Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(5):1764-1768

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The analysis of enterprise imitation behavior in scale-free networks-Based on the neighborhood effect

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ABSTRACT

Having analyzed The Neighborhood Effect ,this paper constructs a dynamic enterprise income model, and then analyze the regulation of behavior-spreading in scale-free networks, in order to conclude the effects of enterprise imitation behavior in scale-free networks, in terms of the standard of strategy changing, the paper analyzes the enterprise imitation behavior in scale-free networks from two perspectives, one is the biggest revenue among the income of surrounding neighborhood , the other is the average revenue of the surrounding neighborhood which happened in last game .

Key words: The structure of scale-free networks; the neighborhood effect; enterprise imitation behavior; dynamic enterprise income model

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INTRODUCTION

In the structure of scale-free networks, enterprise imitation behavior has its own behavior characteristics and law of spreading, under the scale-free cluster network structure, group behavior tend to behave a consistent overall convergence or randomness , Enterprise imitation behavior will hinder corporation technological innovation to some extent.

Ⅰ THE CONSTRUCTION OF DYNAMIC ENTERPRISE INCOME MODEL BASED ON THE NEIGHBORHOOD EFFECT

A.*The standard of neighbor defying*

In clusters, there is a wide variety of links between corporations, including formal links and informal links, as to formal link, it can be connected by technology patents transfer and R & D cooperation, as to informal link, it can be connected by stuff exchanging and reverse R & D of competing products. The informal contact brings a lot of invisible convenience for intra-cluster enterprises to imitate behavior. Informal sector activities tend to be concentrated in a few activities, but also spread across a wide spectrum of industries, They are mainstream both in types of skills used and in products made and distributed [1].Combining related theoretical results of and the field research of case clusters, the paper selected the "kinship" as standard of defying neighbor in network, regarding that it is based on this "kinship" that constitute the link between enterprises in the cluster (or connection). Kinship is fascinating. While not all sociologists will agree with that claim, it is nevertheless a sociological observation and not an expression of personal predilection[2].The so-called kinship relationship, contains both kinship within three generations, three generations as less direct, collateral consanguinity, also including geopolitical or other relationships with a significant degree of discrimination such as old classmates, former colleagues, neighbors and so on geographical concepts and thus constitute a different network architecture standards as the research object, analyzing and discussing the enterprise imitating behavior under different network structures.

B.*The imitation behavior based on the neighborhood effect*

The existing interpretation about enterprise imitation behavior mechanisms in the cluster focused on three perspectives, they are information cost saving, bounded rationality and its uneven distribution in the population, knowledge spillovers. What is different from above perspectives is that this paper regard "the neighborhood effect" as the core idea to interpret this imitation behavior mentioned above. We tend to believe that because of the geographical proximity characteristics of industrial clusters that creating a significant "neighborhood effect" characteristic, clusters are the latest addition to a long list of local systems of production or innovation (growth poles, scientific parks, industrial and technological districts, technopoles, innovation milieus, etc)[3].that is to say, neighborhood ,this role in clusters, has a great impact on how individual corporate making behavior decisions in clusters. Based on analysis above, the article further put forward a new view that whether individual corporate imitate the behavior of others depends on the earnings they got and their neighbor got in the last round of the game under different strategic choices". Moreover, to apply this idea more rationally, in the process of building imitation model, in addition to adding a few articles representative of "neighborhood effect" indicators, such as technology spillover coefficient β, networking groups in the proportion of innovators u, etc., but also around the subject, “neighborhood", making "average income of neighbors" and "maximum income of neighbors " two strategies changing standards.

C.*The model building of individual corporate dynamic income*

The function of individual income this paper sets is that

$$S_{i,j} = N_{i-1} \times (1 + x - \beta) \quad (1)$$

Where:

Dynamic gain value Si, j is the single enterprise in the process of the game

Ni-1 represents the original stock that a individual company got last round game, when i = 1, N0 is the original innovation earning value when company j is not involved in the game, to facilitate the study, we assume N0 = a (a is a constant greater than 0)

i represents the number of the game;

j represents the node;

x represents the innovation earning coefficient that a single enterprise gained when it make innovation, having referred to a lot of literature and carried out discussion about relevant theory, the paper sets a reasonable value to x, that is x= 0.3.

β represents the technology spillover coefficient generated after a single enterprise j made innovation.

In addition, in the network which has a total of m nodes, this paper introduces Yi, j to distinguish different strategic choice that node j made, if node j adopt innovative strategies during the i-th game, that Yi, j = 1; If node j adopt imitative strategy during i-th game, thatYi,j=0 Thus, you can gain coefficient of innovation, technology spillover coefficient values and individual corporate strategies to select further grouped into formula 2, formula 3

$$X = \begin{cases} 0.3 & Y_{i,j} = 1 \\ 0 & Y_{i,j} = 0 \end{cases} \quad (2)$$

That is, when node j adopt innovation strategy during the i-th game, Yi, j = 1, the individual enterprise j obtain innovative coefficient x = 0.3 after innovation; When node j adopt innovative imitation strategies during the i-th game, Yi, j = 0, the individual enterprise j obtain innovative coefficient x = 0 after innovation, because individual enterprise j does not exist innovation behavior.

$$\beta = \begin{cases} \mu / 1+\mu & Y_{i,j} = 1 \\ (1-\mu)^{(1-\mu)} & Y_{i,j} = 0 \end{cases} \quad (3)$$

Where, u is the ratio of innovators in the network group.

