

Research on rumors of law and countermeasures based on big data analysis¹

LIU XIAOMING²

Abstract. The spread of rumors in the era of large data transmission shows the new features with diversification of communication channels, the speed of transmission, the interference of noise and the complexity, which has a wide range and broad harm. In order to avoid a series of sudden group events which can be triggered by rumors and avoid the social harm and economic loss caused by a wider range or longer, this paper analyzes the media reports and rumors based on the data analysis technology. Based on this, the rumor spread model used for considering the role of media is established. And then the simulation is carried out to study the influence of media reports on the spread of rumors. The results show that the interaction mechanism between media reports and rumor spread is highly complex. Finally, the strategic suggestion for the spread of rumors is proposed from different aspects by adjusting the parameters under different factors

Key words. Big data, spreading of rumors, media report.

1. Introduction

Rumors are generally defined as unexplained statements or annotations spreading through various channels. They are usually things or problems that can arouse public interests. It is an important form of social interaction without difference between right and wrong, which has greatly affected people's daily work and life. Currently, China has already into the background of large data dissemination, technical development and changes in the way the audience participation, which has a big impact on the dissemination of information. With the changes in the way of communication, the authority of the mainstream discourse is weakened. The most direct result is that the cycle of rumors processing is shorter and shorter, and the controllability is getting lower and lower, which becomes a big challenge for the government to guide the healthy development of public opinion. In this paper, we

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²Yangtze University College of Arts and Science, Jingzhou, Hubei, 4340201, China

explore the law of rumor spread based on the large data analysis and put forward specific countermeasures to provide reference and suggestions for our response to emergencies.

2. Experimental procedure

2.1. Study on the influence of media report on rumor transmission

Media coverage plays a different role in different stages of rumor spread. In rumors spread latency, it can arouse public attention and increase public knowledge, which plays an early warning role. The public's emotions are often easy to intensify when the spread of rumors into the outbreak and the climax period. During this time, the public is in urgent need of official media coverage of the real information, and media reports play a guiding role in public opinion. In the spread of rumors dissipation, the public's emotional change, instability and media coverage play a role in regulating, stabilizing and appeasing the public uneasiness. However, media coverage is not always positive. When the media credibility is not high, and the release frequency is too high, it can easily lead to panic. For example, during the SARS, the government response is not fast enough, and emergency measures are not strong. In addition, the expert voice is too weak, which leads to a variety of rumors and finally triggers a number of snapping up event [1].

At a macro level, media coverage may change the state of the public. New populations with self-protection and people who are skeptical of rumors are appeared. These transmission rates are significantly lower than those without self-protection blind communicator. Misra and others think that the warning role of media is mainly expressed on the group of "easy to dye" state. The people with awareness will no longer contact with the infected state. Obviously, this assumption is too idealistic. Funk and other experts pointed out that media coverage can enhance public scepticism and raise public awareness of self-protection and rational consciousness. These suggestions can enhance public recognition and remind them no longer blindly believing in the rumors. Meanwhile, the public will be treated with caution to avoid economic losses. These findings provide a solid theoretical basis for further study of the impact of media coverage on rumors [2].

2.2. Research on rumor spread patterns considering the media reporting

First, model assumptions and generation rules will be mentioned. Based on the research results of Misra and Funk, this paper explores the interaction mechanism between media coverage and rumor transmission, and establishes the rumor spread dynamics model considering media coverage. The whole population is divided into four categories according to their state: ignorant (I), communicator (S), skeptics (H) and immunized (R). According to the strength of self-protection consciousness, the ignorant and the communicator are divided into two categories: the ignorant I_m

with self-protection consciousness and the ignorant I_u without self-protection consciousness, the communicator S_m with self-protection consciousness and the communicator S_u without self-protection consciousness. Symbol H represents the number of suspects, and R represents the number of immunized persons. The variable M_e indicates the number of relevant events reported by the media. These media reports can improve self-protection awareness and rational awareness. It also can reduce crowd panic and herd behavior. Table 1 gives the meaning of the basic parameters in the model [4].

