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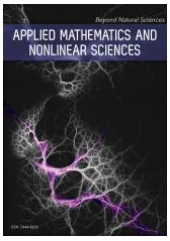

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Using Game Theory to Analyze the Effects of Different News Communication Strategies on Public Opinion Formation

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Abstract

In this paper, the public opinion game model is introduced through the analysis of game theory and news dissemination theory. According to the basic assumptions to form the payment matrix, the mathematical derivation of the benefit expectation function, to get the replication of the main body of the dynamic equations, and its equilibrium point of the stability of the test, so as to complete the construction of the public opinion game model under different news dissemination strategies. The model of this paper is validated and analyzed when the news dissemination to the public economic loss L_g is higher, leading to the rise of the probability of strict government regulation, prompting the public judgment and self-opinion ability to improve. If the government does not intervene in the news media, the gray gains of the news media R_{e2} gradually increase, resulting in the lack of relevant, correct knowledge of the public. In this paper, we study the impact of different news communication strategies on the formation of public opinion and promote the formation of public opinion.

Keywords: Game theoretic model; Benefit expectation function; Payment matrix; Public opinion; Replication dynamic equation.
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1 Introduction

As an important way of information transmission, news communication plays the role of a bridge connecting governments, organizations and the public. Through reporting and commenting, the news media are able to convey a variety of views, opinions, and information to the public, thus guiding the public to form attitudes and opinions on specific issues [1-3]. The news media's angle of reporting, use of language, focus, and choice of reporting all have a direct impact on the transmission and reception of media information, which in turn affects the public's views [4-5].

The way the news media choose to report on different events or topics will have a direct impact on the formation of public opinion [6]. The media will intentionally and selectively emphasize or reduce the coverage of some events, thus triggering the formation of a certain tendency of opinion among the public [7-8]. In addition, the news media will interpret and comment on events or issues in their reports and guide the formation of public opinion by adopting specific language, expressing specific emotional colors, and interviewing specific groups of people [9-11]. The public has limited cognition and choice in processing information [12]. Due to the diversity and large number of information sources, the public cannot fully access all the information and analyze it in depth. Therefore, they rely more on news dissemination to form their own opinions [13-15].

Literature [16] states that with the role of the news media, American citizens have actively expressed their views and courageously expressed what they think in the process of national policy-making, which is an important part of democratic politics in the United States. Literature [17] studied a large media company that offers a subscription system for consumers. In addition, the communication strategies of paid mass media companies are described. Literature [18] emphasizes that the news media has a significant impact on investors' perceptions that outweigh the firm's coping strategies and that in different media environments, bad news can have a greater impact than good news. Literature [19] introduced media strategy into the strategy of crisis communication. Stakeholders' expectation strategies were analyzed. Literature [20] stated that the period of the epidemic brought a huge flow of information to society, and various news media sites disseminated fake news related to health, a phenomenon that tends to lead to the adoption of fake news and influences the formulation of health policies. Literature [21] suggests that the strategy of adapting the news media needs to be responsive to the development goals of the country, and if it goes against the development goals of the country, adapting the media cannot be a strategic model.

This paper puts forward the basic assumption of the model according to the relationship between the government, the news dissemination media, and the public, and the payment matrix of the relevant parameters is designed according to this assumption. The replicated dynamic equation of the participating subjects is obtained through mathematical calculation of the benefit expectation function, and the equilibrium point of this replicated dynamic equation is detected. Use the control variables method to simulate and analyze the behavior of the participants under the game theory model and reveal the game relationship between the three. The model constructed in this paper is used to investigate the impact of news communication on public opinion of the "epidemic" in order to quantitatively analyze the impact of different news communication strategies on the formation of public opinion.

2 Game theory and information dissemination

2.1 Game Theory

Game theory can also be referred to as game science, countermeasure theory, or game theory [22]. Game theory is essentially the use of information analysis and the ability to judge to study the multiple decision-making subjects with each other's behavioral interactions and mutual equilibrium. The most important way of its research on the interaction of incentive structures after the formula is the study of a variety of struggles and competitive relationships of mathematical theory and methods. Game theorists try to understand conflict and cooperation by studying quantitative models and hypothetical cases. Moreover, these hypothetical cases are detached from reality in many aspects, but it is easier to see some basic problems of conflict and cooperation between subjects compared to the complicated and complex reality.

2.1.1 Game Theory Components

In any game event, there must be the most basic components, and the absence of any one of them makes the game incomplete and lacks the significance and value of research [23]. The most basic five elements in game theory are the players, strategy, gain, information, and order of action.

1) Players

   Two or more participants involved in the game process are called players. The players in the game theory do not only include people, but also organizations, groups, countries, enterprises, groups, and nature.

2) Strategies

   The totality of all the strategies of a sitter is called the set of strategies of that sitter. Strategies, in essence, are the rules of action for all players in a game under certain information, which stipulate what kind of actions the players in a game should take at what time.

3) Gain

   Through a game event, the players in the game can ultimately gain financial benefits, honor, etc., which is called the gains of the players in the game.

4) Information

   The main concepts of information in game theory include complete information, incomplete information, perfect information, and imperfect information.

2.1.2 The signaling game

1) Dynamic games with incomplete information

   The so-called dynamic game with incomplete information coincides with the story of "exhausting the donkey's skills". "The story is that the tiger has never seen a donkey, so he does not know whether the strength of the other side can beat him, so he keeps testing the donkey, which causes the donkey to fight back, and after a few times of testing, he realizes that the donkey can only lift its hooves to kick the tiger, and the tiger knows that the donkey's

strength is not very good, so he eats the donkey. This is a typical dynamic game with incomplete information [24].

2) Signaling model

Signaling games are a special type of incomplete information dynamic games. In the signaling model, they are composed of a signal sender and receiver or a leader and followers [25].

2.1.3 Game trees

There are two ways of expressing the game: one is strategy style, and the other is extension style. The way to express the game through the payoff matrix is called strategic, and the way to express the game through the game tree is called extended. Combined with the specificity of the game in this paper, the game expression used is the game tree, which is the extended game. Usually, the game tree is constructed in a top-down manner, including the players of the game, the order of actions, the set of action strategies, the payoff function, and the set of information [26].

