RESEARCH ON THE EVOLUTION MECHANISM OF ECOSYSTEM OF CYBER SOCIETY BASED ON THE HAKEN MODEL

Xiaolan Guan and Zhenji Zhang
School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, P.R. China

Keywords: Ecosystem of cyber society, Self-organization, Haken model, Order parameter, Evolution mechanism.

Abstract: The cyber-society is a new social form derived from the emergence of computer and Internet technology which serve as the representatives of the information technology. It is similar to the ecological system, and its internal structure is hierarchical and composed according to a certain structure, and self-organization is an important mechanism of its evolution. Based on the theory of self-organization and by the cross-disciplinary analysis and research, this paper analyzes the self-organization conditions of Ecosystem of cyber-society, constructs the evolution model based on the Haken model, and then analyzes the functions of competition and coordination between the system elements and the process that the order parameter dominates that they bring. Finally, it selects the Internet development measurement data of Beijing, Shanghai, Shanxi, Tianjin, and other 27 provinces and cities in 2006 and 2009 as samples and analyzes the evolution process or China Ecosystem of cyber-society. The result reflects that technology innovation is the dominant order parameter in the evolution of Ecosystem of cyber-society, and a key factor to the development process of China Ecosystem of cyber-society and then the paper puts forward some ideas and suggestions to the development of China Ecosystem of cyber-society.

1 INTRODUCTION

As an integral whole that constituted by the interactions between various elements, the ecosystem of cyber society is an economic and social area that comes into being naturally as the development of the ecosystem of cyber society to a certain stage, and it is the product of interaction between people in the society. During the evolution process of the ecosystem of cyber society, when one element changes, the other elements will change accordingly and thus form a new order (Shi, 2007). The process and result of interrelate and interact between various elements and subsystems in the absence of the specific intervention from the outside world, which create self-organization, self-creation and self-evolution, and thus make the ecosystem of cyber society develop from disordered to ordered structures is a self-organizing process. The various elements that interact at different levels with different structures play a role in promoting the evolution of the whole ecosystem of cyber society from different perspectives and different aspects coordinately. If we can identify the key behaviors that affect the system evolution and development at one stage, namely the order parameter, then it is no doubt very significant to both of the managers or participants of the ecosystem of cyber society.

Based on the theory of self-organization and by the cross-disciplinary analysis and research, this paper analyzes the self-organization conditions of ecosystem of cyber-society, constructs the evolution model based on the Haken model, and then analyzes the functions of competition and coordination between the system elements and the process that the order parameter dominates that they bring, in order to give some guidelines to the rational development of ecosystem of cyber society, and also guarantee its healthy, orderly and rapid development.

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2 ANALYSIS ON THE CONDITIONS OF SELF-ORGANIZATION OF THE ECOSYSTEM OF CYBER SOCIETY

According to the theory of dissipative structure, the system must meet the following four conditions to generate the phenomenon of self-organization and form a dissipative structure: open and open to a certain extent, far from equilibrium, nonlinear interaction and fluctuations.

(1) Open and open to a certain extent

The ecosystem of cyber society is a system that constructed over the Internet. Open is one of the most fundamental characteristics of Internet, and the Internet is built on the basis of free and open. Meanwhile, as to the ecosystem of cyber society that depends on both of the technology and economics, it is placed in a larger system of human society, and the exchange of material, energy and information with the external environment is a necessary condition of its survival and development. The Internet is an image of the real world, so what happens in the real world will appear in the virtual space. There is no information on the Internet itself, and the information comes from the real society. If people simply try to get information from the Internet without making the production, processing and transmission of information, then there will be energy (information) imbalances within the system and lead to the destruction of ecosystem of cyber society.

(2) Far from equilibrium

The ecosystem of cyber society is not a system that is isolated and in a quiescent state, it contacts with the outside world closely. The entire system changes with time, and it shows non-uniform and diverse characteristics with different degrees within the system, and the distribution and development of its network groups are non-equilibrium. For example, shown as Figure 1, there is a clear imbalance between the regional distributions of Internet users in China. At the same time, although the Internet resources are abundant and diversified, their distributions are still uneven. Shown as Figure 2, there is also a clear imbalance between the regional distributions of domain names in China. As the human social activities in the ecosystem of cyber society are unpredictable, creative, and changeable over time, the information content that they create is also dynamic and unpredictable. Therefore, the entire ecosystem of cyber society is unstable, and far from equilibrium.

