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The evolution analysis of companies imitating behavior in Small-world networks

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ABSTRACT

The imitating behavioris an important factor affecting industrial operation,in the context of industrial clusters,having analyzed the theory of Neighborhood Effect, this paper, in order to conclude the effects of enterprise imitation behavior in Small-world 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.

KEYWORDS

The structure of Small-world networks; The neighborhood effect; Enterprise imitation behavior; Behavioral evolution.

INTRODUCTION

Small-world networks are between the regular network and random network, which are constructed by connecting each edge of regular network to a new node in the network with probability p randomly. The structure of industrial clusters has the same features with the Small-world networks that are small world and high clustering feature, moreover, with Small-world networks research, we can better analyze the evolution law of companies imitating behavior in industrial clusters.

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

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.

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, Every agent is directly connected to the same small number of his nearest neighbours[4] this role in clusters, has a great impact on how individual corporate making behavior decisions in clusters. Theories of neighborhood effects are uncertain as to the spatial scale at which the relevant processes operate[5]. 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.

The model building of individual corporate dynamic income

The function of individual income this paper sets is that

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

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

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

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.

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

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

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

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

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

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 : Yi,j : 1 to 0 or 0 to 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.

STRUCTURAL CHARACTERISTICS OF SMALL-WORLD NETWORKS

1998, Watts and Strogatz reconnected the connection of nodes of partly regular system and thus building a network between the regular network and totally random network, namely Small-world networks model (WS model).

The formation rules of Small-world networks are as follows:

One-dimensional network with N nodes, the nodes of the network are connected with its nearest adjacent nodes and second near adjacent nodes, forming an annular. That is, the network has high clustering feature, the node has very close relation with geographic proximity enterprises.

Each edge reconnect with probability P, that is keep one node of edge unchanged, while the other end is chosen randomly among the network, and the agreement is achieved that there is one edge at most between any of two nodes in the network, and no node can connect with itself. In other words, there is also a randomness associated property in Small-world network.

Small-world networks are such a network that has both small world feature and high aggregation feature, by connecting each edge in the regular network to a new node in network with probability p randomly, a new network that between the regular network and the random network is built, the structure diagram of Small-world networks is shown in Figure 1.

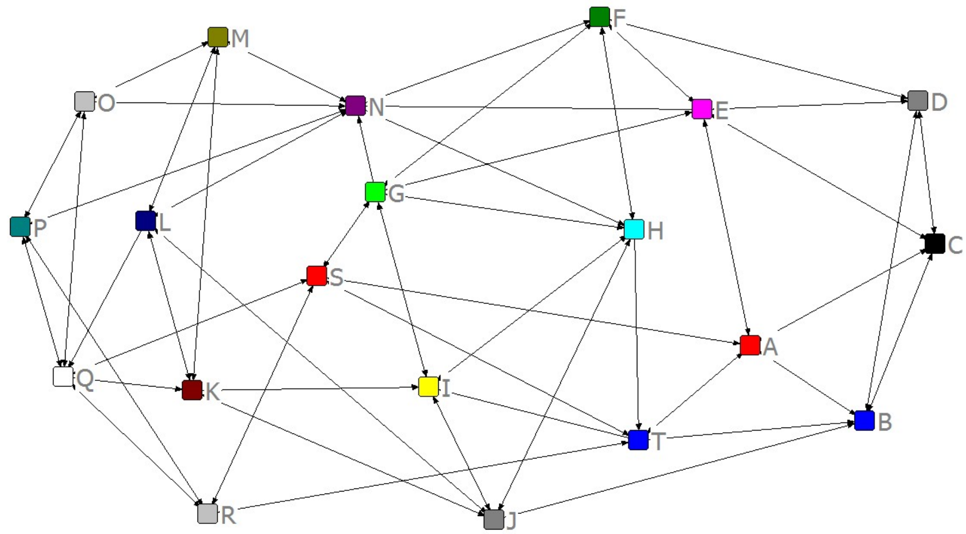


Figure 1 : The structure diagram of Small-world networks

Thus, this article concludes the behavior propagation law of Small-world networks to the following two points:

