Research on the User Behaviour Game Analysis of Social Network Rumour Propagation Based on the Weibo

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Keywords: Social Media, Weibo Rumor Propagation, Game Theory, User Behavior, Multi-Group Game-Theoretic Model.

Abstract: "Rumor propagation on social media poses significant challenges to public trust and social stability." In today's digital world, rumour propagation on social media has posed significant challenges to public trust and social stability. Weibo, China's dominant social media platform, accelerates rumor propagation through its openness and real-time features, leading to social panic, trust crises, and economic losses. This paper innovatively develops a multi-group game-theoretic model that classifies users into spreaders, refuters, and ordinary users, analyzing their payoff functions and strategic choices through Nash Equilibrium theory to uncover the potential influence factors of rumor spread. The study demonstrates that algorithmic recommendation mechanisms, users' psychological characteristics, and the response efficiency of debunking systems constitute the three pivotal factors affecting rumor propagation. Accordingly, we propose an integrated solution framework: restructuring platform incentives to modify user payoffs, implementing media literacy programs, enhancing rumor-refuting systems for rapid response, and recalibrating algorithms to reduce misinformation exposure. This research not only extends the application of game theory in social media studies but also establishes a theoretically grounded and practically viable approach for platform governance, providing actionable insights for improving social media governance and mitigating the negative impacts of rumors.

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1 INTRODUCTION

As the social network develops by leaps and bounds, Weibo, as one of the largest social media platforms in China, has become a significant channel for information dissemination. However, the democracy of knowledge and resources also makes rumor propagation easier. Until 2025.3.14, the Chinese Internet rumor-refuting platform Weibo has released 13097 posts about clarifying rumors, which even ignored the unfound rumors. The spread of fake information can not only cause social panic but can also severely harm commercial brands, government credibility, and individuals' reputations. For instance, The cover of Hong Kong-based Next magazine said, "Bawang causes cancer" and claimed the product contained dioxane. The whole article was merely based on "expert speculation" alone, and the listed company with annual sales of HK $1.7 billion lost HK $2.4 billion. Therefore, investigating the users' behavior in rumor spreading on the internet, especially from a multi-group game-theoretic perspective, is of significant practical importance and urgency.

This paper selects Weibo as an example and a research object to analyze participants' acting strategies(e.g., spreading, refuting, silence) when they face rumors based on a game theory. It can not only provide an iconic example and theoretical foundations for rumor control on general platforms but also offers valuable insights for national authorities and enterprises in formulating information management strategies, showcasing crucial social and commercial values.

In the field of online rumor propagation, many scholars have already explored the topic from various perspectives, for example:

Li, Ma, and Fang investigated the impact of emotion types and intensity on rumor spreading,

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finding negative feelings have a more significant influence on the evolution of rumors. But, they mainly focused on sentimental aspects, lacking the overall strategy analysis (Li, Ma, and Fang, 2023).

Yi, Liu, and Wang proposed the Twin-SIR model to analyze the unsatisfactory speed of clarifying rumors and introduce a "rumor dispeller" to improve it. But, they did not deeply consider the game-theoretic aspects of participants' strategies (Yi, Liu, and Wang, 2021).

Li and Liu set up the ET game model to find an equilibrium but did not combine it into empirical data, particularly social media (Li and Liu, 2016).

Liu and Liu developed a tripartite evolutionary game model based on game theory. This consists of the insider, the media, and the government regulatory agencies (Liu and Liu, 2021).

Liu, Wang and Ouyang modeled all online users are represented as a node in one of five compartments. The transition dynamics are obtained as a system of ordinary differential equations, and the system is described using an edge-based formulation (Liu, Wang and Ouyang, 2022).

Although much research has been conducted on rumor propagation on the internet, most studies focus on dynamic models, sentimental factors, or improvement of present rumour detection systems; few scholars have deeply investigated the interaction of users' behaviour strategies and application in reality from a game-theoretic perspective. This paper aims to fill this gap by constructing a multi-group game-theoretic model to analyse user behaviour and its impact on rumour propagation.

In order to achieve this, filling this gap, the following structure of this paper is presented:

Firstly, the establishment of a multi-group game-theoretic model is completed, categorizing participants into spreaders, refuters, and ordinary users and analyzing their strategy choices (e.g., spreading, refuting, silence) and payoff functions, which is based on the real data from Weibo.

Secondly, the Nash Equilibrium will be solved to explore different behavior strategies under equilibrium and their influence on rumor transmission.