(3) Nonlinear interaction

The change of various elements within the ecosystem of cyber society is complex, and there are interlinks and interactions between the various elements. When the environment influences one or several elements of the ecosystem of cyber society, the ecosystem of cyber society will not take the change behavior of this element as the result, however, this element will influences the other elements, and other elements also counterproductive to the other elements, then the ecosystem of cyber society will show some changes in each other. The changes of the elements can not only cause the quantitative changes of the system, but also can cause the changes of morphology, structure and function of the system, and this kind of changes from quantity to quality is the result of the nonlinear effects (Xu, 2009). The fundamental reason why the ecosystem of cyber society is so colorful, and the life is so diversified is due to the nonlinear interactions during the evolution of ecosystem of cyber society.

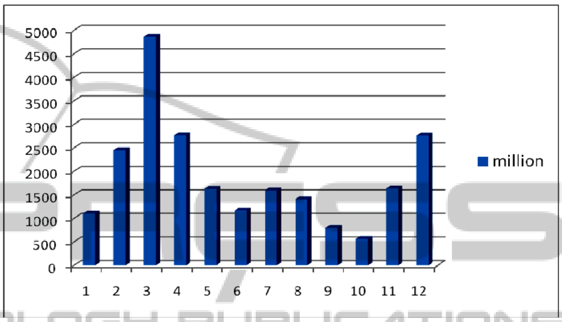

Figure 1: The number of Internet users in different provinces of China in 2009.

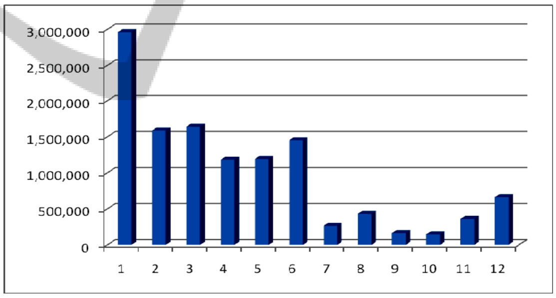

Figure 2: The number of domain names in different provinces of China in 2009.

(4) Fluctuations

The evolution process of the ecosystem of cyber society from a lower degree of organization to a higher degree of organization is the process of level upgrading, and it needs a cluster size at a certain critical point that can lead to qualitative change. And at the critical point of its evolution, the ‘fluctuation’ plays an important role in triggering, such as the breakthrough of network technology, the emergence of new species and so on. Fluctuations can lead to a non-equilibrium process in obtaining material, energy and information between various populations of ecosystem of cyber society. Almost all the species have ‘equal rights’ in competition at first, but then some populations have a greater advantage on accessing to ‘resources’ due to the intrinsic random fluctuations inside or outside, while others lost their edge. So the differences increase, and the unbalance exacerbates. The amplification of the fluctuations near the critical point will also further exacerbate this process, and then make the ecosystem of cyber society can not maintain its original structure as avalanche, thus result in a new ordered structure.

3 MODEL CONSTRUCTION OF THE SELF-ORGANIZATION EVOLUTION OF ECOSYSTEM OF CYBER SOCIETY BASED ON THE HAKEN MODEL

As a complex giant system, the state of the ecosystem of cyber society has to be described by using multiple variables, and it also has to depend on the state variables of the system to analyze its evolution of self-organization (Wei, 2006; Chen and Zhong, 2005). These state variables change over time according to their characteristics, and they can be divided into fast time-varying variables and slow time-varying variables. According to the Servo Principle of Haken, we can know that when the system changes, the evolution process and characteristics of the system are determined mainly by the slow variables. The evolution of the system is dominated by the slow variables, and the fast variables are servitude by the slow variables. Therefore, we can distinguish fast and slow variables by calculating, find the linear instability point, eliminate fast variables, and then obtain the order parameter equation which can be used to reveal the formation and evolution process of self-organization of the ecosystem of cyber society with ordered structure.

3.1 Model Assumptions

We will give the following assumptions before constructing the model.

