

Tripartite Evolution Game Analysis among Public Opinion Speaking Subjects in the Network Public Opinion Field

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Abstract. The arrival of the omnimedia era has formed a new form of information exchange and public opinion environment. This study proposes the concept of network public opinion field, and constructs a tripartite evolutionary game model of "network media-opinion leaders-netizens" as the main body. The simulation analysis of the model results is carried out, and some suggestions are put forward for the evolution and governance of network public opinion in the omnimedia era from the perspective of field theory.

Keywords: Field theory, Online public opinion, Evolutionary game, Capital, Habitus.

1. Introduction

Bourdieu defines a field as "a network or configuration of objective relations between objectively defined positions." [1]. In field theory, economic capital is the resource used to generate economic value [2]. Cultural capital is a cognitive structure based on knowledge and skills [3][4] produced personality and behavior [5]. Social capital includes social networks or "relationships of mutual knowledge and recognition" [6]. Symbolic capital is the power acquired by individuals through the mobilization of other capital, which is manifested as social rank, class status, etc [7]. Habitus is a matrix of plans, judgments and behaviors, and is the organizing principle of practice [8]. All relevant objects in the space will compete with each other in the field, and capital will dominate, influence, produce and renew the structure within the customary logic of the field.

In the era of omnimedia, the Internet is the main place for new media to be active, which provides space for the generation and evolution of public opinion. Therefore, the author tries to give the following definition: the field of network public opinion refers to a set of network professional activity system and communication channel which has been tested by practice and formed by the main participants of network public opinion as actors, carrying out activities and capital interaction according to specific habits.

Due to the openness and virtuality of the network, network public opinion is characterized by randomness, diversity and deviation [9], and it is bounded rationality. Evolutionary game is an effective method to analyze the behavior paradigm of bounded rationality under incomplete information. Askalizadeh et al [10]. constructed an evolutionary game model to analyze rumor propagation and control in social networks. Yin et al [11]. used evolutionary game theory to study the dynamic changes of users' opinions and proposed an agent-based network opinion formation model from the perspectives of sociology and psychology. Dai et al [12]. coupled the SEIR model with the evolutionary game model to construct a tripartite evolutionary game model involving local governments, pollutant discharging enterprise and the public. Based on evolutionary game theory, Zhang et al [13]. constructed an evolutionary model of online public opinion communication with Internet media, Internet users and government as the main body.

From the current research status, we can find that there is no quantitative study that combines online public opinion with field theory and there are few researches on the evolutionary game of network public opinion, and the game system cannot do without government intervention at present.

In order to overcome the above limitations, this paper studies the relatively independent tripartite evolutionary game system of "network media -- opinion leaders -- netizens" in the online public opinion field without considering the government intervention, and puts forward suggestions from the perspective of field theory. It provides practical reference significance for reducing government intervention, reducing governance costs and improving the self-coordination ability of the evolution system of public opinion propagation.

2. Methods

2.1 Division of game players

We divide the main body of the game into network media with high authority of speech, netizens with high freedom of speech, and opinion leaders who act as loudspeakers between the two.

2.2 Model Setting

We denote the strategy for the network media to select full coverage as m_1 , and the required cost is C_{11} . Rational participation of netizens will bring benefits R_{11} . If the opinion leader forwards it at this time, it will bring additional benefits R_{12} . If the opinion leader makes inappropriate remarks, the criticism cost C_{13} will be triggered. We denote the incomplete reporting strategy as m_2 , where the criticism of Internet users incurs a loss of L_{11} , and in this case, the criticism of opinion leaders incurs an additional loss of L_{12} . Criticism from others incurs a self-correcting cost C_{12} for online media. The strategy that opinion leaders choose to make appropriate remarks is denoted as o_1 , and the required cost is C_{21} . At this time, support from netizens will bring benefits R_{21} , and it will bring additional revenue R_{22} if online media forwarding. When online media coverage is incomplete, there is an additional cost C_{22} for making appropriate remarks. The strategy that opinion leaders choose to make inappropriate remarks is denoted as o_2 . At this time, netizens' criticism will cause loss L_{21} , and if online media criticism or outside intervention will bring additional loss L_{22} . The rational participation strategy chosen by netizens is denoted as n_1 , and the required cost is C_{31} . At this time, it will bring benefits such as psychological satisfaction R_{31} . When the network media does not report comprehensively and the media makes inappropriate remarks, it will cause the loss of negative emotions L_{31} , and the network media will cause the gain of positive emotions R_{32} when it criticizes opinion leaders in a timely manner. The strategy that netizens choose to participate blindly is denoted as n_2 , being criticized by others will cause losses L_{32} .