Thirdly, parameter analysis and sensitivity testing are conducted to examine the specific effect of different factors (e.g., spreading benefits, refuting cost) on rumor spreading.

Finally, the rumor-preventing strategies based on the results will be proposed to offer the theoretical foundations for rumor control on social platforms.

2 CASE DESCRIPTION

2.1 Introduction of Weibo as a Typical Social Media Platform

Weibo, as the counterpart of Twitter, is one of the most prevailing social media platforms in China, with over 605 million monthly active users until 2023. It enable people around the world to communicate instantly and easily, democratizing variable information and updating users on current affairs. With the characteristics of openness and frequent interaction, Weibo has become a hotspot for both legal information dissemination and the transmission of rumors. This platform's real-time nature and large user base make it particularly vulnerable to the rapid spread of fake news, which can lead to critical social and economic consequences.

2.2 Overview of Rumor Propagation on Weibo

As a common phenomenon on Weibo, rumor propagation is often exaggerated by high user engagement and fast dissemination speed. According to the "2023 Weibo 'We-Media' Governance Report", until 2023, Weibo has already handled over 27000 rumors and over 428000 fake accounts. These rumors cover a wide range of aspects, including medical health, food security, and social science, influencing people quietly.

2.3 Main Characteristics of Rumor Propagation on Weibo

There are several predominant features of rumor:

Fast speed and large scale: Since Weibo is a real-time platform with the convenience and availability of vast information, with just a single click, rumors can spread there at a rate never seen before. Within hours, a single rumor can reach millions of users, making it challenging to stop once it starts to spread.

Conformity of user behavior: People frequently participate in rumor spreading on Weibo merely because they are curious, afraid, or want to contribute eye-catching content. Therefore, rumors are further spread via the platform's algorithm, which gives priority to popular subjects.

Impact on society and economy: Rumors on Weibo have the potential to cause social unrest, harm to people's reputations, and financial losses, along with other not-mentioned negative consequences. For instance, the "Bawang causes cancer" event, which

was mentioned before, has resulted in the loss of HK $2.4 billion to the company.

According to the relevant research, the rumors also tend to possess periodic spikes, different from the single prominent sipes in terms of the temporal aspect, illustrating the repeated characteristic of rumors; the fake news is also inclined to form a "Bigfoot" diffusion network rather than "Summize" diffusion network, demonstrating the blindness and uni-directivity of rumors (Kwon, Cha, Jung, Chen & Wang, 2013). The spread of rumors on Weibo is a complicated problem that presents serious difficulties for the site and its users. Consequently, social media's dynamic nature necessitates ongoing efforts to address this issue adequately.

3 ANALYSIS OF THE PROBLEM

3.1 Severe Influences of Rumor Propagation

3.1.1 Social Panic and Trust Crisis

The rapid spread of rumors often leads to social unrest, especially on prevailing social platforms like Weibo. For example, during the COVID-19 pandemic in 2020, false information about the origin and treatment of the virus spread widely on social media, resulting in large-scale social panic and distrust in the government and medical institutions (Bukhari, 2020). Many people were already swayed by the rumors when official sources tried to provide clarification, which resulted in resistance and a skeptical attitude towards official comments. Because it damages the credibility of reliable sources and makes future communication attempts more difficult, this crisis of confidence may have long-term consequences. The psychological impact of such rumors can also lead to a breakdown in social cohesion, as individuals become more suspicious of each other and less willing to cooperate with authorities. These declinations on government credibility not only destabilize society but may also lead to public resistance to official information, further exacerbating the chaos in rumor dissemination.

3.1.2 Damage to Individual, Group, or Brand Reputation

The blinded transmission of fake news can also cause severe consequences to related people or brand reputation. For instance, in 2022, there was a common rumor that a "nurse was playing on her phone while rescuing a child." However, the nurse was actually using her phone to call a doctor for help with the rescue. The rumor-creators purposefully made up false information to gather attention, which was extremely deceptive, and took advantage of the important roles that nurses and volunteers play in preventing and controlling epidemics (Global Times, 2022). Despite the clarifications on the multi-platforms, the impact of the rumor still exists and even spreads. Such reputational damage not only affects the short-term individuals' mental health, the credibility of medical workers, or the economic interest of relevant corporations but may also have long-term implications for their development. The damage to reputation is often difficult to quantify but can have lasting effects on both personal and professional lives.