Assumption I: The self-growth rate of each element of the ecosystem of cyber society is λ_i;

Assumption II: The development and evolution of the ecosystem of cyber society is related to its self-accumulation $q(t)$, and the higher the self-accumulation is, the faster the development is;

Assumption III: There are relationships of cooperation and competition between the various elements of the ecosystem of cyber society, and the interaction coefficients are α、$\beta\ldots$;

Assumption IV: There is mathematical sense of continuity with the development and evolution of the ecosystem of cyber society.

3.2 Model Construction

According to the Haken model, the interactions between different variables within the ecosystem of cyber society that make the system evolution process occurred can be described in a mathematical form, shown as equation (1).

$$q_i^* = -\lambda_i q_i + \sum_{j=1,\ldots,i-1,i+1,\ldots,n} \alpha q_i q_j ,\ i = 1,2,\ldots,n \tag{1}$$

Here, q_i is a state variable, α and λ_i are the control parameters. And α represents the intensity of competition and cooperation between different variables. If α is positive, then there will be inhibition between q_i and other variables. Otherwise, if α is negative, then there will be synergistic effect between these variables.

We can get the quantitative relationship between these variables through solving equation (1), and then identify the system order parameter.

We will only take two variables as an example to solve the equation. For ease of application, discrete the above equation into the following.

$$\begin{cases} q_1(t+1) = (1-\lambda_1)q_1(t) - \alpha q_1(t) q_2(t) \\ q_2(t+1) = (1-\lambda_2)q_2(t) + \beta q_1^2(t) \end{cases} \tag{2}$$

First put the original values of q_1 and q_2 into equation (2) and execute the regression analysis to get the control parameters values of α、β、λ_1、λ_2. Then put them into (1) which reflects the interaction between q_i and q_2, and let $q_1^* = 0$ to get the solution using the method of adiabatic approximation.

$$q_2 \approx {\beta}/{\lambda_2}\, q_1^2 \tag{3}$$

We can see from (3) that q_1 decides q_2, that is to say that the latter changes with the former, indicating that q_1 is the order parameter of the system. Then put

(3) into (1) and get the order parameter equation.

$$q_1^* = -\lambda_1 q_1 - \frac{\alpha\beta}{\lambda_2} q_1^3 \qquad (4)$$

And then get the potential function by calculating its opposite number.

$$v = 0.5\lambda_1 q_1^2 + \frac{\alpha\beta}{4\lambda_2} q_1^4 \qquad (5)$$

We can determine the convex and concave character of the potential function v by its second derivative, and then describe it graphically. The structural characteristics of the potential function can reflect the evolution mechanisms of the ecosystem of cyber society intuitively, that is, when the state variables and control parameters change, the system potential function also changes, and the original stable state comes into an unstable state.

We can get the stationary solution of the order parameter by equation (4), and there are two cases shown as follows.

① If $\lambda_1 > 0$, then equation (4) has only one unique stable solution $q_1 = 0$, and its potential function is shown as Figure 3 (Put the simulated data into Matlab6.5, assuming $\lambda_2 = 1$, and $\alpha\beta = 0.01$).

② If $\lambda_1 < 0$, then equation (4) has three solutions, $q_1^1 = 0$, $q_1^2 = \sqrt{-\frac{\lambda_1\lambda_2}{\alpha\beta}}$, and $q_1^3 = -\sqrt{-\frac{\lambda_1\lambda_2}{\alpha\beta}}$。 Among them, the first solution is unstable, but the other two solutions are stable, shown as Figure 4. They show that the system can come into a new stable state through mutation. The change of q_1 can affect the changes of the entire system.

4 ANALYSES ON THE SELF-ORGANIZATION EVOLUTION MECHANISM OF THE CHINA ECOSYSTEM OF CYBER SOCIETY

4.1 Variable Selection and Data Collection

The key to the research on the formation and evolution of ecosystem of cyber society is to analyze the development process of its various components after they come into being, and summarize the nature of the evolution of ecosystem of cyber society from its complex forms. There are two viewpoints in the development promotion of ecosystem of cyber, one is that we should increase the investment on the Internet-based resources to improve the resource environment of ecosystem of cyber society, that is to say that we should focus on the investment on construction practices, including domain names, IP addresses, websites and other network infrastructures; while the other one is that we should develop the productivity of the ecosystem of cyber society and improve the information productivity of the information resources through technology innovation, that is, we should focus on the behaviour of technology innovation, such as innovation of network communication, web technology, network security, online payment and so on. In essence, both of these viewpoints are all aim to improve the ecosystem of cyber society, so we don't think that they are contradictory. If we can identify the key behaviours that affect the evolution of the system at one stage,

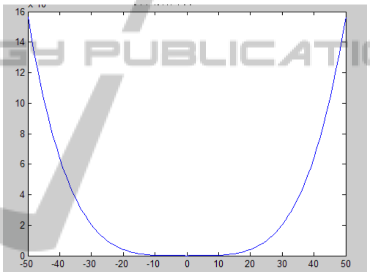

Figure 3: The potential function when $\lambda_1 > 0$.