2.1.4 Perfect Bayesian Equilibrium

A perfect Bayesian equilibrium for the signaling game is a combination of strategy combination $\{m^*(\theta), y^*(m)\}$ and posterior probability $\tilde{P}(\theta \mathrm{lm})$ and satisfies the following conditions:

$$m^*(\theta) \in \underset{m}{argnax}_1(\theta, m, y^*(m)) \tag{1}$$

$$y^*(m) \in \mathrm{a\ r\ gn\ y\ a} \sum_{\theta} \tilde{P}(\theta \mid m) u_2(\theta, m, y) \tag{2}$$

$$\tilde{P}(\theta \mid m) = \frac{P(\theta)P'(m \mid \theta)}{\sum_{\theta' \in \Theta} P(\theta)P'(m \mid \theta')} \quad \text{and} \sum_{\theta' \in \Theta} P(\theta')P'(m \mid \theta') > 0 \tag{3}$$

Assuming that there are only two types of signalers and two signals in the game, then if in the separating equilibrium, m_1 is the optimal strategy choice for θ_1, then m_1 will not be the optimal choice for θ_2, and the optimal choice for θ_2 will be m_2. Then for θ_1, the utility of choice m_1 is higher than the utility of choice m_2, as shown in the following equation:

$$u_1(m_1, y^*(m), \theta_1) > u_1(m_2, y^*(m), \theta_1) \tag{4}$$

$$u_2(m_2, y^*(m), \theta_2) > u_2(m_1, y^*(m), \theta_2) \tag{5}$$

Hence, the posterior probability $\tilde{P}(\theta \mathrm{lm})$:

$$\tilde{P}(\theta_1 \mathrm{lm}_1) = 1 \quad \tilde{P}(\theta_1 \mathrm{lm}_2) = 0 \tag{6}$$

$$\tilde{P}(\theta_2 \mathrm{lm}_1) = 0 \quad \tilde{P}(\theta_2 \mathrm{lm}_2) = 1 \tag{7}$$

Assuming that m_j is the equilibrium strategy of the game, the utility of choosing m_j is higher than the utility of all other choices for any signal sender, that is:

$$u_1(m_j, y^*(m), \theta_1) \geq u_1(m, y^*(m), \theta_1) \tag{8}$$

$$u_2(m_j, y^*(m), \theta_2) \geq u_2(m, y^*(m), \theta_2) \tag{9}$$

$$\tilde{P}(\theta_k \mid m_j) = P(\theta_k) \tag{10}$$

Under the same assumptions as in the separating equilibrium, the signaler has two types and two signals. θ_1 randomly chooses either m_1 or m_2, θ_1 chooses m_1 with probability μ and m_2 with probability $1-\mu$. θ_2 chooses a particular signal with a probability 100% m_2. If this strategy combination is an equilibrium strategy combination, then:

$$u_1(m_1, y^*(m), \theta_1) > u_1(m_2, y^*(m), \theta_1) \tag{11}$$

$$u_1(m_1, y^*(m), \theta_2) = u_1(m_2, y^*(m), \theta_2) \tag{12}$$

$$\tilde{P}(\theta_1 \mid m_1) = \frac{\mu p(\theta_1)}{\mu p(\theta_1) + 0 \times p(\theta_2)} = 1 \tag{13}$$

$$\tilde{P}(\theta_1 \mid m_2) = \frac{(1-\mu) p(\theta_1)}{(1-\mu) p(\theta_1) + 1 \times p(\theta_2)} < p(\theta_1) \tag{14}$$

$$\tilde{P}(\theta_2 \mid m_2) = \frac{1 \times p(\theta_2)}{(1-\mu) p(\theta_1) + 1 \times p(\theta_2)} > p(\theta_1) \tag{15}$$

2.2 Dissemination of information

2.2.1 Laws of information dissemination

The study of the laws of news dissemination needs to be based on the essence and the relationship between its essence. First, the facts that satisfy the public's needs and have theoretical content should be considered. The second thing is to present the theory in news articles in a way that is appealing to the public. The third task is to narrate the news facts objectively and scientifically. The coordinated relationship between news facts, the government, and the public should be well-managed in order to realize the positive energy-leading role of news dissemination.

2.2.2 Interaction between news dissemination and the public

Based on the interaction between news communication and the public, news opinions are effectively disseminated and public opinion in society is gradually formed. Although news public opinion is media public opinion, based on this understanding, the main body of media public opinion is also the news media. Then a question arises whether the opinion of the media reporter represents the opinion of an organization or the opinion of the public. In contrast, public opinion is obviously easier to identify, mainly as a collection of public opinions of individuals who are members of society. Public

opinion is generated by the public and disseminated by them. News dissemination, on the other hand, is based on the facts of the news and directly publishes opinions on the news. The formation of public opinion is mainly based on the facts of news dissemination. Therefore, news dissemination needs to make necessary "thinning" to some negative or negative opinions in public opinion in order to lead the public opinion to show the positive side and disseminate more positive energy on the basis of dissemination of facts.

3 Impact of news dissemination strategies on public opinion from a game theory perspective

3.1 Model Basic Assumptions and Payment Matrix

3.1.1 Basic assumptions of the model

In order to facilitate the subsequent study, this subsection constructs the logical relationship between the subjects of the three-party evolutionary game. Figure 1 shows the logical relationship diagram of the three-party evolutionary game model, and the following assumptions are put forward according to the logical relationship between the subjects of the three-party evolutionary game:

Assumption 1: Under the operation of news media and government regulation, there are three participating subjects, namely, the government, news media, and the public. All three subjects are limited rationality.

Hypothesis 2: The government's strategic choice space Q1 = (regulation, no regulation). The news media's strategic choice space Q2 = (violate, do not violate). Strategic choice space for public emotional, cognitive behavior Q3 = (influence, no influence). In the model, the proportion of government regulation is x, and the proportion of choosing not to regulate is $1-x$. The proportion of news media choosing to violate the law is y, and the proportion of choosing not to violate the law is $1-y$. The proportion of the public's emotional and cognitive behaviors being affected is z, and the proportion of not being affected is $1-z$, where $x, y, z[0,1]$.

Hypothesis 3: The cost factors related to the government, news media, and the public under different strategies are as follows: (1) The regulatory system platform owned by the government itself needs daily maintenance, and the maintenance cost is G_{11}. When governments regulate news outlets, there are additional costs, such as time G_{12}. At the same time, when dealing with news media violations, on-site surveys require costs such as manpower G_{13}. When the government does not regulate, the illegal information has a negative impact on the public's emotional cognition and behavior, resulting in losses such as reduced public trust in the government and questioning its ability W_{11}. At the same time, it is easy to cause risk losses such as network chaos W_{12}. (2) The daily maintenance cost of the news media platform is G_{21}. When a news media chooses to violate the law, it will have to suffer losses such as a decrease in public attention W_{21}, and if the government chooses to regulate at this time, the news media will be held legally liable W_{22}. In addition, the proportion of risk losses caused by news media violations to losses that have a negative impact on the public. The coefficient is m. (3) When the public receives illegal information, it is easy to cause them panic, emotional loss, and other losses W_{31}. The public lives in a news media environment that is not regulated by the government, and the risk of negative emotional cognitive behavior is W_{32}.