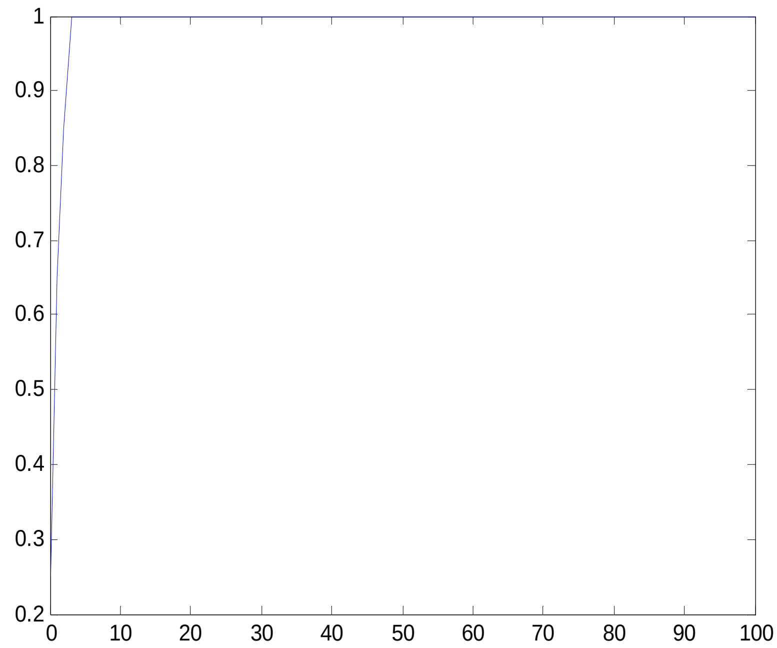
One, the adjacent nodes in clusters are closely connected, overall, it has nice coordination and strong drive property.

Second, there are both regularity and randomness feature between the connected nodes, individual behavior propagation are also with regularity feature (transient or full convergence characteristics) and randomness feature (transient or continuous wave characteristics);

THE ANALYSIS OF COMPANIES IMITATION BEHAVIORS IN SMALL-WORLD NETWORKS

Make the highest revenue among the surrounding neighborhood as the standard of strategy changing

In Small-world network structure, when individual enterprises make the highest revenue among the surrounding neighborhood in last game as the reference of its own strategy changing, the simulation results are as follows:

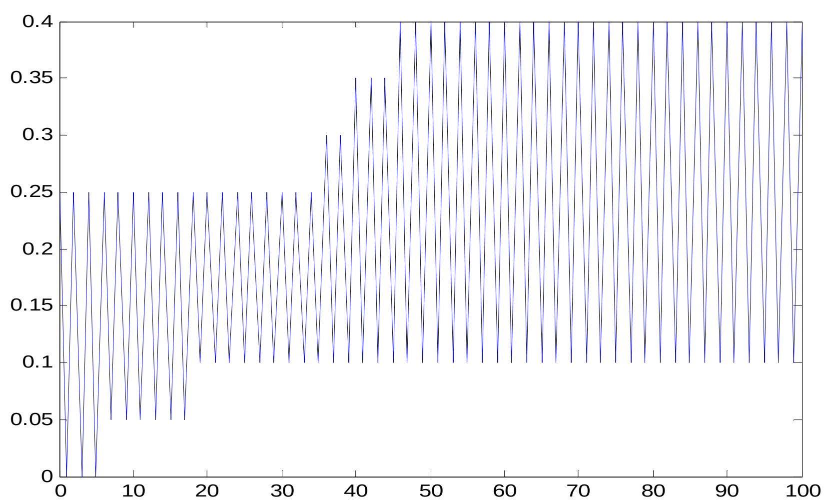


when the maximum benefit is the reference in Small-world networks, the imitation-innovative state evolution map

When individual enterprises make the maximum benefit among the surrounding neighborhood as its own revenue policy update reference object, the imitation - innovative evolution state in the clusters are as follows:the first two times during the game, the number of innovators has a significant increase, the growth rate is faster first, then, it is slower, however, after the third game, all businesses have tended to innovation.

Make the average revenue of the surrounding neighborhood in the last round as the standard of strategy changing

Under the Small-world network structure, when individual enterprises make the average revenue of the surrounding neighborhood in the last round as the reference of strategy changing, the simulation results are as follows:



when the average benefit is the reference in Small-world networks, the imitation-innovative state evolution map

When individual enterprises make the average benefit among the surrounding neighborhood in the last game as its own revenue policy update reference object, the imitation - innovative evolution state in the clusters are as follows:in this case, the ratio of innovators presented volatility, and this volatility difference is small, the fluctuations in intensity is weakened from strong and then gradually increased until it reaches innovation cycle fluctuations.

CONCLUSION

Based on the above analysis, we can see that when making the highest revenue among the surrounding neighborhood as the standard of strategy changing, group as a whole tend to innovation after three times games, and has highly collaborative group behavior; while when making the average revenue among the surrounding neighborhood in the last round as the reference object to update its own policy, the group were not tend towards equilibrium after 100 times games, after the first 46 games, its showed a fixed and a large amplitude range (0.1-0.4) continued volatility. Thus, it can be seen in the small-world network structure, there are extremely close links between nodes, group behavior presents strong synergies, regularity (totally tends to innovation under maximum standards) and randomness (the mean and the standard fluctuations) coexist. This is in agreement with concludes of last paper about behavior propagation law in Small-world networks (one, the adjacent nodes in clusters are closely connected, overall, it has nice coordination; second, individual behavior propagation are also with regularity feature and randomness feature)

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