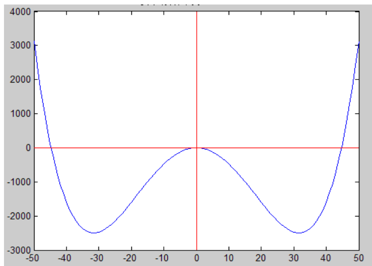

Figure 4: The potential function when $\lambda_1 < 0$.

namely the order parameter, then it is no doubt very significant to both of the managers or participants of the ecosystem of cyber society.

Based on the above two viewpoints, this paper will mainly select the following two variables as an example to study.

① R_e——Internet-based resources index;

② P_e——The number of dynamic web pages per Internet user has. Here, we take the number of dynamic web pages per Internet user has as the information productivity of the ecosystem of cyber society, and also as a symptom of technology innovation. This variable can be used as the state representative of the production of information resources, but it is not the only one state variable.

As to the previous two selected variables, in need of special note here is that in view of the research on the ecosystem of cyber society is still in an early stage, there are very few relevant studies about its evolution mechanism, and there is not a mature variable system that has been recognized, so the hypothesis we make here is only a theory hypothesis to the ecosystem of cyber society. We have done a lot of data analysis and spreadsheet work in the selection of these variables to make sure that these two variables meet the requirements of Haken model and basically reflect the nature of the ecosystem of cyber society. And we also learn from the variables selection criteria in the other researches about system evolution based on the Haken model.

Due to the model computing needs, this paper selectes the Internet development measurement data of Beijing, Shanghai, Shaanxi, Tianjin, and other 27 provinces and cities in China in 2006 and 2009 as a sample for quantitative empirical research.

4.2 Model Calculation

We can get the values of R_e by using the calculation formula of the Internet-based resources index in the '27th China Internet Development Status Survey Report' that released by the China Internet Network Information Centre, shown as Table 1.

The index value of each basic indicator = the current number per Internet user has / the number per Internet user has in the base period[1]*100

Internet-based resources index = 0.3005 × IP Address Index+ 0.2435 × Domain Index + 0.2727 × Website Index + 0.1833 × International Bandwidth Index[2]

Identify the fast variable and slow variable.

Assume that R_e is q_1, and P_e is q_2 first, shown as equation (6), and then verify the variable hypotheses.

$$\begin{cases} R_e(t+1) = (1-\lambda_1) R_e(t) - \alpha P_e(t) R_e(t) \\ P_e(t+1) = (1-\lambda_2) P_e(t) + \beta R_e^2(t) \end{cases} \tag{6}$$

1 This paper selects the average from December 2005 to June 2007 of China as base of data.

2 The International bandwidth is the ability that one country can connect to other countries or regions. In the model we build in this paper, as we select the provincial and local networks as an application, and there is no disaggregated statistics, so we use the national data during the actual calculations instead, that is, 98.0 in 2006, and 133.7 in 2009.

Execute the regression analysis with the calculated R_e and P_e using the linear process of SPSS 13.0 based on the multivariate regression model, and use Enter variable analysis.

We can get the following equation from the above running result.

$$\begin{cases} R_e(t+1)^* = \underset{(2.178)}{0.443} R_e(t) + \underset{(4.956)}{0.008} P_e(t) R_e(t) + \underset{(2.280)}{33.387} \\ P_e(t+1)^* = \underset{(5.232)}{1.352} P_e(t) + \underset{(4.773)}{0.001} R_e^2(t) + \underset{(0.618)}{1.756} \end{cases} \tag{7}$$

Analyze the running results of SPSS 13.0, and we can see that there is higher degree of model fit no matter to ① or ② in (7) (R approaches 1), and the significance level of F test is 0.00. The regression results are very good. The figures in parentheses are the t test value (The same below).This equation can better reflect the relationship between different variables, and the results are reliable.