3.1.3 Fluctuation in Economy and Market

Rumor propagation can also trigger the whole economy and market to become more unstable. Like the "Bawang causes cancers" fake news, which is mentioned before, a single false claim leads to a loss of HK$2.4 billion for a listed company, causing significant losses to investors. In addition to disrupting businesses' regular operations, this economic volatility may also have an adverse impact on the entire industry. In certain instances, rumors may result in regulatory scrutiny, legal disputes, and higher operating costs for businesses attempting to repair the harm. The financial impact of rumors is not restricted to specific businesses; it can also impact entire sectors, causing wider economic instability. This fake information about certain corporations can lead to drastic fluctuations in stock prices and market shares, undermining investor confidence and market stability, resulting in a ripple effect on the entire industry. In 2012, following political unrest in the Maldives, a rumor spread claiming the country was unsafe for tourists. Despite government clarifications, the rumor led to massive cancellations of travel plans and a sharp decline in hotel bookings. This incident highlights the devastating impact of rumors on the tourism industry, causing significant economic losses for the Maldives in a short period.

3.1.4 Psychological Impact on Individuals

In addition to the negative social and economic effects, rumors can have a significant psychological effect on people. False information spreading can make people anxious, stressed, and afraid, particularly when it comes to health or personal safety. For instance, during the COVID-19 pandemic,

widespread panic and irrational behavior, including hoarding medical supplies and avoiding healthcare institutions, were caused by rumors about the virus's lethality and the efficacy of specific therapies (Bukhari, 2020). Vulnerable groups, such as the elderly or people with underlying mental health issues, may be most affected psychologically. Rumors have an emotional cost that can result in long-term psychological stress that impairs a person's general well-being and quality of life. According to related research, rumor-spreading behavior is also more significantly influenced by negative emotions (e.g., anger and disappointment), as the recipient is more likely to spread rumors to express emotions or seek empathy. This type of emotion-driven communication behavior is especially prevalent in social networks, which exacerbates the further transmission of fake news (Kim & Bock, 2011).

3.2 Problems of Rumor Propagation on Weibo

3.2.1 Uncontrollability of Information Dissemination

As an open social platform, Weibo's speed and scale of diverse information dissemination are difficult to control. A single rumor can reach millions of users within hours, and the platform's algorithm further accelerates its spread. Although Weibo has already implemented measures such as content moderation and rumor-debunking systems, its response speed and coverage are still insufficient to defeat the rapid speed of false information fully. The fact that a rumor may have reached a large amount of users by the time it is detected and addressed makes it difficult to control. This uncontrollability is a serious problem since it permits rumors to proliferate unchecked, causing extensive harm before they can be successfully challenged.

3.2.2 Complexity of User Behavior

Participants' behaviors in rumor propagation are varied, ranging from passive sharing driven by curiosity or fear to active sharing driven by personal interest. Some users may share rumors without verifying their authenticity simply because the content aligns with their beliefs or interests, while others may actively broadcast incorrect information to get attention, gain followers, or even profit monetarily. According to related research, the variety of user behavior depends on the user's information perception(e.g., Number of followers and social network activity) and activity, individuals' psychological aspect(e.g., Profit-seeking psychology or Herd mentality), and the competitive mechanism of rumor and anti-rumor information (Xiao, Chen, Wei et al., 2019). Another research study also pointed out that people who hesitate to join in the propagation of rumors can even exacerbate their speed (Hu, Pan, Hou and He, 2018). This complexity makes it challenging to predict the motivations behind rumor propagation, which, therefore, further increases the difficulty of rumor control.

3.2.3 Limitations of Rumor-Refuting System

Despite the diverse measures taken by Weibo to deter the dissemination of rumors, the limitation of its rumor-refuting system still exists. According to related research, the speed and scale of refuting information are often less than the rumor itself, and the former is more likely to be confined within the scientific chamber without being exposed to a large number of ordinary people, which results in limited efficiency. Additionally, the results of the research showed that some users have low trust in rumor-refuting information and even resist it. This resistance can be due to a variety of factors, including pre-existing biases, distrust of official sources, or the influence of echo chambers within social networks (Zollo, Bessi, Del Vicario et al., 2017). In some cases, debunking efforts may even have the opposite impact, as users who are deeply invested in a particular rumor may view the debunking as an attempt to suppress the truth, leading to further resistance and skepticism.