2.3 Strategy selection and stability analysis

Suppose that for network media, the expected revenue of the full reporting strategy is M_1 , the expected revenue of the incomplete reporting strategy is M_2 , and the average expected revenue is \bar{M} , then:

$$M_1 = yz(R_{11} + R_{12} - C_{11}) + y(1 - z)(R_{12} - C_{11}) + (1 - y)z(R_{11} - C_{11} - C_{13}) + (1 - y)(1 - z)(-C_{11} - C_{13}). \quad (1)$$

$$M_2 = yz(-L_{11} - L_{12} - C_{12}) + y(1 - z)(-L_{11} - L_{12} - C_{12}) + (1 - y)z(-L_{11}). \quad (2)$$

$$\bar{M} = xM_1 + (1 - x)M_2. \quad (3)$$

The replicator dynamic equation of network media is:

$$F(x) = \frac{dx}{dt} = x(M_1 - \bar{M}) = x(1 - x)(yC_{12} - C_{13} - C_{11} + yC_{13} + yL_{11} + yL_{12} + zL_{11} + yR_{12} + zR_{11} - yzL_{11}). \quad (4)$$

Suppose that for opinion leaders, the expected gain of speaking appropriately strategy is L_1 , the expected gain of making inappropriate statements strategy is L_2 , and the average expected gain is \bar{L} , then:

$$L_1 = xz(R_{21} + R_{22} - C_{21}) + x(1 - z)(R_{22} - C_{21}) + (1 - x)z(R_{21} - C_{21} - C_{22}) + (1 - x)(1 - z)(-C_{21} - C_{22}). \quad (5)$$

$$L_2 = xz(-L_{21} - L_{22}) + x(1 - z)(-L_{22}) + (1 - x)z(-L_{21}). \quad (6)$$

$$\bar{L} = yL_1 + (1 - y)L_2 \quad (7)$$

The replicator dynamic equation of opinion leaders is

$$F(y) = \frac{dy}{dt} = y(L_1 - \bar{L}) = y(1 - y)(xC_{22} - C_{22} - C_{21} + xL_{22} + zL_{21} + xR_{22} + zR_{21}). \quad (8)$$

Suppose that for netizens, the expected gain of rational participation strategy is P_1 , the expected gain of blind participation strategy is P_2 , the replicator dynamic equation of netizens is \bar{P} , then:

$$P_1 = xy(R_{31} - C_{31}) + x(1 - y)(R_{31} - C_{31} + R_{32}) + (1 - x)y(R_{31} - C_{32} - C_{31}) + (1 - x)(1 - y)(R_{31} - L_{32} - C_{31}). \quad (9)$$

$$P_2 = xy(-L_{31}) + x(1 - y)(-L_{31}) + (1 - x)y(-L_{31}) + (1 - x)(1 - y)(-L_{31}). \quad (10)$$

$$\bar{P} = zP_1 + (1 - z)P_2 \quad (11)$$

The replicator dynamic equation of netizens is

$$F(z) = \frac{dz}{dt} = z(P_1 - \bar{P}) = z(1 - z)(L_{31} - C_{31} - L_{32} + R_{31} - yC_{32} + xL_{32} + yL_{32} + xR_{32} + xyC_{32} - xyL_{32} - xyR_{32}). \quad (12)$$

Let $F(x) = 0, F(y) = 0, F(z) = 0$, then:

$$\begin{cases} x^* = \frac{C_{31} + L_{32} - L_{31} - R_{31}}{L_{32} + R_{32} + y(C_{32} - L_{32} - R_{32})} \\ y^* = \frac{C_{13} + C_{11} - zL_{11} - zR_{11}}{C_{12} + C_{13} + L_{11} + L_{12} + R_{12} - zL_{11}} \\ z^* = \frac{C_{22} + C_{21} - xC_{22} - xL_{22} - xR_{22}}{R_{21} + L_{21}} \end{cases} \quad (13)$$

We obtain one mixed strategy equilibrium of the game system is (x^*, y^*, z^*) and eight pure strategic equilibrium points respectively are $(0,0,0), (0,0,1), (0,1,1), (1,0,1), (1,1,0), (1,1,1)$. Since the evolutionarily stable equilibrium of the multi-population evolutionary game must be a strict Nash equilibrium, we substitute the pure strategy equilibrium point into the Jacobian matrix, and the corresponding three eigenvalues are shown in Table 1.