Hypothesis 4: The relevant benefits to the government, news media, and the public under different strategies are as follows: (1) When the government chooses to regulate, it receives benefits such as increased public trust and recognition of its competence, etc. P_{11}. At the same time, it creates a healthy and stable environment that brings additional benefits, etc. P_{12}. (2) When the news media chooses to refrain from violating the law, it receives benefits such as more attention from the public and an increase in traffic flow, etc. P_{21}. At the same time, the proportionate factor of the potential benefits to the positive effect on the ratio coefficient of the positive impact on the public is n. (3) When the public receives positive information, they can enjoy benefits such as knowledge and psychological satisfaction P_{31}.

3.1.2 Payment matrix

According to the principle of three-party game model construction, each parameter assumption specifically involved in the participating subjects is shown in Table 1, and according to the above concept definition and parameter assumption setting, the three-party game model is established, and the game payment matrix of the three-party participating subjects is shown in Table 2.

Table 1. The various parameters of the participating subject are assumed

Participating body	Parameter	Parametric meaning
Government	G_{11}	The daily operation and maintenance cost of the network required by the government not regulating the news media
	G_{12}	Additional costs required by government regulatory news media
	G_{13}	The cost of dealing with media violations in the government's regulation of media violations
	p_{11}	When the government regulates the negative impact of the news media on the public, the public's confidence in the government and the recognition of government capacity also benefit.
	p_{12}	When the government regulates news media, the extra benefits of creating a healthy and stable network environment
	W_{11}	When the government does not regulate the negative impact of the news media on the public, the public's loss of trust in the government and the loss of government's ability to question the consequences of the government
	W_{12}	The government does not regulate the network environment instability and other risk losses.
News media	G_{21}	Daily operation and maintenance cost of news media
	p_{21}	When the news media have a positive impact on the public, the public's income from the news media is increased.
	W_{21}	The loss of public attention to the news media is reduced by the negative impact of the media on the public.
	W_{22}	The government is punished by the government when the government regulates news media violations.
	m	The risk loss of news media violations accounts for the proportion of the negative impact on the public.
	n	The potential gains generated by news media violations are the proportion of the positive impact on the public.
The public	p_{31}	The news media receive the public to influence knowledge, psychological satisfaction, and other benefits.
	p_{32}	Public life is a guarantee of positive influence in the environment of government regulation news media.
	W_{31}	The public is affected by the panic and emotional loss caused by the negative influence of the news media.
	W_{32}	Public life risks negative perceptions of emotional perceptions in the news media environment that the government does not regulate

Table 2. The game payment matrix of the three parties

Game strategy	Government income	News media revenue	Public income
(regulation, violation, influence)	$p_{11}+p_{12}-G_{11}+G_{12}-G_{13}$	$-G_{11}+W_{21}-W_{22}$	$p_{32}-W_{31}$
(regulation, violation, no impact)	$p_{12}-G_{11}-G_{12}-G_{13}$	$-G_{21}-m(W_{22}+W_{21})$	p_{32}
(regulation, non-violation, impact)	$p_{12}-G_{11}-G_{12}$	$p_{12}-G_{21}$	$p_{32}+p_{31}$
(regulation, non-violation, no impact)	$p_{12}-G_{11}-G_{12}$	$np_{21}-G_{21}$	p_{32}
(no regulation, violation, or impact)	$-G_{11}-W_{11}-W_{12}$	$-G_{21}-W_{21}$	$-W_{32}-W_{31}$
(no regulation, violation, no impact)	$-G_{11}-W_{12}$	$-G_{21}-mW_{21}$	$-W_{32}$
(no regulation, no violation, no violation)	$-G_{11}+W_{12}$	$P_{21}-G_{21}$	$p_{31}-W_{32}$
(no regulation, no violation, no impact)	$-G_{11}-W_{12}$	$np_{21}-G_{21}$	$-W_{32}$

3.2 Mathematical modeling

3.2.1 Return Expectation Function

According to Table 2, the expected return U_{11}, expected return U_{12} and average expected return U_{13} of the government choosing the "regulation" strategy and the "non-regulation" strategy in the game are, respectively:

$$\begin{aligned}U_{11}&=yz(P_{11}+P_{12}-G_{11}-G_{12}-G_{13})+y(1-z)(P_{12}-G_{11}-G_{12}-G_{13})\\&+(1-y)z(P_{12}-G_{11}-G_{12})+(1-y)(1-z)(P_{12}-G_{11}-G_{12})\\&=yzP_{11}-yG_{13}+P_{12}-G_{11}-G_{12}\end{aligned}\tag{16}$$

$$\begin{aligned}U_{12}&=yz(-G_{11}-W_{11}-W_{12})+y(1-z)(-G_{11}-W_{12})+(1-y)z(-G_{11}-W_{12})\\&+(1-y)(1-z)(-G_{11}-W_{12})=-G_{11}-W_{12}-yzW_{11}\end{aligned}\tag{17}$$

$$\begin{aligned}U_{13}&=xU_{11}+(1-x)U_{12}\\&=xyzP_{11}-xyG_{13}+xP_{12}-xG_{12}-G_{11}-W_{12}-yzW_{11}+xW_{12}+xyzW_{11}\end{aligned}\tag{18}$$

The expected payoffs to the news media for choosing the "non-compliance" strategy, the expected payoffs for choosing the "non-compliance" strategy, and the average expected payoffs for choosing the "non-compliance" strategy, are U_{21}, U_{22}, and U_{23}, respectively, at the time of the game:

$$\begin{aligned}U_{21}&=xz(-G_{21}-W_{21}-W_{22})+x(1-z)[-G_{21}-m(W_{22}+W_{21})]\\&+(1-x)z(-G21-W21)+(1-x)(1-z)(-G21-mW21)\\&=-xzW_{22}-xmW_{22}+xzmW_{22}-zW_{21}-G_{21}-mW_{21}+zmW_{21}\end{aligned}\tag{19}$$

$$\begin{aligned}U_{22}&=xz(P_{21}-G_{21})+x(1-z)(nP_{21}-G_{21})+(1-x)z(P_{21}-G_{21})\\&+(1-x)(1-z)(nP_{21}-G_{21})=zP_{21}+nP_{21}-G_{21}-znP_{21}\end{aligned}\tag{20}$$

$$\begin{aligned}U_{23}&=yU_{21}+(1-y)U_{22}=y(-xzW_{22}-xmW_{22}+xzmW_{22}-zW_{21}\\&-G_{21}-mW_{21}+zmW_{21})+(1-y)(zP_{21}+nP_{21}-G_{21}-znP_{21})\end{aligned}\tag{21}$$

The public's emotional perceptions during the game are affected by the expected payoff U_{31} of the "affected" strategy, the expected payoff U_{32} of the "unaffected" strategy, and the average expected payoff U_{33}, respectively:

$$\begin{aligned} U_{31} &= xy(P_{32} - W_{31}) + x(1-y)(P_{31} + P_{32}) + (1-x)y(-W_{31} - W_{32}) \\ &+(1-x)(1-y)(P_{31} - W_{32}) = xP_{32} - yW_{31} + P_{31} - W_{32} - yP_{31} + xW_{32} \end{aligned} \tag{22}$$

$$\begin{aligned} U_{32} &= xyP_{32} + x(1-y)P_{32} + (1-x)y(-W_{32}) + (1-x)(1-y)(-W_{32}) \\ &= xP_{32} - W_{32} + xW_{32} \end{aligned} \tag{23}$$