Moreover, based on N0=a, the paper assumes the following iterative relationship about innovative stock gains

$$N_1 = (N_0 + S_1) / 2$$

$$N_2 = (N_0 + S_1 + S_2) / 3$$

$$N_3 = (S_1 + S_2 + S_3) / 3$$

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D.*Game evolution: Two standard setting of game evolution*

Regard the average revenue of the surrounding neighborhood as the standard of strategy changing. Assumption: in the i-th round game, a single enterprise j make policy changes : $Y_{i,j}$: 1 ⟶ 0 or 0 ⟶ 1。 Then, when earnings enterprise j gained in the i-th round game less than the average income of the surrounding neighborhood got in this game round, that is, when $S_{i,j} < (\sum_0^k S_{i,j,l})/k$, individual enterprises j make strategic adjustments, take the same game strategy with neighbors, l represents the neighbor of node j , k is the number of its neighbors, k = (0,1,2,3,4 ......).

Regard the biggest revenue among the surrounding neighborhood as the standard of strategy changing. Assumption: when earnings enterprise j gained in the i-th round game less than the earning that neighbor I gained in this round(I gained most among all the neighbors of j) that is, when $S_{i,j} < \max(S_{i,j,l})$, individual enterprises j will make strategic adjustments, take the same strategy with I .Strategy update process can be expressed as When $S_{i,j} < \max(S_{i,j,l})$ $S_{i,j,l}$ Where, Si,j represents the revenue that node j obtained in the i-th round game, Si,j,l represents the revenue that I who is the neighbor of node j obtained in the i-th round game, and I obtained most.

Ⅱ The analysis of enterprises imitation behavior in scale-free networks

A The law of behavior spreading in scale-free networks

1999, scholars Barabasi, Albert and Jeong questioned on Poisson distribution network through a lot of research networks, and they made supplement. They believe, in reality, there are many forms which meet the power-law distribution network. Power-law degree distributions, called scale free[4] ,Power-law distributions come in two basic flavors: continuous distributions governing continuous real numbers and discrete distributions where the quantity of interest can take only a discrete set of values, typically positive integers[5].For example the well-known World Wide Web, the study found, in the World Wide Web, only a few well-known sites have a far more significant than the general level of large number of links, however, most of the pages only have a few links, that is, only a few node is connected with a large degree, while the vast majority of nodes connected with only a small degree, they call this characteristic scale-free networks characteristics. Many natural and manmade networks have been shown to possess a scale-free degree distribution, including the internet[6], To better explain the principle of power-law distribution generated form networks, Barabasi and Albert further proposed scale-free network model, also known as the BA scale-free network model. Scale-free networks are remarkably resistant to accidental failures, a property which is rooted in their inhomogeneous topology[7].A scale-free network is inhomogeneous in nature[8].Scale-free networks with two significantly different from other network features:

Growth characteristics. The first network have a total of x0 nodes, with time goes by, new node will be introduced to the network continually, the new node will connect to the existing node in the network one by one.

Priority connect features. That is, new entrants tend to choose nodes connected with a higher degree of "big" nodes to connect, this phenomenon is similar to the management theory of "Matthew (Matthew Effect)"[9]. The Matthew Effect according to which the rich get richer and the poor get poorer is a principle in sociology and economics[10].When selecting a new node connection, assuming that the probability π (ki) that new node connected to node i, depends on the degree of node i (where, N is the number of nodes in the network).

$$\pi(k_i)=k_i+\frac{1}{\sum_{j=1}^{N}(k_i+1)}$$

In short, BA scale-free networks have two important structural characteristics, one is the growth characteristics, namely the continually expanding of the network size; the other is the priority connectivity, new entrants tend to choose nodes connected with a higher degree of "big" node to connect. This is similar to enterprise imitation behavior in the cluster, both of which are derived from the characteristics of core business. Based on discussed above, The law of behavior spreading in scale-free networks can be summarized in the following two points:

In the cluster, there are nodes with much higher than average degree of clustering, that is, leading enterprises, small degree nodes are significantly affected by big degree node.

With the constantly changing tactics of large node behavior, group behavior presents the overall convergence or randomness (volatility).