Table 1. The Jacobian eigenvalues of pure strategy equilibrium points

Equilibrium Points	Eigenvalue			System Stability
	λ_1	λ_2	λ_3	
(0,0,0)	$-C_{11} - C_{13}$	$-C_{21} - C_{22}$	$L_{31} - C_{31} - L_{32} + R_{31}$	Asymptotic stability
(0,0,1)	$\frac{L_{11} - C_{13} - C_{11}}{+ R_{11}}$	$L_{21} - C_{22} - C_{21} + R_{21}$	$C_{31} - L_{31} + L_{32} - R_{31}$	Asymptotic stability
(0,1,0)	$C_{21} + C_{22}$	$L_{31} - C_{32} - C_{31} + R_{31}$	$\frac{C_{12} - C_{11} + L_{11} + L_{12}}{+ R_{12}}$	Unsteady
(0,1,1)	$\frac{C_{12} - C_{11} + L_{11}}{+ L_{12} + R_{11} + R_{12}}$	$C_{21} + C_{22} - L_{21} - R_{12}$	$C_{31} + C_{32} - L_{31} - R_{31}$	Asymptotic stability
(1,0,0)	$C_{11} + C_{13}$	$L_{22} - C_{21} + R_{22}$	$-C_{31} + L_{31} + R_{31} + R_{32}$	Unsteady
(1,0,1)	$\frac{-C_{11} - C_{13} - L_{11}}{- R_{11}}$	$\frac{L_{21} - C_{21} + L_{22} + R_{21}}{+ R_{22}}$	$C_{31} - L_{31} - R_{31} - R_{32}$	Asymptotic stability
(1,1,0)	$\frac{C_{11} - C_{12} - L_{11}}{- L_{12} - R_{12}}$	$-L_{22} + C_{21} - R_{22}$	$-C_{31} + L_{31} + R_{31}$	Asymptotic stability
(1,1,1)	$\frac{C_{11} - C_{12} - L_{11}}{- L_{12} - R_{11} - R_{12}}$	$\frac{-L_{21} + C_{21} - L_{22} - R_{21}}{- R_{22}}$	$C_{31} - L_{31} - R_{31}$	Asymptotic stability

When the game is at (0,0,0), the negativity of the three parties will inevitably lead to deterioration of public opinion. When the game is in states (1,0,1), (0,0,1) and (1,0,1), the parameter setting is too demanding. Therefore, this paper will analyze the two strategy choices (1,1,0) and (1,1,1).

3. Simulation and Discussion

3.1 Discussion of evolutionary equilibrium point (1,1,1)

Assume that the initial time is 0 and the end time is 25. The parameters are set to $x = 0.6, y = 0.5, z = 0.4, R_{11} = 0.85, R_{12} = 0.15, C_{11} = 0.6, L_{11} = 0.2, L_{12} = 0.2, C_{12} = 0.35, C_{13} = 0.1, R_{21} = 0.7, R_{22} = 0.25, C_{21} = 0.4, C_{22} = 0.4, L_{21} = 0.35, L_{22} = 0.2, R_{31} = 0.4, L_{31} = 0.15, L_{32} = 0.15, C_{31} = 0.3, R_{32} = 0.1, C_{32} = 0.1$. The simulation result is shown in Fig. 1. When the strategy selection is (m_1, o_1, n_1) , the threeway game system composed of network media, opinion leaders and Internet users eventually tends to the evolutionary stability point (1,1,1).

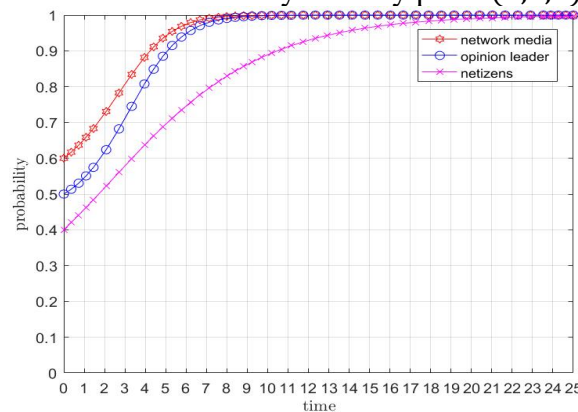


Fig. 1 "Network media-opinion Leaders-netizens" social ideal state evolution game trend chart

Adjustment scenario 1: Increase the loss caused by netizens blindly participating in criticism. The parameter L_{31} is adjusted to 0.35, and the simulation result is shown in Fig. 2.

It can be seen that network media and opinion leaders should pay more attention to netizens, criticize and supervise bad speech in time, clarify the consequences of bad speech, and weaken their habit of fluke psychology.