3.2.2 Replicating the dynamic equations

On the basis of the above analysis, the dynamic equation of government replication can be shown to be:

$$\begin{aligned} U_{33} &= zU_{31} + (1-z)U_{32} \\ &= -yzW31 + zP31 - yzP31 + xP32 - W32 + xW32 \end{aligned} \tag{24}$$

$$\begin{aligned} F(x) &= \frac{dx}{dt} = x(U_{11} - U_{13}) \\ &= x(1-x)(yzP_{11} - yG_{13} + P_{12} - G_{12} + W_{12} + yzW_{11}) \end{aligned} \tag{25}$$

The equation for the replication dynamics of news media is:

$$\begin{aligned} F(y) &= \frac{dy}{dt} = y(U_{21} - U_{23}) \\ &= y(1-y)[(zm - z - m)(xW_{22} + W_{21}) + (zn - z - n)P_{21}] \end{aligned} \tag{26}$$

The equation for the replication dynamics of the public is:

$$F(z) = \frac{dz}{dt} = z(U_{31} - U_{33}) = z(1-z)(P_{31} - yW_{31} - yP_{31}) \tag{27}$$

The replication dynamics system for the government, the news media, and the public is obtained by associating Eqs. (25), (26), and (27) as:

$$\begin{cases} F(x) = x(1-x)(yzP_{11} - yG_{13} + P_{12} - G_{12} + W_{12} + yzW_{11}) \\ F(y) = y(1-y)[(zm - z - m)(xW_{22} + W_{21}) + (zn - z - n)P_{21}] \\ F(z) = z(1-z)(P_{31} - yW_{31} - yP_{31}) \end{cases} \tag{28}$$

The evolutionary stabilization strategy (ESS) of the system of differential equations can be obtained from the local stability analysis of the Jacobi matrix of this system, which is obtained from Eq. (28) as (29):

$$J=\begin{bmatrix} (1-2x)(yzP_{11}-yG_{13} & x(1-x)(zP_{11}-G_{13}+zW_{11}) & x(1-x)(yP_{11}+yW_{11}) \\ +P_{12}-G_{12}+W_{12}+yzW_{11}) & & \\ W_{22}y(1-y)(zm-z-m) & (1-2y)[(zm-z-m)(xW_{22}+W_{21}) & y(1-y)[(m-1)(xW_{22} \\ & +(zn-z-n)Pz1] & +W21)+(n-1)P21 \\ 0 & z(1-z)(-W31-Pn) & (1-2z)(P31-yWs1 \\ & & -yP_{31}) \end{bmatrix} \tag{29}$$

From the evolutionary game theory, the equilibrium point that satisfies all the eigenvalues of the Jacobi matrix is non-positive and is the evolutionary stability point of the system.

3.2.3 Equilibrium Point Stability

The analytic equilibrium is the Jacobi matrix for $E_1(0,0,0)$:

$$J_1=\begin{bmatrix} P_{12}-G_{12}+W_{12} & 0 & 0 \\ 0 & -mW_{21}-nP_{21} & 0 \\ 0 & 0 & P_{31} \end{bmatrix} \tag{30}$$

The eigenvalues of this Jacobi matrix are:

$$\lambda_1=P_{12}-G_{12}+W_{12};\lambda_2=-mW_{21}-nP_{21};\lambda_3=P_{31} \tag{31}$$

In addition, the other seven equilibrium points are substituted into the Jacobi matrix (31), and the eigenvalues of the Jacobi matrix corresponding to each equilibrium point are shown in Table 3, and the stability analysis of the equilibrium points is shown in Table 4. In order to analyze the positive and negative signs of the eigenvalues corresponding to each equilibrium point without loss of generality, assumption $P_{12}-(G_{12}+G_{13})>0$, i.e., the additional benefit gained from creating a healthy and stable network environment when the government regulates the news media is greater than the sum of the additional cost required when the government regulates the news media and the cost required when the government regulates the news media violations to deal with the violations of the news media. In this case, Table 4 shows that the eigenvalues of the Jacobi matrix corresponding to the equilibrium point $E_6(1,0,1)$ are all negative, and then the system has a stable point (1, 0, 1), which corresponds to the evolutionary strategy (regulation, no violation, influence).

Table 3. The eigenvalues of the Jacobian matrix corresponding to each equilibrium point

Equilibrium point	Eigenvalue λ_1	Eigenvalue λ_2	Eigenvalue λ_3
$E_1(0,0,0)$	$P_{12}-G_{12}+W_{12}$	$-mW_{21}-nP_{21}$	P_{31}
$E_2(0,0,1)$	$P_{12}-G_{12}+W_{12}$	$-W_{21}-P_{21}$	$\cdot P_{31}$
$E_3(0,1,0)$	$P_{12}+W_{12}-G_{13}-G_{12}$	$nP_{21}+mW_{21}$	$-W_{31}$
$E_4(0,1,1)$	$P_{11}+P_{12}+W_{11}+W_{12}-G_{12}-G_{13}$	$W_{21}+P_{21}$	W_{31}
$E_5(1,0,0)$	$G_{12}-P_{12}-W_{12}$	$-mW_{21}-mW_{22}-nP_{21}$	P_{31}
$E_6(1,0,1)$	$G_{12}-W_{12}-P_{12}$	$-W_{21}-W_{22}P_{21}$	$-P_{31}$
$E_7(1,1,0)$	$G_{12}+G_{13}-P_{12}-W_{12}$	$mW_{21}+mW_{22}+nP_{21}$	$-W_{31}$
$E_8(1,1,1)$	$G_{12}+G_{13}-P_{11}-P_{12}-W_{11}-W_{12}$	$W_{21}+W_{22}+P_{21}$	W_{31}

Table 4. Analysis of equilibrium stability

Equilibrium point	Eigenvalue λ_1	Eigenvalue λ_2	Eigenvalue λ_3	Stability
$E_1(0,0,0)$	+	-	+	Unstable point
$E_2(0,0,1)$	+	-	-	Unstable point
$E_3(0,1,0)$	+	+	-	Unstable point
$E_4(0,1,1)$	+	+	+	Saddle point
$E_5(1,0,0)$	-	-	+	Unstable point
$E_6(1,0,1)$	-	-	-	ESS
$E_7(1,1,0)$	-	+	-	Unstable point
$E_8(1,1,1)$	-	+	+	Unstable point

