A New Model of the Economic Stereoscopic Innovation Value Networks in Digital Economy

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Abstract: Now, the digital economy is the hot topic in recent years. Most researchers do some research about it. The innovation ecosystem is one of them. In most papers, the economical or industry innovation ecosystem in different levels, just like in a country, region or a company, have been researched, which were the focus on the elements of the innovation ecosystem and the relationships between them just in a plane. In this paper, a new model of the economical stereoscopic innovation ecosystem is proposed, which has not been proposed by other many researchers, especially in the economy field. In this paper, we believe there are different value networks and niches in different innovation ecosystem. The value point, market, technology niches and value network are the necessary elements in a scientific innovation ecosystem. The model is proposed to quantize the innovation ecosystem to promote the digital economical development, which also will to guide a regional digital economical development. In the experiment, the model is tested using the simulated data to prove the model reasonable.

1. Introduction

Because the digital economy has become a new momentum to drive economic development to many countries in all over the world. It has become more and more important to the social development. So, many countries have paid more attention on the digital economy. And more policies have been made to support or promote the development of the digital economy by them. The Integrative development of digital economy and Industry or the many fields is a trend in the future. So more and more researchers have paid more attention on the technology, legislation, business model and management of the digital economy, and so on. The Cloud computer, Big data, Deep learning and Artificial intelligence have become the hot topics in the many fields include the government, college, research institution and company. So, to accurately promote the development of the digital economy, the innovation ecosystem should be studied and be created scientifically using mathematical method. This is the purpose of this paper.

Many researchers have analyzed the cooperative innovation system of coexistence, symbiosis and coevolution between the companies of the ecosystem using the ecological theory, management science etc. In [1], Freeman firstly proposed the National Innovation System (NIS). After that, many researchers proposed many definitions of the NIS. In [2],the definition of the NIS, which is an interactive network system for the manufacture, storage and transfer of knowledge, skills and new products, was accepted. That means the most researchers believe the NIS was a network system which was consisted of enterprises, universities and research institutions participating in the development and diffusion of new technologies. In [3], industrial innovation system is a network system with market demand as the driving force, policy regulation as the guidance, good domestic and foreign environment as the guarantee, innovative technology supply as the core, and the realization of specific industrial innovation as the goal. In [4-7], researchers believed that the industrial innovation system consists of knowledge and technology, creators and networks, besides

the institutions around the innovative actions. The paper [8] has pay attention to the innovation failure and proposed a new method to resolve the problem. The evaluation index of industrial innovation system was constructed, and the efficiency evaluation model of industrial innovation system was established by using DEA method[9]. In [10], innovation ecosystem was a new relationship created between the government, enterprises, colleges and workers. In [11-13], the ecological theory and method were used in the management.

But the most researchers have not researched the quantization relationship between the components in the digital economical system. The interactive function between them has not been studied. All most of them have only studied the plane ecosystem, did not have study the stereoscopic innovation system. The transform of different station of the system has not studied also. So, in this paper, a new transform algorithm, interactive relationship function between components and the coevolution of the digital ecosystem are proposed. The model quantizes the interaction and the transformation of the different niches in the digital ecosystem, using the ecology theory and the computer social theory.The advantages of the logistic model, Lotka-Volterra model are used in this paper. The experiment proves the model is reasonable and scientific.

2. Steroscopic Innovation Ecosystem

2.1 Different Niches

There are many niches to a company in traditional industry field, just like technology, market etc. In the digital economy, there are also many different development paradigm or model to the company. So, especially, in the digital economy, relationship between companies is more cooperative than competitive, which is not like relationship between companies in the traditional field. They are in a mutually beneficial cooperation system in the digital economy ecosystem. In the ecosystem, more resources mean more speaking right or more decision-making power. The resource includes technology, market information and human resource, etc. The value of the resource in a company, decides the value-node and the statues in a network system. Different niche means different function or impact in the system. Same niche means the same roles.

So, in this paper, we believe that there are three components, which are the technology, market and value, in the digital economy ecosystem. We defined the plane digital innovation from the perspective of the niches, the plane digital innovation ecosystem VN_n is consisted of the new technology niches T_n, new market niches M_n and new value niches V_n.

$$VN_n = f(T_n, M_n, V_n) \qquad (1)$$

The technology niches T_n is the new technology for research and development, or the new advanced technology which is not exist before it is invented. The market niches M_n is a kind of initial market or marginal market after the birth of new technology, where new technology avoids the competition with mainstream market, and chooses non-mainstream market to hatch and develop. The value niches V_n is to use different business models and the different attributes of product performance, to occupy a certain ecological position in the value network system. The VN_n is a series of value networks, which the company can implement dimension up attack or dimension reduction attack to survival and is first mentioned in this paper. The market niches, technology niches and value niches are the basic factors in a plane innovation ecosystem. The value networks are consisted of different technology, market niches and value niches. Stereoscopic innovation ecosystem is consisted of different two value network system at least.

2.2 Components of Digital Ecosystem

In a plane innovation economic ecosystem, the innovation ecological model mainly includes four factors: financial capital, innovation subject, innovator ecosystem (including science and technology service intermediary agencies), and government platform (including government, law,

infrastructure, office environment and preferential policies), we use $F_n, C_n, R_n, G_n,$ which respectively stands for the these factors, $n \in (1,2,3,N)$ means different value network niches in the ecosystem.