Adjustment scenario 2: Increase the additional income brought by the participation of opinion leaders in the case of comprehensive media coverage, and increase the additional income brought by media support when opinion leaders make appropriate remarks. The parameter R_{12} is adjusted to 0.35 and R_{22} to 0.45. The simulation result is shown in Fig. 3.

The results show that the evolution of media and opinion leaders to a steady state is accelerating, and network media and opinion leaders should take the initiative to strengthen cooperation: network media make full use of their own economic capital to explore and interact with influential opinion leaders; Opinion leaders should follow up and comment on quality media coverage. The two jointly improve the efficiency of public opinion development, and continuously accumulate its influence and other symbolic capital and social capital.

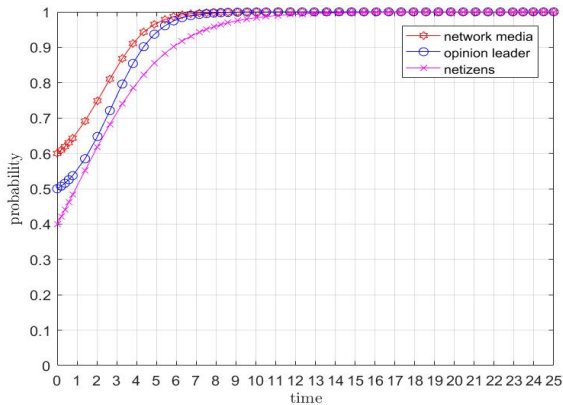


Fig. 2 The tripartite evolutionary game chart of Adjustment scenario 1

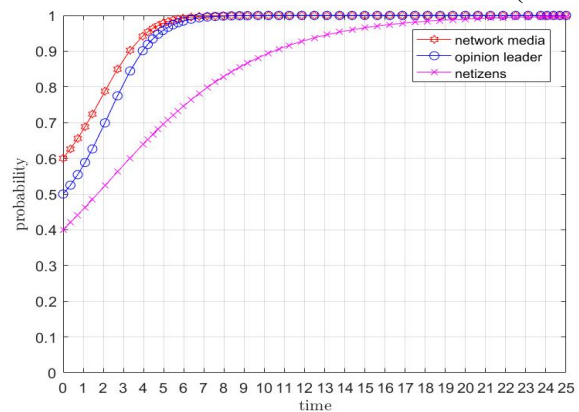


Fig. 3 The tripartite evolutionary game chart of Adjustment scenario 2

3.2 Discussion of evolutionary equilibrium point (1,1,0)

When the cost of netizens' rational participation in public opinion increases to the point that the total expenditure of satisfying netizens' rational participation in public opinion is greater than the loss of their blind participation in public opinion, netizens will tend to choose blind participation in public opinion. Adjust the parameters, C_{31} from 0.3 to 0.65, R_{11} from 0.85 to 0.65, R_{21} from 0.7 to 0.6. The simulation result is shown in Fig. 4, the game system does not reach a steady state. Adjust the end time from 25 to 95, the simulation result is shown in Fig. 5.

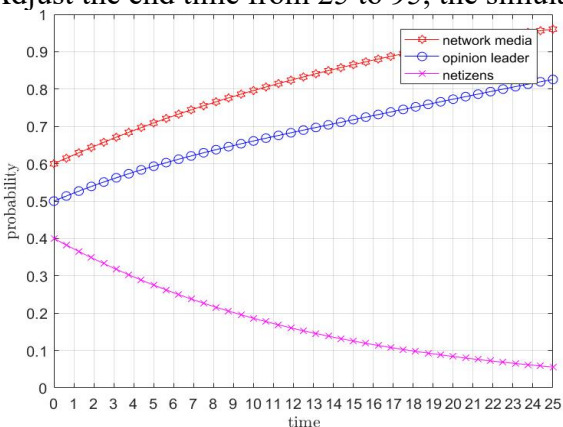


Fig. 4 The tripartite evolutionary game chart when the cost of netizen rational participation in public opinion increases

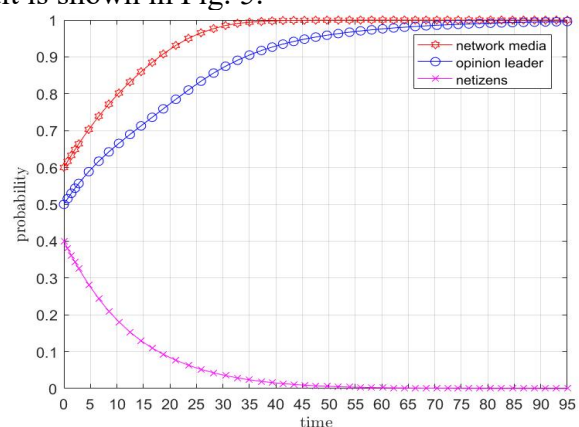


Fig. 5 The tripartite evolutionary game chart 2 when the cost of netizen rational participation in public opinion increases