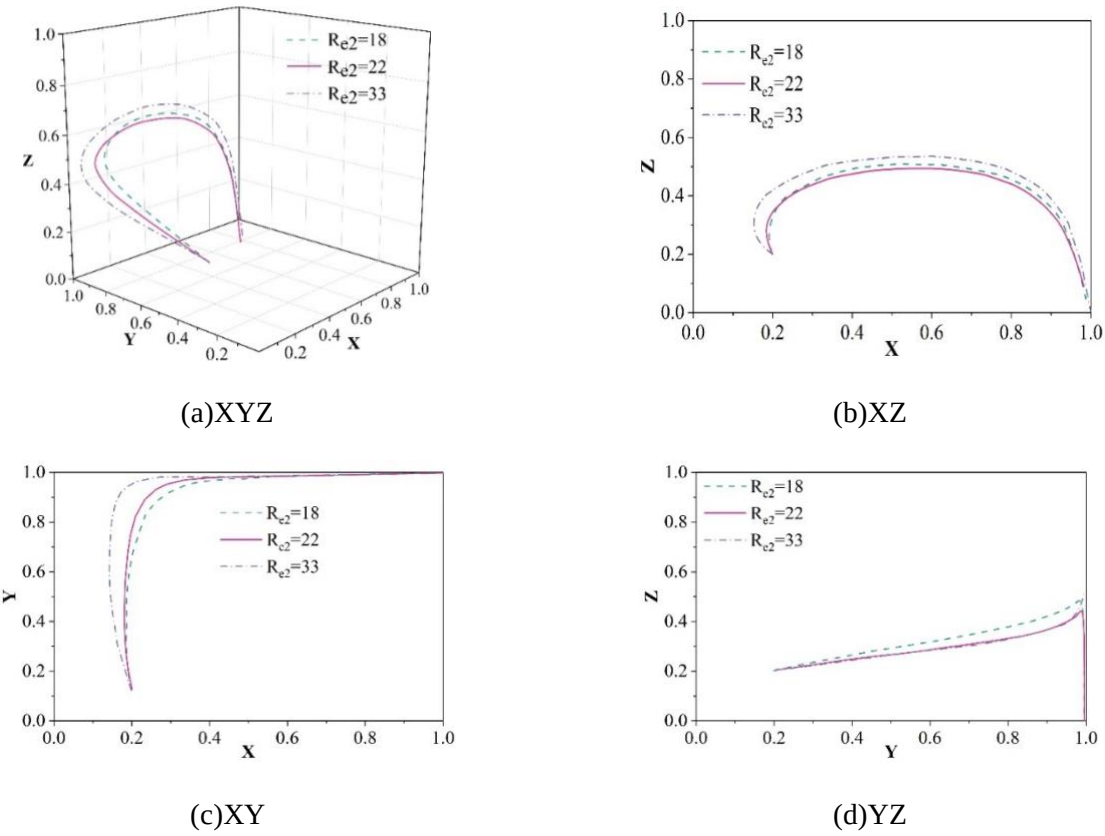
4 Analysis of the impact of news dissemination on public opinion under a game theory model

4.1 Behavioral Analysis of Participating Subjects

In this subsection, the simulation analysis of the behavior of the participating subjects in the evolutionary game of news dissemination is carried out, adopting the method of controlling variables by adjusting the cost or benefit parameter of a subject in the game model to obtain the influence of parameter changes on the evolutionary speed and direction of evolution in the process of the evolutionary game replicating the dynamics of the system to reach the evolutionary stable state.

4.1.1 Analysis of the actions of the main bodies of information dissemination

To analyze the influence of simulation parameter R_{e2} on the process and results of the news communication evolution game, assign R_{e2} to $R_{e2}=18,22,33$ respectively, and the simulation results of its replicated dynamic equation system evolved many times are shown in Fig. 1, where (a) ~ (c) XYZ, XZ, XY, YZ, X, Y, Z, represent the probability of strategy selection of the three participating subjects of the news media, the public, and the government, respectively. The results show that during the evolution of the system to the stable point, the enhancement of gray gains in the news dissemination subject due to rumor-mongering can accelerate the evolution of positive public opinion. The overall change of the probability of strict regulation by government regulators is increasing and then decreasing, and finally reaches stabilization at 0. However, as R_{e2} increases, the probability of strict regulation by government regulators increases. Therefore, the gray gain of the news dissemination subject is an important indicator of whether the industry is regulated or not. At the same time, the increase of the gray gain of the news dissemination subject, the economic loss suffered by the public due to following the trend will make the public tend to news organizations to disseminate positive public opinion, it can also be said that the Internet has a certain self-purification ability in the process of dissemination of this kind of public opinion events, and the government can appropriately save the cost of regulation, according to the public and news dissemination The government can save the cost of regulation and decide whether to regulate or not according to the strategic choice between the public and the news dissemination subject. Meanwhile, the government can improve the public's self-judgment ability by increasing the disclosure ability of the media, so as to accelerate the speed of the game to reach equilibrium.

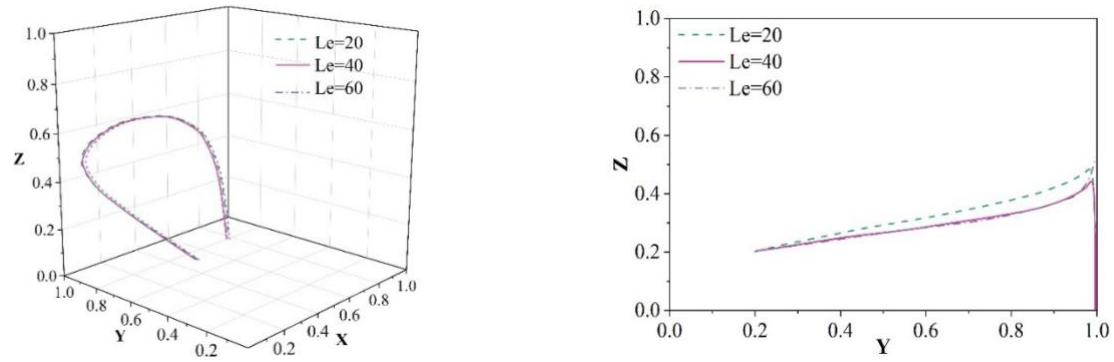


(a)XYZ (b)XZ

(c)XY (d)YZ

Figure 1. The grey gains of news spread

Analyze the impact of the simulation parameter L_e change on the evolutionary game process, and results will be assigned to $L_e = 20, 40, 60$, respectively, to replicate the dynamic equations to evolve the simulation results many times, as shown in Figure 2. It can be seen that in the process of the system evolution to the stability point, when the government chooses a strict regulation strategy, the government will be the existence of rumor-mongering news media to punish, when L_e increases, the probability of the government's stability regulatory strategy gradually decreases and reaches the stability point of the game to speed up the speed of the game, it can be seen that the government to develop incentives and penalties mechanism, increase the intensity of punishment, and to stimulate the news dissemination agencies to assume their social responsibility.