Then get the values of control parameters.

$\alpha = -0.008$, $\beta = 0.001$, $\lambda_1 = 0.557$, $\lambda_2 = -0.352$

Here, $|\lambda_1| > |\lambda_2|$, indicating that the change of R_e is faster than the change of P_e, so P_e should be the order parameter that changes slowly. The assumption we made above is incorrect, we should take P_e as q_1 , R_e as q_2 , and then re-establish the equation shown as (8) below.

$$\begin{cases} P_e(t+1) = (1-\lambda_1) P_e(t) - \alpha P_e(t) R_e(t) \\ R_e(t+1) = (1-\lambda_2) R_e(t) + \beta P_e^2(t) \end{cases} \tag{8}$$

Execute the regression analysis to (8), and then get the following equation.

$$\begin{cases} P_e(t+1) = \underset{(3.387)}{1.146} P_e(t) + \underset{(4.178)}{0.004} P_e(t) R_e(t) + \underset{(1.950)}{0.146} \\ R_e(t+1) = \underset{(2.452)}{0.490} R_e(t) + \underset{(4.821)}{0.024} P_e^2(t) + \underset{(2.176)}{32.655} \end{cases} \tag{9}$$

Analyze the running results of SPSS, and we can see that there is higher degree of model fit to (9) (R approaches 1), and the significance level of F test is 0.00. The regression results are very good. So this equation can better reflect the relationship between different variables, and the results are reliable. Meanwhile, analysis on the parameter value of t test shows that the square of P_e or the product of P_e and R_e in 2006 has a certain influence to P_e or R_e in 2009. The result is consistent with the hypothesis we made above that takes P_e as the slow variable, so the result here has a certain interpretation of meaning.

Then we can get the control parameters values.

$\alpha = -0.004$, $\beta = 0.024$, $\lambda_1 = -0.146$, $\lambda_2 = 0.510$

At this point, $|\lambda_1| < |\lambda_2|$, so P_e is the order parameter and R_e changes with P_e. α and β reflect the results of interaction between these two factors. Thus, we can get the differential equations that reflect the interaction between R_e and P_e, shown as (10).

$$\begin{cases} P_e(t+1)^* = \big(1-\underset{(3.387)}{(-0.146)}\big)P_e(t) - \underset{(4.178)}{(-0.004)}P_e(t)R_e(t) + \underset{(1.950)}{0.146} \\ R_e(t+1)* = \big(1-\underset{(2.452)}{0.510}\big)R_e(t) + \underset{(4.821)}{0.024}P_e^2(t) + \underset{(2.176)}{32.655} \end{cases} \tag{10}$$

Let $P_e(t+1)^* = 0$, then we can get the solution of the equation.

$$R_e(t+1) \approx \beta/\lambda_2\, P_e^2 = 0.024/0.510\, P_e^2 \approx 0.0470588P_e^2 \tag{11}$$

We can see from (11) that P_e determines R_e, that is to say the latter changes with the former, indicating that P_e is the order parameter of the system. Put (11) into (10) and get the order parameter equation.

$$P_e^* = -\lambda_1 P_e - \alpha\beta/\lambda_2\, P_e^3 = 0.416P_e + 1.8823529*10^{-4}P_e^3 \tag{12}$$

And then get the potential function by calculating its opposite number.

$$\nu = 0.5\lambda_1 P_e^2 + \alpha\beta/4\lambda_2\, P_e^4 = -0.073P_e^2 - 4.70588*10^{-5}P_e^4 \tag{13}$$

Let $d\nu/dP_e = 0$, put the calculated values of α 、β 、λ_1 、λ_2 into (13) and get the stable solution of the order parameter equation as follows. The system will generate a new ordered structure at the stable solution obtained.

P_{e_1}=27.85， P_{e_1}=-27.85

We can determine the convex and concave character of the potential function by its second derivative $d^2\nu/d(P_e)^2$.

Table 1: The values of R_e and P_e of 31 provinces and cities in China in 2006 and 2009.