It can be seen that the game system will eventually tend to the asymptotically stable point of (1,1,0), but compared with the evolutionary game system where all the above three parties make positive choices, it takes more than three times as long for the system to reach stability. Therefore the media should grasp its symbolic capital and fully report the facts. Opinion leaders should use their social capital to help netizens understand the facts with rational and objective remarks, and both sides should jointly guide netizens to correctly participate in public opinion, so as to reduce the cost of netizens 'rational participation in public opinion. Internet users should fully recognize the cultural capital and make rational comments with their own semantic style to obtain the satisfaction of others' recognition.

The three parties supervise and cooperate with each other, so that the four kinds of capital continue to flow and accumulate in the habits logic of the network public opinion field, and jointly lead the healthy development of public opinion.

4. Conclusion

The main contributions of this paper can be summarized as follows:

(1) On the basis of field theory, the concept of network public opinion field is put forward.

(2) A three-party evolutionary game system of "network media-opinion leaders-netizens" excluding the government is constructed. The research results can provide reference suggestions for the decentralization and function transfer of the government in the process of public opinion regulation, which has practical significance.

(3) The asymptotic stability of the two evolutionary games is simulated and analyzed, and the corresponding strategy suggestions are put forward from the perspective of field theory, which is a significant innovation in the combined research of field theory and quantification of network public opinion.

However, this paper also has some limitations. Network public opinion supervision cannot be completely separated from the government, and it is too ideal to only consider the tripartite game outside the government. Therefore, it is necessary to introduce the government into a more appropriate game model. At the same time, how to realize the transformation from simulation experiments to empirical analysis also needs further research.

References

- [1] Qi L .Transformation and Reconstruction of Ideological and Political Education in Campus Micro Communication Circle under the Perspective of Field Theory.Journal of Chongqing College of Electronic Engineering, 2017, 26(1): 58-62.
- [2] Bourdieu P .The Forms of Capital.In J. G. Riachardson (Ed.). Handbook of theory and research for the sociology of education , 1986, 241–258.
- [3] Clark M , Zukas M .A Bourdieusian approach to understanding employability: becoming a 'fish in water'.Journal of Vocational Education & Training, 2013, 65(2):208-219.
- [4] Nash R. Bourdieu on education and social and cultural reproduction. British journal of sociology of education, 1990, 11(4): 431-447.
- [5] Tomlinson M. Forms of graduate capital and their relationship to graduate employability. Education+ Training, 2017, 59(4): 338-352.
- [6] Bourdieu P, Wacquant L J D. An invitation to reflexive sociology. University of Chicago press, 1992.
- [7] Joy S, Game A M, Toshniwal I G. Applying Bourdieu's capital-field-habitus framework to migrant careers: Taking stock and adding a transnational perspective. The International Journal of Human Resource Management, 2020, 31(20): 2541-2564.
- [8] C. P G,R. N B,R. S S, et al. Sports Journalism's Uncertain Future: Navigating the Current Media Ecosystem in the Wake of the COVID-19 Pandemic. Journalism Studies,2022,23(10):1178-1196.
- [9] Wen H , Liang K , Li Y .An Evolutionary Game Analysis of Internet Public Opinion Events at Universities: A Case from China.Mathematical Problems in Engineering, 2020, 2020(19):1-14.
- [10] Ma A, Btl A, Mhm B. An evolutionary game model for analysis of rumor propagation and control in social networks-sciencedirect. Phys. A Stat. Mech. Appl, 2019, 523: 21-39.
- [11] Yin X, Wang H, Yin P, et al. Agent-based opinion formation modeling in social network: A perspective of social psychology. Physica A: Statistical Mechanics and its Applications, 2019, 532: 121786.
- [12] Jing D,Yaohong Y,Yi Z, et al. The Evolutionary Game Analysis of Public Opinion on Pollution Control in the Citizen Journalism Environment. Water,2022,14(23): 3902.
- [13] Zhang W, Chen Y. Research on Evolutionary Model and Dynamic Analysis for Internet Public Opinion Spreading. Complexity, 2021, 2021: 1-11.