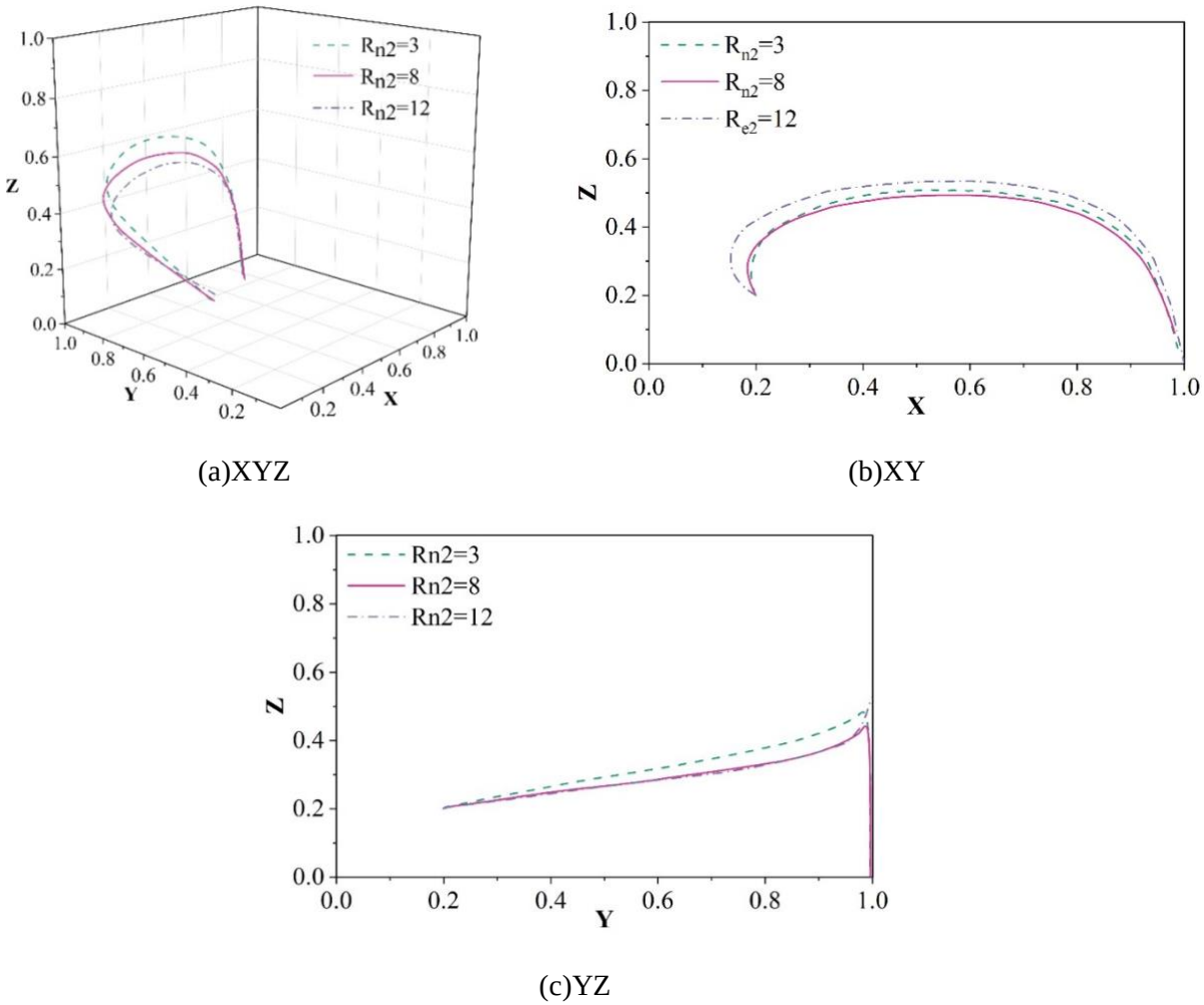


(a)XYZ (b)YZ

Figure 2. Government penalties for news media

4.1.2 Analysis of the actions of public subjects

The popularity gain of public dissemination of positive public opinion is shown in Fig. 3. During the evolution of the game, as R_{n2} increases, the probability of choosing strict government regulation gradually decreases, and the probability of news media choosing to positively guide the dissemination increases. When the public dissemination of positive speech popularity gain R_{n2} is higher, the figure has a very obvious decline in the probability of strict government regulation, showing that the social atmosphere is good and the public generally has a strong ability to discriminate when the public in the process of public opinion processing has a strong ability to influence, the public also plays a positive guidance role in the news media, at this time, the government can obtain leisure gains, consciously form a good social atmosphere, conducive to security and stability, and the government should take measures to enhance the public's awareness of public opinion. The government needs to take measures to improve the public's ability to discern information.