Table 1. Meaning of parameters in the model

α	Doubt rate coefficient
γ	Immunization rate coefficient
ν	Self-protection awareness coefficient
β_m	Media report infectious rate coefficient
β_u	Rumor transmission rate coefficient
u_i	Ignorant alertness loss rate coefficient
u_s	Communicator's alertness loss coefficient
δ_i	Effective contact rate coefficient of ignorant with self-protection awareness
δ_s	Effective contact rate coefficient of communicator with self-protection awareness
p_s	The impact coefficient of the communicator on the media coverage
p_h	The impact coefficient of the reporter on the media coverage
p	Media report consumption rate

The basic assumptions about the dynamics of media coverage and rumors are as the follows:

(1) Media coverage is affected by the number of communicators and suspects. On the one hand, the rate of change in the number of media reports is proportional to the number of communicators ($S_u + S_m$). The influence coefficient is p_s . On the other hand, the rate of change in the number of media reports is proportional to the number of skeptics H with the speed of proportionality coefficient p_h . With the pass of time and the release of emergency information, the rate of change in the number of media reports has gradually become slow with a speed of the consumption rate p . Therefore, p_s and p_h can be considered as the influence of communicators and suspects on the media, and P is the consumption of media coverage caused by the weakening of vigilance.

(2) In the people of I_m group, the contact with the communicator will be reduced. The contacts include mobile phones, text messages, word of mouth and other means. This paper assumes that the contact rate is reduced to the ratio of δ_i ($0 < \delta_i < 1$), so that the number of ignorant persons who are effectively contacted with the communicator is reduced to $\delta_i I_m$. Similarly, in the people of the S_m group, the effective contact rate between the communicator and the ignorant with the self-protection will reduce [3]. We assume that the ratio is reduced to δ_s ($0 < \delta_s < 1$), then the number of communicators in effective contact with the ignorant is $\delta_s S_m$.

(3) In the people of I_u group, due to the impact of media coverage, the ignorant without self-protection consciousness will become an ignorant I_m with self-protection consciousness at β_m transport rate. The communicator S_u without self-protection awareness will become a communicator S_m with self-protection awareness by a rate of v part. The change of the ignorant with self-protection consciousness is influenced by the media coverage, and the communicator's self-protection consciousness is mainly influenced by the degree of self-protection and the knowledge of the popular science knowledge. With the pass of time, the flow of real information and the impact of human self-forgotten mechanism, self-protection consciousness often lose their vigilance. After a certain period of time, an ignorant I_m with self-protection awareness changes into the ignorance I_u without self-protection awareness by the proportion u_i part. The communicator S_m with self-protection awareness changes into the communicator S_u without self-protection awareness by the rate of u_s part.

The members of I_m group can transform a communicator S_m with protection awareness through connecting with the two communicators S_m and S_u . The members of I_u group can transform a transmitter S_u without protection awareness through connecting with S_m and S_u . Quantity I_u will not directly become a communicator S_m with protection awareness. It will become I_m first, and then will become S_m , or directly will become S_u .

Based on the above four rules, Fig.1 shows the interaction schematic diagram between the media reports and rumors. This paper does not take into account the flow of migratory factors in the discussion.

In conjunction with the model framework, we can see that the rumors of media coverage are as follows:

$$\left\{ \begin{array}{l} \frac{dI_m}{dt} = -\beta_u \delta_i I_m (S_u + \delta_s S_m) + \beta_m I_u M_e - u_i I_m, \\ \frac{dI_u}{dt} = -\beta_u I_u (S_u + \delta_s S_m) - \beta_m I_u M_e + u_i I_m, \\ \frac{dS_m}{dt} = \beta_u \delta_i I_m (S_u + \delta_s S_m) + v S_u - (a + u_s) S_m, \\ \frac{dS_u}{dt} = \beta_u I_u (S_u + \delta_s S_m) + u_s S_m - (a + v) S_u, \\ \frac{dH}{dt} = a(S_u + S_m) - \gamma H, \\ \frac{dM_e}{dt} = p_s(S_u + S_m) + p_h H - p M_e. \end{array} \right. \quad (1)$$