3. The Competition-Cooperation Model

3.1 Competitive-Cooperative Model

In the digital economy field, the competitive relationship is less, and the cooperation-coevolution relationships between companies are more important. There are more cooperative development between the companies of the point, line, plane and stereoscopic dimension in the system. We use the function to stand for the model.

$$\frac{dN_i}{dt} = r_i \cdot N_i \cdot (1 - \frac{N_i}{\sum_{j=1}^{4} W_{ji} K_j})$$
(2)

This function stands for the cooperation-coevolution model. W_{ji} means the impact between the No. j populations to the No. i populations, when, $j = i$, $W_{ji} = 1$, others, $1 > W_{ji} > 0$. N_i is the number of the No i populations, the r_i is natural growth rate, K_i means the total resources of the No. i populations. The F_n, C_n, R_n, G_n populations represent different populations.

3.2 Interactive Function between Populations

The interaction between different populations in an ecosystem, especially the information flow, are very important and also the key factor to promote emergence of the new niche in the ecosystem. The information flow between each other can promote the development of the system. Flow more fast can promote more quickly of the development. We use the function 3 to stand for the function of the interaction between the populations.

$$E_n = U_n \bullet \left(\frac{N_{F_n}}{N_{F_n} + N_{C_n} + N_{R_n} + N_{G_n}}, \frac{N_{C_n}}{N_{F_n} + N_{C_n} + N_{R_n} + N_{G_n}}, \frac{N_{R_n}}{N_{F_n} + N_{C_n} + N_{R_n} + N_{G_n}}, \frac{N_{G_n}}{N_{F_n} + N_{C_n} + N_{R_n} + N_{G_n}} \right)$$
(3)

This function means statistical distribution of different factors in the No. n value niches, the E_n means the statistical distribution in the n value network. U_n means the information flow distribution between factors , $1 \geq U_n > 0$, which is the matrix, just like function 3, the U_n value of factor is 1 when it interacts to itself. N_{F_n} is number of the financial capital in the n value niches. N_{C_n} is number of innovation subject in the n value niches. N_{R_n} is the number of the innovator in the n value niches. N_{G_n} is the number of the government platform in the n value niches.

$$U_n = \begin{bmatrix} 1, & U_{1,2}, \cdots, U_{1,n} \\ U_{2,1}, 1, & \cdots, U_{2,n} \\ \vdots & \cdots, \cdots \\ U_{n,1}, U_{n,2}, \cdots, & 1 \end{bmatrix}$$
(4)

3.3 Model of Value Niches

The innovation ecosystem of digital economy is often composed of more innovation ecosystems. The old innovation ecosystem is constantly shrinking and disappearing, the new innovation ecosystem is constantly growing, and more new and little innovation ecosystems are automatically

generated. There is a struggle between different ecosystems. The new innovation ecosystem is obstructed usually by the older innovation ecosystem.

We let E_n stands for the plane innovation ecosystem, which is the n value niches of system.

$$E = \bigcup E_n \qquad (5)$$

The $n \in (1,2,3,\cdots,N)$, different value of the n stands for the different values niches and value networks in an ecosystem. There are combat or competition, obstruct or cooperation between the different populations in an innovation ecosystems. The relationship between elements of the ecosystems is cooperation-competition, just like the Lotka-Volterra model. Two or more populations are competition. Actually, there are mutual support and coevolution between them in the digital economy ecosystem.

There are not generally many stereo-innovation ecosystems. There are usually 2 or 3 niches in a well ecosystem at least. The stereo-innovation ecosystem is becoming because the transformation between different niches.

The transformation relationship between E_n and E_{n-1}, which is used the follow function.

$$E_n = \frac{1}{1 + e^{(-E_{n-1} \times \omega)}} \cdot E_{n-1} \qquad (6)$$

The ω is the probability or the rate of new niche in the ecosystem. According to the advantages of the digital economy, we use the function to stand for the transformation relationship of the n-1 value niches status to the n value niches status in an ecosystem. The trigger point of an innovation ecosystem evolution is to create a new value network system and form a network ecosystem in a new value niche of the system.

4. Experiment

4.1 The Interactive Function Experiment

In this paper, we focus on the transform function between different value network ecosystem and the interactive function between populations in the ecosystem. So we simple the competition-cooperation model in the plane ecosystem using the interactive function. In the ecosystem of n-1 value network, we set the($F_{n-1}, C_{n-1}, R_{n-1}, G_{n-1}$)value is(10,70,15,5)in the plane ecosystem. If the transform matrix U_n value is follow.

$$\begin{bmatrix} 1.0.4,0.4,0.8 \\ 0.8,1,0.8,0.5 \\ 0.5,0.8,1,0.6 \\ 0.5,0.6,0.4,1 \end{bmatrix}$$

More bigger means that the information flow faster between different populations. The information flow means the interaction between them. According to the function 4, we can get the value(48,92.5,79,58)in the same value network.

4.2 Steroscopic Innovation Transform Experiment

In the experiment, we set the probability ω is 0.01 in the formula 6. The E_{n-1} is(19,77,31,21.5).Through calculating, the E_n result is (10,52,17,11),that is a new value network. In the next niches, there are little new population.

5. Conclusion

In this paper, we proposed a new stereoscopic innovation ecosystem model on the different value

networks in digital innovative ecosystem. The knowledge of the ecosystem is used in the model. We use the ecosystem theory to analysis the natural growth rate and the competition and cooperation model. To promote the development of the digital ecosystem is the most important. Through analyzed the interaction and the transform algorithm, we can believe that the interaction and the new niches are more important. The reasonable and the key factors is high-flow information between components in an ecosystem. The experiment proves the model which will promote the development of the digital economy.

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