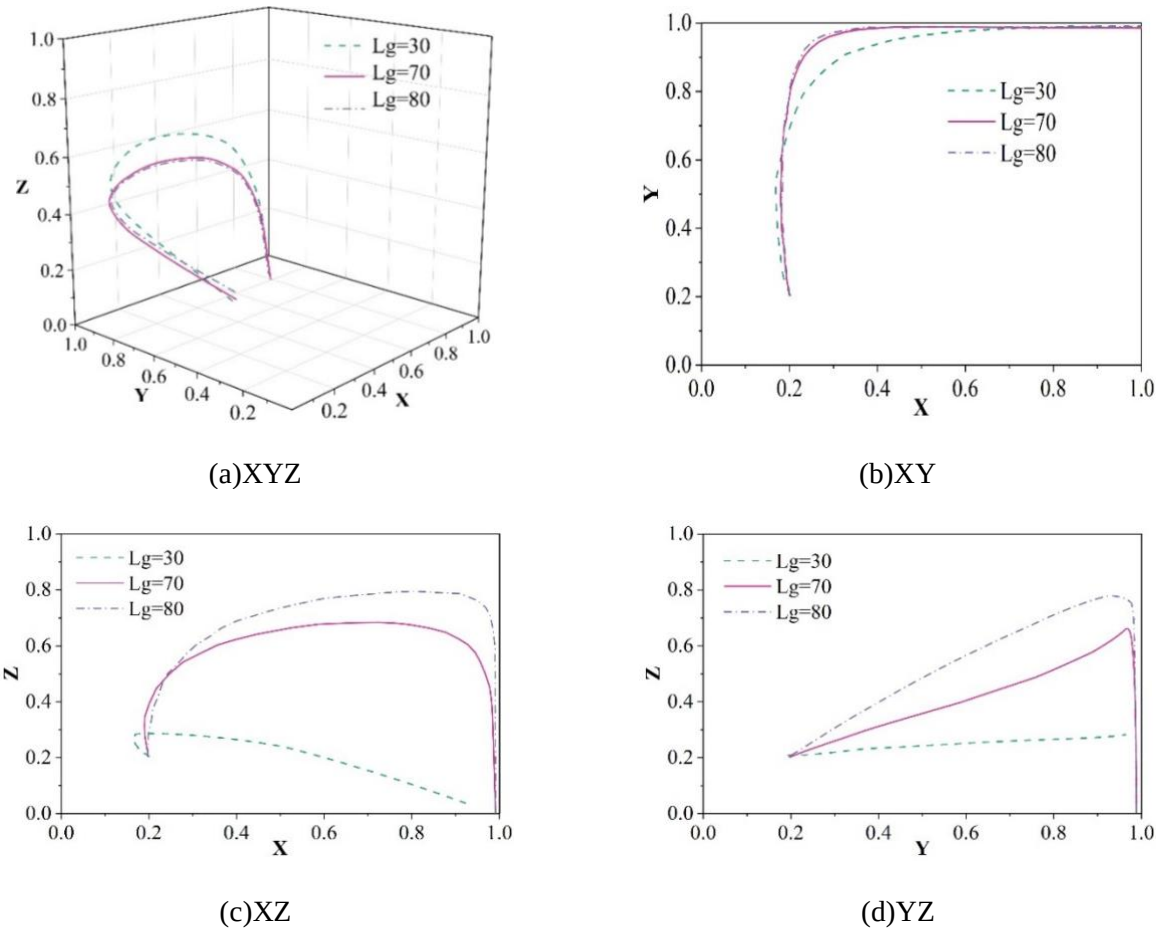
(a)XYZ (b)XY

(c)YZ

Figure 3. Public communication is a popular

Public dissemination of positive public opinion economic loss simulation curve shown in Figure 4, in the evolution process, as L_g that is, when the public chooses to disseminate positive public opinion, the higher the economic loss, the government chooses to strictly regulate the probability increases. When the public dissemination of positive public opinion economic loss L_g higher, the graph of the government's strict supervision probability of the increase shows that the government is

more sensitive to the economic loss of the public group, and the public strategy and the government regulatory strategy probability of change shows a linear increase in the relationship between the public strategy and the government regulatory strategy probability of change when the public dissemination of positive public opinion is conducive to the formation of a clean and positive Internet environment, which is a positive promotion of the public's judgment and self-opinion ability, but also It shows that the public is more satisfied with the government's services, which is a good cycle of motivation and a manifestation of the government's credibility, and shows the relevance of the government in social governance and the maintenance of public rights and interests.



(a)XYZ (b)XY

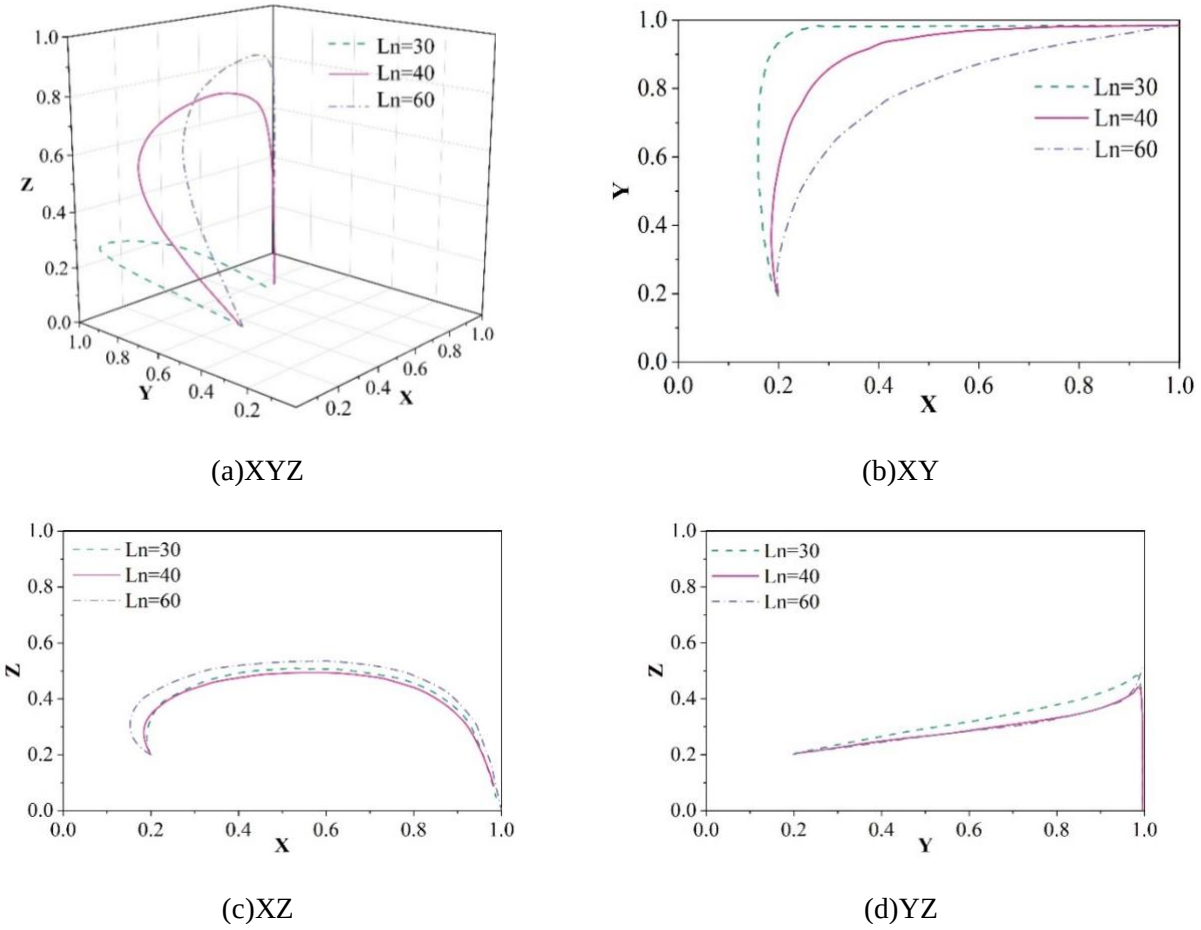
(c)XZ (d)YZ

Figure 4. Internet users spread positive public opinion economic loss simulation curve

4.1.3 Analysis of the actions of governmental entities

In order to analyze the impact of L_n change on the evolutionary game process, results will be assigned $L_n = 30, 40, 60$ respectively, replicating the simulation results of the dynamic equations evolving 50 times, as shown in Figure 5. When the government is subject to lower administrative penalties from higher authorities, such as $L_n = 30$, which is the red curve in the figure, this time reflects the lack of binding force of government governance, which reduces the evolutionary speed of the evolutionary stabilization strategy of the evolutionary game of the public communication of positive public opinion, and the government's deterrent effect on the news media is reduced. With the increase of punishment Ln by the higher authorities, the government's deterrence and prestige increase, making the public and news media more inclined to spread positive public opinion. It should be increased that the implementation of severe administrative penalties by the higher government can

make the regulators continue to have a higher rate of strict supervision. The news media's emphasis on popularity gain is an important indicator of the government's supervision of its fulfillment of corporate social responsibility. When the news media is in the spirit of a responsible attitude for serving the people, the quality of its communication is guaranteed. The network's public opinion guiding strategy will be positive, which ensures that the news media will be able to disseminate positive opinions on the network. This ensures the robustness of the news media's speech on the Internet. If the news media are not supervised and managed by the government, the news media will gradually be led into the land of lawlessness as the additional gray income R_{e2} from publishing adulterated and negative rumors gradually increases.