Sudbury and others consider that the population density who never heard the rumor is 0.203 when the total population tends to infinity. That is, due to the limits of transmission and other conditions, in the process of rumor spread, the number of ignorant is relatively stable. Therefore, this paper assumes that the number of ignorant in the whole process is relatively fixed. The total number of ignorant can be approximated as a constant in a short time. This assumption is also very similar to that given by Liu and others. To keep it simple, the symbol $I = I_m + I_u$ and $S = S_m + S_u$ is introduced, which represents the total population of the ignorant and the total number of communicators, respectively. The model of rumor spread

considering the media coverage can transform the following form:

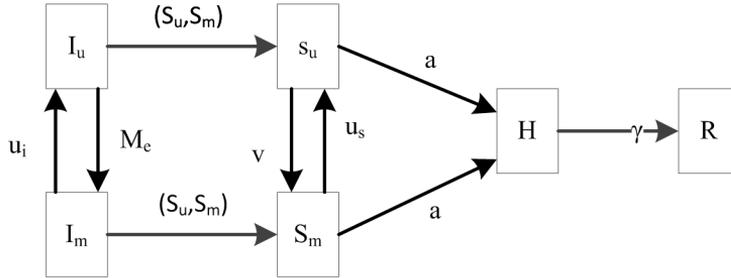


Fig. 1. Schematic diagram of rumor spread considering the media coverage

$$\left\{ \begin{array}{l} \frac{dI_m}{dt} = -\beta_u \delta_i I_m (S_u + \delta_s S_m) + \beta_m (I - I_m) M_e - u_i I_m, \\ \frac{dS_m}{dt} = \beta_u \delta_i I_m (S_u + \delta_s S_m) + v S_u - (a + u_s) S_m, \\ \frac{dS_u}{dt} = \beta_u (I - I_m) (S_u + \delta_s S_m) + u_s S_m - (a + v) S_u, \\ \frac{dH}{dt} = a (S_u + S_m) - \gamma H, \\ \frac{dM_e}{dt} = p_s (S_u + S_m) + p_h H - p M_e. \end{array} \right. \quad (2)$$

In this paper, the model of rumor spread proposed considering media coverage is more general than previous studies.

2.3. Model simulation

The simulation results show that the total number of virtual systems is 5446105, and the number of the initial communicators is one. Generally, the basic number of reproduction is the key threshold value of the rumors spread. Based on the above analysis, this paper calculates the basic regeneration number of the model $R_0 = 1.106$, agreeing with the basic reproductive number data reported by official. In addition, the local equilibrium of the model $E_1 = (763920, 1169.6, 1218.4, 13134, 17909)$ and 5 eigenvalues ($\lambda_{12} = \pm 0.0261$, $\lambda_3 = -0.0746$, $\lambda_4 = -0.3374$, $\lambda_5 = -0.2985$) also can be calculated.

Table 2 shows further evaluated parameters.

Table 2. Meaning of parameters in the model

Symbol	α	γ	δ_i	δ_s	v	p_h	p_s	p	u_i	u_s
Evaluation	0.33	0.05	0.50	0.50	0.27	0.08	0.01	0.06	0.01	0.001

(Note: the evaluation of parameters a , γ , p_h , δ_i , δ_s , p comes from reference, and the evaluation of others comes from survey experiment.)