3.2.4 Algorithmic Amplification of Rumors

The platform's algorithm's function in spreading misleading information is one of the biggest obstacles to regulating rumor propagation on Weibo. The algorithm gives priority to content that receives a lot of likes, shares, and comments. The algorithm is more likely to promote rumors than true facts since rumors frequently provoke powerful emotional responses. As a result of this algorithmic bias, rumors spread more quickly since they become more visible when more people share them. Recording to a relevant research, videos with a high level of involvement (likes, comments, shares) are typically recommended by the social media's algorithm. The rumor may spread more quickly if the algorithm pushes it to more users and creates a lot of interaction, especially if the information is controversial. Second, the algorithm might distribute the item to more users faster if it is produced when users are active, which would accelerate the spread of the rumor. Additionally, users

still tended to employ algorithmic hashtags (such as #fyp, #foryou) to boost visibility, even though the study indicated that utilizing popular hashtags did not directly enhance the number of video plays. The algorithm may mistake the rumored content for popular content and recommend it to additional viewers if it utilizes these tags. Lastly, because people don't fully comprehend the algorithm, they try different tactics to cater to it. Because of this uncertainty, rumor content may be chosen by algorithms and disseminated using a variety of tactics (e.g., high interaction, contentious headlines, etc.) (Klug, Qin, Evans and Kaufman, 2021). To solve this problem, social media algorithms' content prioritization must be fundamentally rethought, placing more weight on accuracy and dependability than just engagement numbers.

4 SUGGESTIONS

4.1 Optimizing Platform Governance Through Incentive Mechanisms

The rapid and large-scale spread of rumors on Weibo stems from the platform's open nature and algorithmic amplification. To mitigate this, Weibo should adopt a multi-layered governance approach by using the multi-group game-theoretic model.

4.1.1 Construction of the Multi-Group Game-Theoretic model

Participants: Spreaders, Refuters, and Ordinary users

Strategies: Spreaders: Spreading or Not Spreading; Refuters: Refuting or Not Refuting; (P.S. Ordinary users choose silence as the default strategy and do not include it in the calculation of Nash Equilibrium.)

Parameter Setting:

Spreader's payoff:

Successful spread: +B (social capital, e.g., increase the fan base).

Being refuted: −C (penalty, e.g., account suspension).

Refuter's payoff:

Successful refute: +R (platform reward).

Cost of refuting: −E (time effort).

Construction of the matrix, as shown in Table:

Table 1: Payoff Matrix of Rumor Propagation Participants

	Refuters: Refuting	Refuters: Not Refuting
Spreaders: Spreading	(B-C, R-E)	(B, 0)
Spreaders: Not Spreading	(0, -E)	(0, 0)

4.1.2 Calculation of Nash Equilibrium

From Spreaders' perspective, firstly, suppose Refuters choose "Refuting", Spreaders will get (B – C) for "Spreading", and 0 for "Not Spreading". Therefore, their optimal strategy is to choose "Spreading" if (B−C)> 0; otherwise, the optimal strategy is to choose "Not Spreading".

Secondly, suppose Refuters choose "Not Refuting", Spreaders will get B for "Spreading", and 0 for "Not Spreading". Therefore, their optimal strategy is always choosing "Spreading" if B > 0.

From Refuters' perspective, firstly, suppose Spreaders choose "Spreading", Refuter will gets (R – E) for "Refuting", and 0 for "Not Refuting". Therefore their optimal strategy is to choose "Refuting" if (R – E) > 0; otherwise, the optimal strategy is to choose "Not Refuting".

Secondly, suppose Spreaders choose "Not Spreading", Refuters' payoff is 0, regardless. Therefore, their optimal strategy is always choosing "Not Refuting" to save cost.

Consequently, we can conclude 2 Nash Equilibrium from the analysis above:

Firstly, when B > 0 and (R-E) <= 0, Spreaders choose "Spreading", and Refuters choose "Not Refuting".

Secondly, when (B-C) <= 0 and (R-E) > 0, Spreaders choose "Not Spreading", and Refuters choose "Refuting".

4.1.3 Application in Real Cases

The game-theoretic model suggests that modifying user payoffs can effectively reduce rumor propagation. Therefore, Weibo should modify these payoffs in its incentive structure to lessen the spread of rumors:

Firstly, reducing the benefits of spreading rumors (B). Applying algorithmic demotion to remove unconfirmed content from recommendation feeds and hot topics reduces its visibility. Additionally, implementing account penalties such as temporarily suspending or shadow-ban accounts that repeatedly share false information decreases their influence.

Secondly, increasing the costs of spreading rumors (C). Using Fact-Checking Alerts to automatically flag suspected rumors with warnings (e.g., "This post conflicts with verified reports").