	Provinces	Variable (R_e)		Variable (P_e)		Variable calculation		
		2006	2009	2006	2009	R_e*R_e	R_e*P_e	P_e*P_e
1	Beijing	386.84	542.98	115.61	311.72	149641.5	44723.62	13366.62
2	Zhejiang	105.24	149.08	20.05	65.08	11076.45	2110.16	402.00
3	Guangdong	101.07	100.93	13.39	39.70	10215.59	1353.48	179.32
4	Shandong	63.97	91.42	9.14	14.14	4092.07	584.73	83.55
5	Fujian	121.11	120.00	19.79	48.76	14666.67	2396.18	391.48
6	Shanghai	185.10	236.39	64.73	131.16	34260.70	11981.69	4190.25
7	Liaoning	86.11	66.78	8.33	13.86	7415.13	717.22	69.37
8	Hunan	67.03	95.79	10.02	11.84	4492.61	671.80	100.46
9	Chongqing	89.98	79.10	31.16	19.19	8096.04	2804.09	971.21
10	Tianjin	87.15	93.28	19.24	49.95	7594.36	1676.67	370.17
11	Sichuan	63.55	69.19	10.28	27.26	4038.73	653.38	105.70
12	Jiangsu	97.69	82.20	11.62	41.68	9543.06	1134.82	134.95
13	Gansu	51.06	39.92	8.96	4.62	2607.30	457.29	80.20
14	Henan	78.64	55.96	12.22	27.59	6183.73	961.19	149.40
15	Hebei	67.23	67.78	6.49	15.51	4519.29	436.26	42.11
16	Jiangxi	69.04	75.39	10.10	21.77	4766.87	697.08	101.94
17	Yunnan	55.10	47.35	4.19	6.70	3035.95	230.61	17.52
18	Hubei	69.57	73.26	14.09	26.37	4840.45	980.57	198.64
19	Shaanxi	56.34	97.32	5.25	16.03	3173.85	295.96	27.60
20	Qinghai	54.59	49.43	1.05	1.68	2979.89	57.15	1.10
21	Guangxi	51.22	60.51	5.79	13.99	2623.00	296.29	33.47
22	Anhui	71.16	61.38	13.02	25.62	5063.94	926.61	169.55
23	Heilongjiang	60.95	86.00	6.03	14.98	3714.70	367.67	36.39
24	Jilin	75.74	64.36	5.13	8.06	5736.58	388.18	26.27
25	Hainan	80.19	87.59	2.55	45.50	6430.37	204.80	6.52
26	Neimenggu	61.13	52.49	1.38	4.81	3737.12	84.57	1.91
27	Xinjiang	61.99	42.21	6.75	0.49	3842.59	420.74	45.53
28	Guizhou	63.69	49.46	2.42	6.15	4055.98	154.76	5.84
29	Shanxi	47.98	51.93	2.56	4.04	2302.49	123.92	6.57
30	Ningxia	139.88	63.33	3.56	14.87	19566.07	498.90	12.65
31	Xizang	73.62	27.89	0.69	0.06	5420.50	51.01	0.48

$$d^2v \Big/ d(P_e)^2 = -0.146 + 5.647*10^{-3} P_e^2 \tag{14}$$

Put the stable solution into (14), we can get $d^2v \Big/ d(P_e)^2 = 4.23394 > 0$, which indicates that the potential function has a minimum at these two points of $P_e = \pm 27.85$. And then use Matlab 6.5 to simulate data and get the potential function curve of self-organization evolution of China ecosystem of cyber society, shown as Figure 5. The structural characteristics of the potential function reflect the evolution mechanism of China ecosystem of cyber society, that is, when the state parameters R_e and P_e, and the control parameters α 、β 、λ_1 、λ_2 change, the potential function of the system will change correspongdlly, and change from the original stable state to an unstable state.

4.3 Analysis and Implications

The state of the potential function depends on the state variables that reflect the behavior of the system (R_e and P_e in this paper), and the control parameters that reflect the impact of the environment on the system (α , β , λ_1 and λ_2 in this paper). When the state variables and control parameters change, the potential function of the system also changes, and the original stable state changes into an unstable state. As to the ecosystem of cyber society, certain structure determines the limit of its development, so when approaching the limit, the system would be difficult to adapt the original structure. However, the development of Internet-based resource, progress of the science (information) technology will enable the ecosystem of cyber society to upgrade its structure, and then the values of α , β , λ_1 and λ_2 in the equation will change and thus form a new structure, which can accommodates a higher limit of development. The system operates in a new potential function and comes into a stable state of higher level. This is the formation and evolution of the ecosystem of cyber society, and the continuous development is the process of self-organization of the system which is such a complex super-cycle with self-catalytic.