3. Results and discussion

3.1. Simulation results analysis

Using the Runge-Kutta method, Fig. 2, left upper part, shows the trend of the number of communicators with self-protection and self-protection. This paper simulates the variation of the number of communicators with time changes. It is clear that the number of communicators with self-protection and without self-protection is showing the characteristics of amplitude-cycle oscillations with the evolution of time. In addition, the number of communicators without self-protection awareness shows a large scatter [5]. Fig. 2, left upper part, also shows that the number of people without self-protection awareness is relatively large. These people are more likely to believe in and spreading rumours. During this time, the emergency information released of official can play a better role in public opinion. Fig. 2, right upper part, we can see that the number of suspects and the number of media reports also show the phenomenon of periodic oscillation. The number of rumors and suspects is far greater than the number of communicators, which means that most of the communicators began to think rationally and doubt the original blind rumors after the official release of emergency information. From Fig. 2, bottom part, we can see that the number of people with self-protection awareness also appeared in the trend of cyclical swings with time changes [6].

In order to further study the equilibrium point of the model, this paper uses MATLAB software to give a phase diagram of the rumor propagation model considering the influence of the media. Fig. 3 shows the impact of media reports on the number of skeptical on the plane $M_e H$ and relationship of the number of people with self-protection awareness and suspects on the plane $I_m - H$. From the two limit cycles in the figure, it can be easily seen that due to the intervention of the media emergency information, the number of skeptical has cyclical shock with the changes of the number of media reports and ignorant with self-protection awareness. During this time, the system is in the emergency management of the turbulent state. If the rumor is handled properly, it will gradually be clarified. However, if it is handled in a wrong way, then the situation is easy to get out of control [7].

Then, this paper discusses the countermeasures of rumor spread from the perspective of rumors, the contact patterns, the self-protection consciousness and the media coverage. By adjusting the parameters under different influencing factors, the effective coping strategies for rumor spread are extracted. This paper gives two numerical results to illustrate this problem. Fig. 4 simulates the effects of media exposure rate, rumor spread rate, and the communicator's effective contact rate on rumors. Fig. 4, left part, simulates the variation of the number of suspects under the two media transmission rate coefficients satisfying the periodic shock conditions, in which the larger media attention rate reduces the number of suspects. Fig. 4, right part, simulates the impact of the rumor transmission rate coefficient on the number of suspects.

When $\beta_u = 0.47/5446105$, and the parameters meet the conditions of the cycle of shock, then the number of skeptical has a period of oscillation with the increase