(a)XYZ (b)XY

(c)XZ (d)YZ

Figure 5. Analysis of Government Action

4.2 Case studies on the impact of news dissemination on public opinion

4.2.1 Changes in the volume of public snagging

The change of the public's snapping volume is shown in Figure 6. At the beginning of the news dissemination about the epidemic, the public mainly makes judgments based on their own intuition, experience, or external factors, which is subject to the influence of subjective factors, and their snapping volume will evolve to 1, and as the public's snapping volume (M) increases, the speed of evolution accelerates, and the time to evolve to 1 is gradually shortened. With the development of news dissemination about the "epidemic", the public will rationally analyze the information and the uncertainty of the environment during the epidemic and gradually rationally view the development of the situation. The amount of snapping up will be evolved to 0, and with the increase of the public

snapping up (M), the rate of evolution slows down the time of evolution to 0 is gradually lengthened. In the early stage of news dissemination about the "epidemic", the public lacks the relevant, correct knowledge and will unthinkingly hoard a large number of masks, while with the development of the epidemic, the public's ability to recognize the public is also gradually improved, and will objectively analyze the situation, and will not hoard a large number of masks.

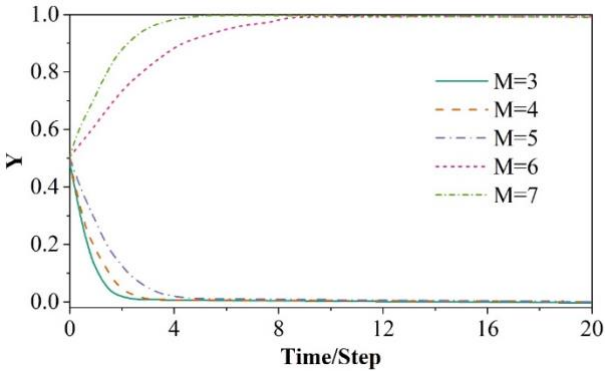


Figure 6. The change in public buying

4.2.2 Changes in public critical capacity

The change in public critical ability is shown in Figure 7. As the public critical ability increases, the public's trust in the rumors about the epidemic decreases, the willingness to participate in the rush to buy decreases, and gradually evolves to zero, and as the public critical ability (u) increases, the time for it to evolve to zero gradually shortens. In the early stage of the development of news dissemination about the epidemic, the public does not recognize the seriousness of the epidemic, lacks awareness of epidemic prevention, is gullible enough to believe in false news dissemination, and has a higher willingness to participate in the purchase of masks. With the openness and transparency of information about the epidemic and the government's active efforts to combat false news dissemination, the public's comprehensive literacy and ability to discern the truth of the information have gradually improved, and the purchase of masks has gradually returned to rationality.

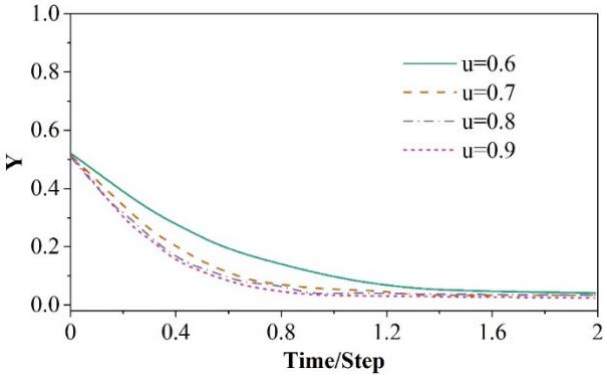


Figure 7. Changes in public critical ability

4.2.3 Impact of Government Disinformation on Public Behavior

The effect of government disinformation on public behavior is shown in Figure 8. The government's strategy of disinformation has a significant impact on the public's snapping volume. When the government refutes rumors, the public's snapping volume gradually evolves to 0, and the time for its

evolution to 0 is gradually prolonged as the public's snapping volume (M) increases. During the de-escalation period of the epidemic development, the supply of masks becomes increasingly sufficient, and although the prices of masks are high, they will show a downward trend. The public stops participating in the rush to buy masks on the assumption that the demand has been partially satisfied to avoid the regrettable losses caused. The government will inevitably take active intervention to prevent the deterioration of the situation. In the preceding period, public demand for masks declines, prices fall to normal levels, and the intervention of higher levels of government and the transparency of information on the epidemic prompts the public to return to rationality. At this time, the public will hoard a certain amount of masks for backup due to the drop in mask prices and to ensure that the demand is met, and the value of the euphoria that the public participates in the rush is higher than the value of the regret that they may feel. At the same time, the government will actively intervene to fulfill its social responsibility of maintaining the market and avoid being punished by the higher-level government. The public's need for information is met, their scientific literacy is improved, and they can maintain some level of rationality during the snapping-up event, resulting in a gradual decrease in the number of masks purchased.

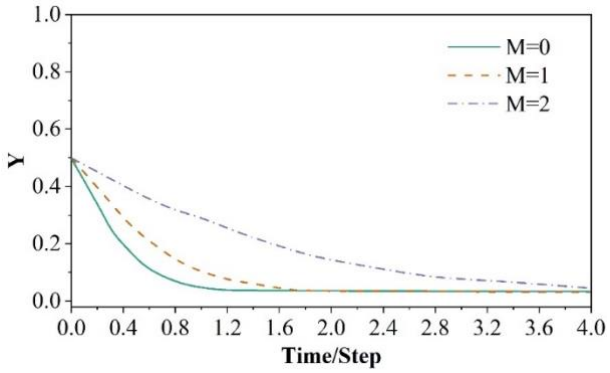


Figure 8. Analysis of the influence of the government on the behavior of the public

5 Conclusion

New media have reshaped the dissemination of news due to its unique method and wider coverage, which has had a more profound impact on the public's ideology. This paper examines the impact of various news dissemination strategies on the formation of public opinion through game theory analysis.

1) When the gray income of the news dissemination subject increases, the public receives economic and psychological harm due to following the trend and finally reaches the stability of 0, so that the public tends to disseminate positive public opinion of news agencies, which can be used to improve the public's ability to judge the information of news dissemination by increasing the disclosure of false news by the government.

2) When the public's critical ability (u) increases, the public's willingness to snap up evolves to 0, indicating that with the openness and transparency of information related to the epidemic, as well as the government's active fight against false news dissemination, the public's self-opinion ability has been improved, which makes the public's desire to snap up products return to normal.

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