Through the above analysis, we can clearly reveal the formation and evolution mechanism of the ecosystem of cyber society, identify accurately the decisive factors, and then provide development

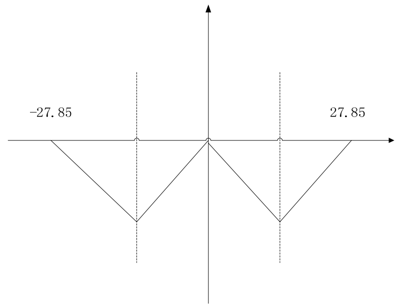

Figure 5: The potential function curve of China ecosystem of cyber society evolution.

direction for the cyber society. From the potential function curve of China ecosystem of cyber society evolution, we can see that in the appropriate control variables, there will be non-zero interactions between the variable R_e which is the representative of Internet-based resources index and the variable P_e which is the representative of technology innovation within the China ecosystem of cyber society, and thus form the stable solution of the system. Here, the order parameter of the system is technology innovation, which is the decisive factor during the development process of China ecosystem of cyber society, and in turn to promote the development direction.

We can get the following implications.

(1) It can be seen from Figure 5 that at the critical point during the evolution process of China ecosystem of cyber society, the critical point that dominates the evolution of system is technology innovation. When the system generates a new ordered structure, there will be a new stable solution $P_e = \pm 27.85$. But from the values of P_e shown in Table1, we can see that the majority of China sub-ecosystems of cyber society has not reached the critical state. Therefore, we should pay more attention to the important role of technology innovation, and take practical measures to increase the research of network, investment on the information technology, especially emphasis on the constructive role of technology innovation and their amplification role.

(2) The behaviours that each control parameter in the model reflects are as follows.

① α is negative, reflecting that the construction of Internet-based resources will promote the technology innovation. It indicates that the transformation of computer equipments and improvement of resources are very important during the process of social development. There are synergistic benefits between the investment of Internet-based resources and technology innovation.

② β is positive, reflecting that the technology innovation will drive the growth of Internet-based resources. It indicates that these two variables promote each other and thus create synergy. The system will achieve good cycle of sustainable development if they increase together.

③ λ_1 is negative, indicating that the China ecosystem of cyber society has established a positive feedback mechanism of technology innovation growing within the system. The larger the absolute value is, the faster the growth will be.

④ λ_2 is positive, indicating that there is a negative feedback mechanism of Internet-based resources index decreasing within the ecosystem of cyber society, that is to say, as the innovation and development of technology, the Internet-based resources index is beginning to show a downward trend to decline after an initial growth phase. However, the study of this paper shows that the Internet-based resources and technology innovation should be the indexes of mutual promotion and coordinated development. The opposite result we got reflects the drawbacks during the formation and development of China ecosystem of cyber society.

The construction investment on the Internet-based resources is the material basis of technology innovation, and the technology innovation is also an important means to increase the Internet-based resources index. Both of them are the important prerequisites and fundamental guarantee for the development of China ecosystem of cyber society. The Internet-based resources and technology innovation promote each other and thus create synergy. The micro-fluctuations amplify and change to giant fluctuations under the effect of nonlinear mechanism, and the entire system comes into a virtuous cycle and thus reaches a new state.

5 CONCLUSIONS

Based on the theory of self-organization and by the cross-disciplinary analysis and research, this paper analyzes the self-organization conditions of Ecosystem of cyber-society, constructs the evolution model based on the Haken model, and then analyzes the functions of competition and coordination between the system elements and the process that the order parameter dominates that they bring. Finally, it selects the Internet development measurement data of Beijing, Shanghai, Shanxi, Tianjin, and other 27 provinces and cities in 2006 and 2009 as samples and analyzes the evolution process or China Ecosystem of cyber-society. The result reflects that technology innovation is the dominant order parameter in the evolution of Ecosystem of cyber-society, and a key factor to the development process of China Ecosystem of cyber-society and then the paper puts forward some ideas and suggestions to the development of China Ecosystem of cyber-society.

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