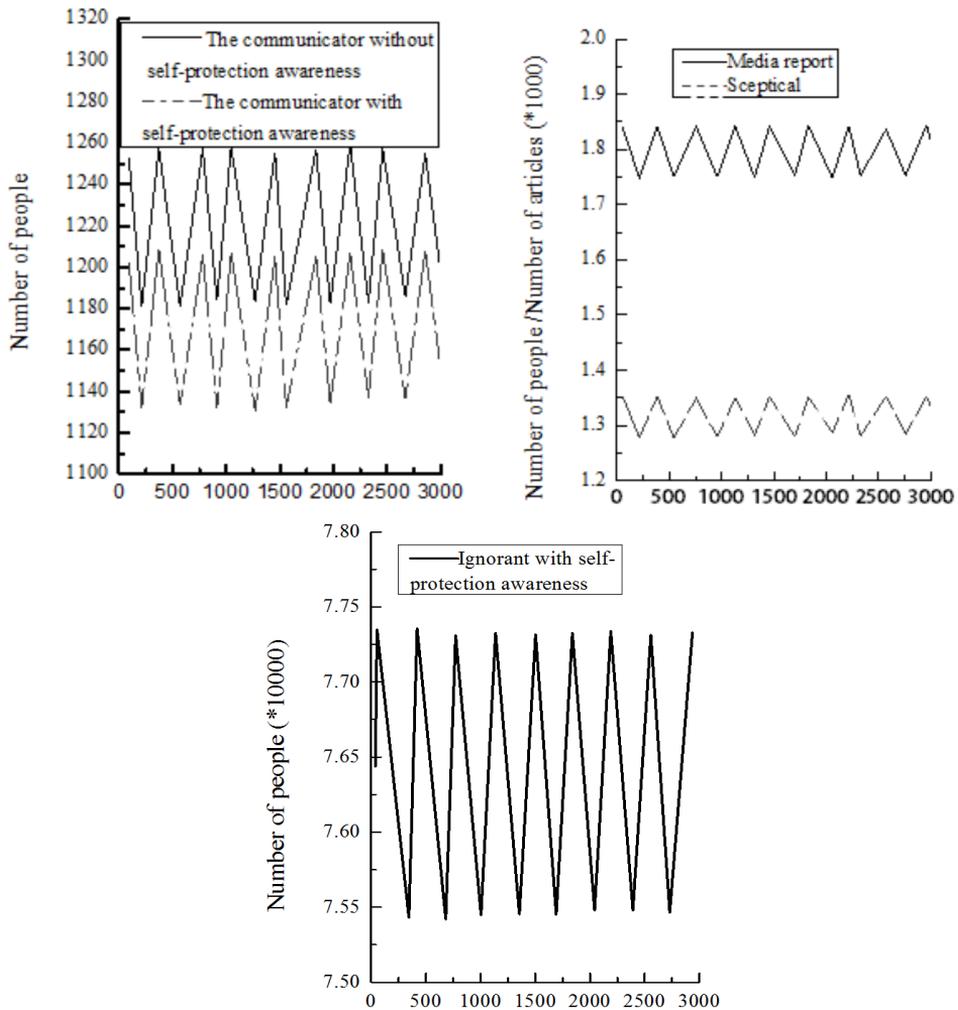


Fig. 2. Changing curve of the number of communicators, the sceptical, ignorant and media reports with time

of time. When the parameters are reduced to 0.45/5446105, and do not meet the conditions of cyclical shocks, that is, the official media reports reduce the spread of rumors at this time and the number of suspects has a sharp decline with the pass of time. This means that media coverage has played a stabilizing role in the spread of rumors. The official media issues emergency information, which can reduce the effective contact rate of rumors between ignorance and communicators. As can be seen from Fig. 4 (c) and (d), the number of skeptics will appear cycle shocks when the contact rate reduce to the half of original [8].

Figure 5 shows that the reduction of the warning awareness and self-protection of the communicator's awareness has a great impact on rumors spread. Figure 5

(a) shows that it is an effective way to deal with rumors by improving the warning awareness of communicators. Figure 5 (b) simulates the effect of the insecure loss rate on the spread of the rumor, which indicates that the improvement of warning awareness for ignorant can reduce the number of skeptics. Based on this, the relevant departments need to grasp the emergency information release time and intensity.

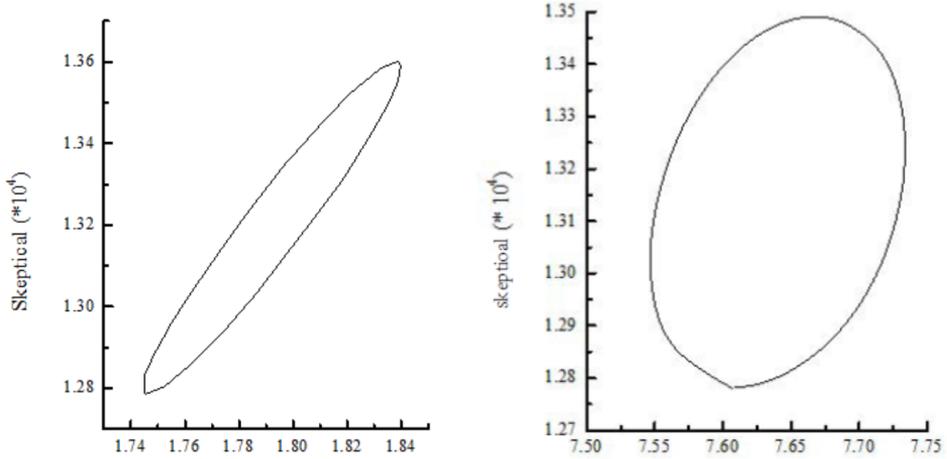


Fig. 3. The phase diagram of rumors spread model considering the media coverage

This article will be from the perspective of Figs. 4 and 5 research, and simulation results can be extracted to deal with the spread of rumors effective measures.