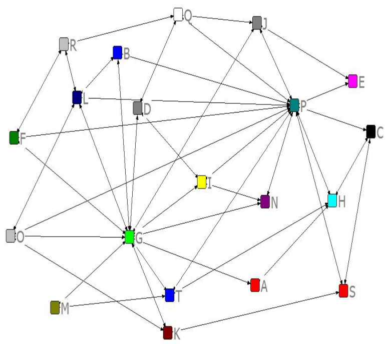

Figure1 Scale-free network structure diagram

B. ***The initial matrix set of Imitation - innovation***

During the simulation, the paper established random network, small-world networks and scale-free network structure made by the 20 nodes,(node name: AT) set the "imitation - innovation" initial matrix [1,0, 0,1,0,0,0,1,0,0,0,0,0,0,1,0,0,0,1,0]. the node A, D, H, O, S are initial innovators that are randomly selected , defined as "1"; remaining 15 are initial imitators, defined as "0."

Ⅲ The analysis of enterprises imitation behavior in scale-free networks

A.*Regard the biggest revenue among the surrounding neighborhood as the standard of strategy changing*

In the scale-free network structure, when the individual enterprise adopt the changing strategy referring to the biggest revenue among the surrounding neighborhood, the simulation results shown in Fig. 2.

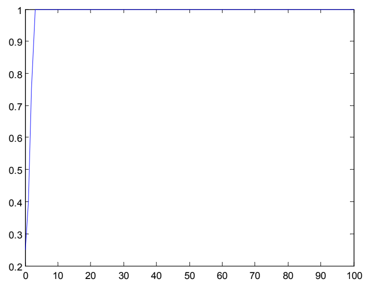

Figure2 Imitation - Innovative state evolution chart in scale-free network when regarding the biggest revenue among the surrounding neighborhood as the standard of strategy changing

In this case, you can see, during the first two round of the game, the number of innovators significantly increased, the growing state showing is that 5 -8 -15, as for the growing speed, at first, slow, then fast, but after the third round of the game, All companies tend to make innovation

B.*Regard the average revenue of the surrounding neighborhood in last round as the standard of strategy changing*

In scale-free network structure, when regarding the average revenue of the surrounding neighborhood in last round as the standard of strategy changing, the simulation results shown in Fig.3.

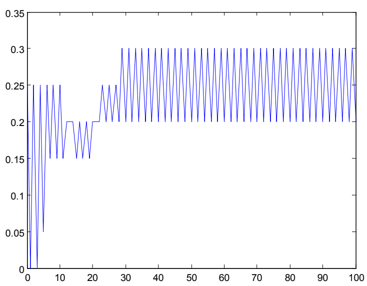

Figure3 Imitation - Innovative state evolution chart in scale-free network structure, when regarding the average revenue of the surrounding neighborhood in last round as the standard of strategy changing

At this time, rate fluctuations shows great innovation, and in the course of the first six games, the innovation rate fluctuate to the maximum, the difference reach to 0.25, followed by a relatively small amplitude fluctuations continue not to appear regularly, after 28 games, the innovation ratio of the entire group shows the regularity of the cycle fluctuations 0.3-0.2.

CONCLUSION

Based on analysis above, we can see that when regarding the biggest revenue among the surrounding neighborhood as the standard of strategy changing, the whole group tend to be innovative after three games , showing a strong group convergence ; When regarding the average revenue of the surrounding neighborhood in last round as the standard of strategy changing , the group were not tend towards equilibrium in the course of 100 games, since the 28th game, the chart shows a fixed and small amplitude range (0.2-0.3) continued to fluctuate, Which demonstrate that in the network structure, there's a very close link between nodes , and small nodes are significantly affected by the large node , showing strong group convergence with behavior changing of large nodes (fast equilibrium with the maximum standards and small fluctuations with the average standard) , regularity (completely tend to be innovative with the maximum standards) and the randomness (continued volatility of the average standards) coexist. And this is similar to the law of behavior spreading in scale-free networks as we have mentioned before,: (1) in the cluster, there are nodes with much higher than average degree of clustering, small degree nodes are significantly affected by big degree node; (2) With the constantly changing tactics of large node behavior, group behavior presents the overall convergence or randomness. In scale-free cluster network structure, there are nodes with much higher than average degree of clustering, small degree nodes are significantly affected by big degree node With the constantly changing tactics of large node behavior, group behavior presents the overall convergence or randomness.

Acknowledgment
The authors wish to thank everyone who helped them. This study is subsidized by the information economy and society-funded research projects of Development Research Center of Zhejiang Province(2013xxhjd004z); the "Zhijiang youth project" of Zhejiang philosophy and social science planning, "a study on the impact of cluster network structure on cooperative R&D Alliances"(13ZJQN022YB); the research program of humanistic and social science from ministry of education "a study on the same trade joint R and D guide mechanism based on cooperation and competition game"(12YJC630202),key disciplines (business management) Graduate Innovation Program of Zhejiang province in school of Management of Hangzhou Dianzi University (GK120201204004/001); College of Humanities and Social Sciences provincial key research base to cultivate outstanding master's degree thesis project "Management Science and Engineering." (GK130202204004/018).

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