: $M(t) = m(t)\, N_0 e^{qm(t)}$, which grows in time to mimic the many new users who joined the community in correspondence of the squeeze. This extensive magnetization exhibits a sharp transition, as shown in Figure 1D for the January user network, properly describing a sudden and large-scale formation of consensus qualitatively similar to the abrupt growth of GME price, which ultimately represents the best proxy for the success of the short squeeze.

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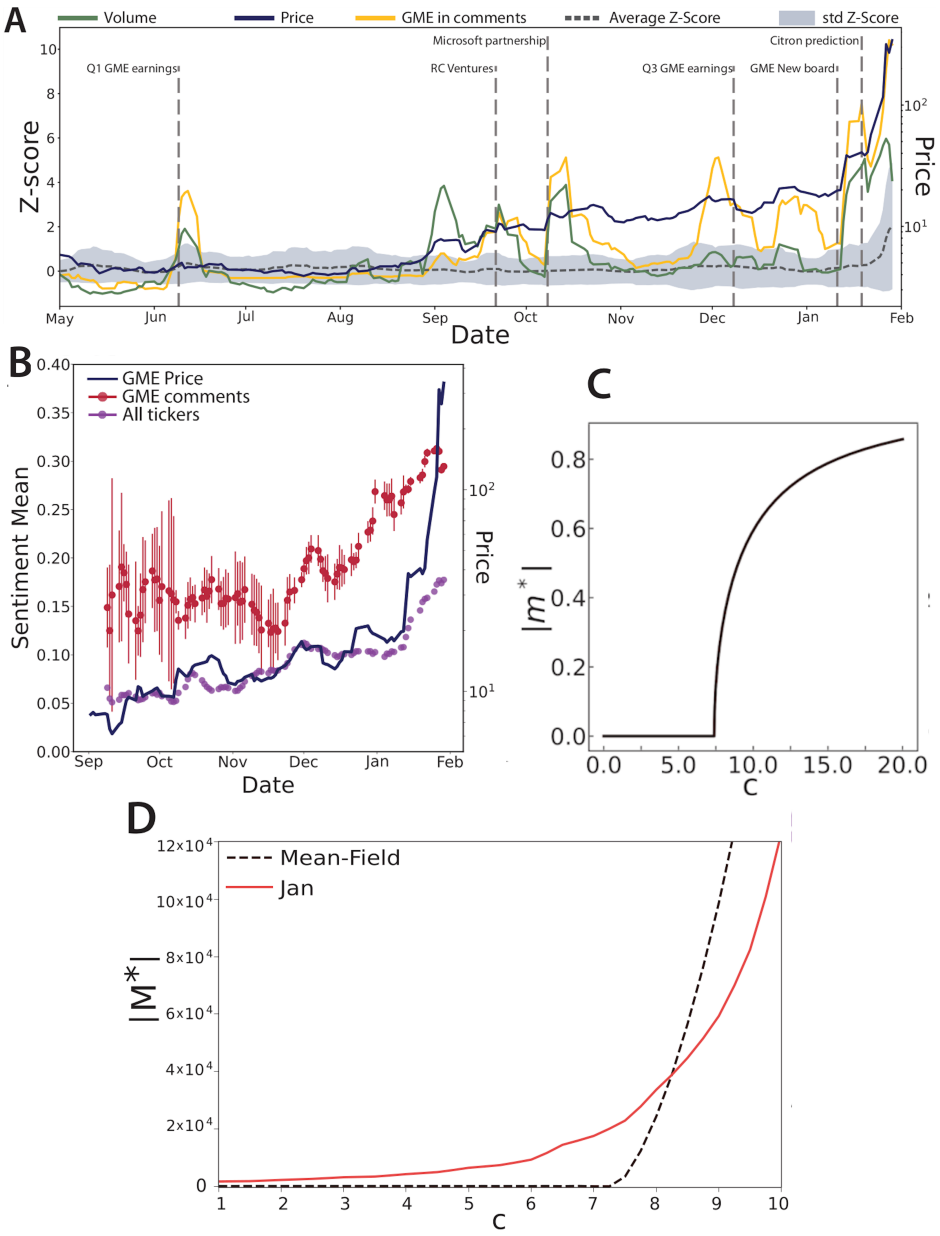

FIG. 1. A) Z-score for the occurrences of "GME" in users comments, compared to the mean Z-score for the occurrences of all stock tickers, and Z-score of the volume of transactions of GME shares. B) Average sentiment of comments containing "GME", with respect to the same quantity computed over all comments and GME closing price. C) Equilibrium points of the magnetization $|m^*|$ as a function of the control parameter c (the level of user engagement), according to mean field approximation. D) Phase transition of the extensive order parameter in the model and for empirical user-user network in Januray.