3.2. Suggestions for rumors spread coping strategies

Rumors spread is influenced by a number of factors, such as the nature of the rumor itself, the strength of self-protection awareness of ignorant and communicator, the strength of the rationality awareness, as well as the time, function and strength of official media emergency information and so on.

First, we should grasp the opportunity to effectively deal with rumors spread. In the early period of rumors spread, the appropriate media coverage can play an early warning role. They can effectively eliminate all kinds of suspicion and clarify rumors using the high credibility and high ratings of the media.

Second, we should pay attention to the media type of emergency information. When the rumors produce local negative view, and the skeptical gradually increase, the media with high credibility and emergency response capability should be used to publish information, such as SMS, Tencent QQ, and the official blog and so on. If we miss the best time of releasing the emergency information, and media type selected by the government does not have a high degree of credibility and ratings, then rumors will took the opportunity and enter inside. In addition, information dissemination and the government's voice all can easily lead to a series of emergencies.

Finally, the government should play the role of public opinion leaders, and establish a higher authority to improve public confidence in the eyes of the public. In the

face of the declining credibility of the mainstream media, if the government voice cannot play an immediate effect, then it will breed new rumors, causing anxiety, suspicion and even fear. It is not conducive to the effective response to rumors.

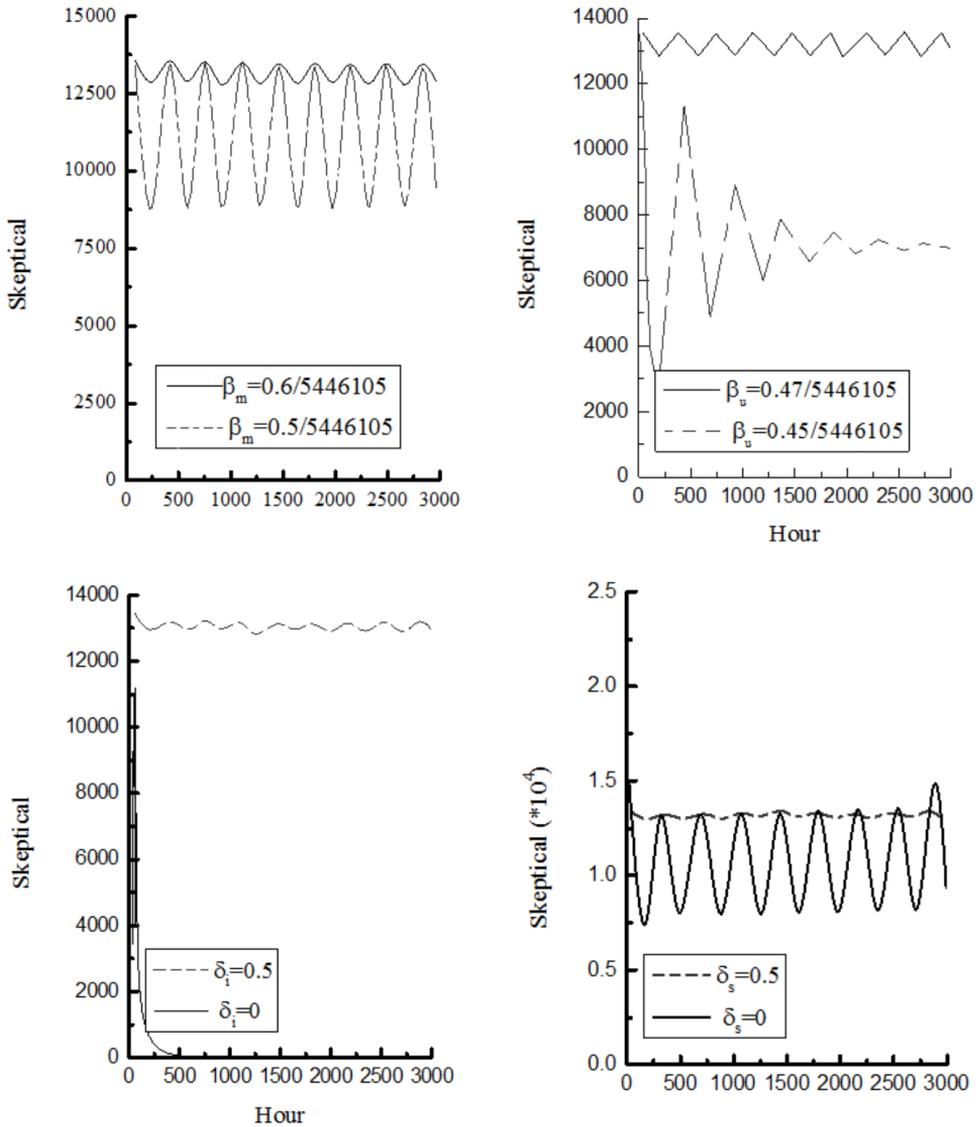


Fig. 4. The influence curve of the transmission rate parameter β_m , β_u and the effective contact rate parameter δ_i , δ_s on the number of the skeptics

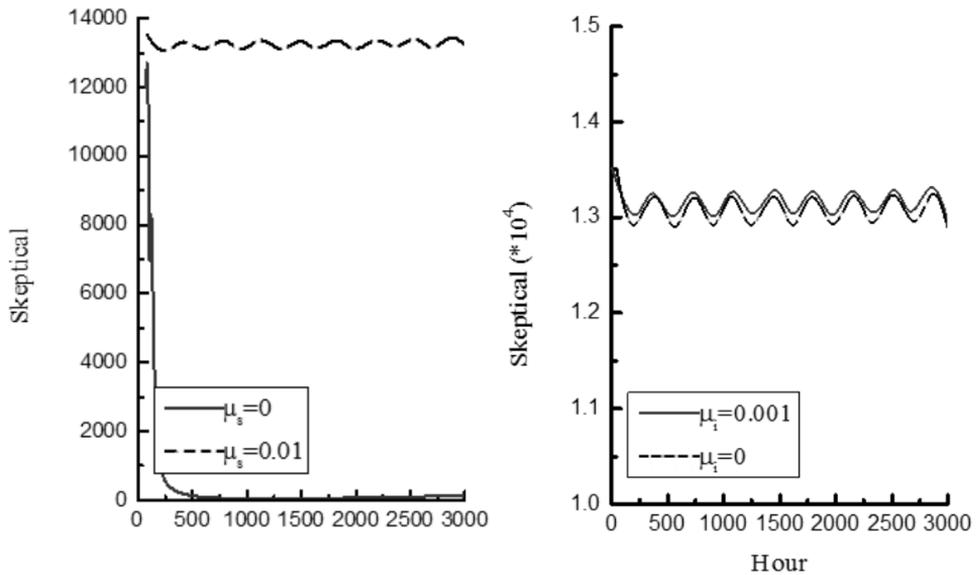


Fig. 5. The change curve of the number of skeptics with time changes under the influence of the weakness rates μ_i , μ_s

4. Conclusion

After entering the era of large data, everyone can be the disseminator or receiver of information. Currently, the rapid expansion of social information has influenced people's life at all time. At the same time, the proliferation of rubbish and false information, especially the existence of huge rumor, have seriously affected people's life. To this end, we should analyze the law of rumors in the era of large data to formulate the corresponding coping strategies. This paper mainly considers the influence of media reports on the spread of rumors and constructs the corresponding rumor spread model. It also studies the influence rule of the media reports on the rumor transmission mechanism through simulation. Through adjusting the parameters under different influencing factors, many response strategies are proposed. The study points that the media with high credibility and responsiveness should be used to clarify rumors at the early stage. At the same time, the government should improve its credibility in the eyes of the public and play the role of public opinion leaders. This study not only provides useful reference for the government to take effective rumor measures, but also provides objective decision-making basis for policymakers to regulate public opinion orientation.

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