Thirdly, rewards for refuting(R) should be boosted. Offering tangible benefits (e.g., badges, monetization opportunities) to users who actively debunk rumors. In addition, allowing credible debunking accounts to earn advertisements' revenue or tipping. Also, amplifying official corrections to prioritize posts from verified sources (e.g., health agencies) in users' feeds.

Lastly, the effort to debunk (E) should be lowered. Establishing One-Click Fact-Checking, such as integrating tools like reverse image search and AI-generated summaries of debunking articles.

By applying these measures, users are more inclined to stop spreading and even debunking rumors; the detection of fake news can also develop by leaps and bounds.

4.2 Enhancing Public Awareness and Critical Thinking

To alleviate the amplification of rumors from herd mentality, several measures should be implemented to increase media literacy:

First of all, constructing the interactive pop-ups. Show quick alerts (such as "Have you checked this with reliable sources?") when people try to share content that hasn't been validated.

Secondly, gamify rumor detection by introducing quizzes that test users' ability to identify misinformation. For example, users can complete interactive quizzes on spotting fake news, with top scorers earning badges and rewards such as platform credits or exclusive features.

Thirdly, collaborating with Educators. Platforms should cooperate with schools to promote digital literacy campaigns targeting younger users.

Through the implementation of these measures, rumors can be eliminated from their roots.

4.3 Improving the Rumor-Refuting System

The inefficiency of the current system is caused by poor credibility and delays. Among the solutions are:

Firstly, implement fact-checking in real time. For example, AI can be used to identify possible rumors, closing the "detection gap quickly".

Secondly, use transparent procedures: Make the process of verifying assertions publicly available (e.g., "This was debunked using CDC data").

Thirdly, it involves participation at the grassroots level. Related authorities should train volunteers to become "rumor detectors" to spot local false information promptly.

Consequently, by using the above solutions, the present rumor-refuting system of Weibo could be improved and provide more efficient and useful services to users.

4.4 Algorithmic Adjustments to Curb Rumor Transmission

Since Weibo's engagement-driven algorithm unintentionally spreads rumors, the reformation should involve the following measures:

Firstly, the platform should prioritize the accuracy signals, like ranking content, by using "trust scores" (e.g., past accuracy of the poster).

Secondly, add brief refutation tips before users confirm that they want to share websites. (e.g., "Read this debunking article before sharing?").

Thirdly, construct user customization. Let users filter out unverified topics or mute frequent rumor spreaders.

Through these algorithmic adjustments, the platform can significantly reduce the unintentional spread of rumors."

5 CONCLUSION

This study provides a comprehensive analysis of rumor propagation on Weibo, identifying key factors and proposing actionable solutions from a game-theoretic perspective. The analysis identifies several critical issues, including complex user motivations such as herd mentality and profit-seeking. These motivations stem from users' pursuit of economic benefits and social recognition. Additionally, algorithmic amplification prioritizing viral but unverified content and inefficiencies in the rumor-refuting system (e.g., delayed responses, low credibility) are also involved in these issues. By constructing a multi-group game model, the research categorizes participants into spreaders, refuters, and ordinary users, analyzing their strategy choices based on payoff functions. Nash Equilibrium solutions reveal two scenarios: rumor outbreaks when refuting costs exceed benefits and rumor suppression when incentives align. Proposed suggestions include redesigning platform incentives, enhancing public media literacy, optimizing fact-checking mechanisms, and algorithmic reforms. These suggestions are aimed at reducing the spread of rumors by adjusting

participants' payoff and improving the efficiency of refuting rumors.

This study offers practical and social value. For social media platforms like Weibo, our findings suggest actionable measures to mitigate rumor risks, such as penalizing unverified content and rewarding debunkers. These measures aim to adjust user payoffs, improve debunking efficiency, and reduce rumor propagation. Policymakers may leverage the model to design regulations (e.g., penalty adjustments) to disrupt the rumors that lead to harmful consequences. Additionally, by advocating digital literacy programs, the research contributes to regaining public trust and social cohesion, addressing challenges caused by the transmission of false information during significant events like COVID-19.

A limitation lies in its reliance on secondary data (e.g., published reports), lacking primary user behavior validation. Future studies could: (1) collaborate with platforms to analyze user logs for precise parameter calibration (e.g., quantifying "B" and " R"); (2) compare cross-cultural differences in rumor-spreading strategies; (3) integrate sentiment analysis to explore emotional drivers of equilibrium shifts. Addressing these limitations will enhance the practical applicability of academic findings.

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