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Coopetition Co-existence Model for Software Industrial Virtual Cluster Based on Business Ecosystems

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Abstract

Coopetition is an important driving force for the formation and sustainable development of Software Industrial Virtual Clusters. But the process of participating in the global coopetition of software enterprises is very complicated. This paper analyzed the characteristic of coopetition in Software Industrial Virtual Clusters by using the theory of business ecosystems, coopetition co-existence model of Software Industrial Virtual Cluster was established, introducing competition coefficient and cooperation coefficient on the basis of Tilman's research. The results of simulation show that the condition of coopetition co-existence is the competitive ability has a nonlinear minus correlation with cooperation ability. The empirical study also found that the initial share is an important factor affecting the competitive advantage.

Keywords: *Business Ecosystems,Software Industrial Virtual Cluster(SIVC),coopetition, Co-existence Model*

1. Introduction

As the core of information industry, the software industry is basic and strategic for the development of modern economic society, featuring fast technological innovation, high product added-value, wide application, strong permeability and low resource consumption. It is a knowledge, technology, intelligence-intensive industry, supporting and leading the national economic development, and closely related to social progress and national security. The model of creating a software industry cluster with the carrier of a software industry park has been widely adopted worldwide, but in practice, in addition to a handful of software industrial parks in Silicon Valley of the United States and Bangalore India, most software industrial parks have neither software technology innovation ability like Silicon Valley nor strong sustainable development momentum. In order to enhance the competitiveness of the software industry clusters, make full use of global resources to capture market opportunities, the software industry virtual cluster (SIVC) produced as a new form of organization, which is an economic community of software developers, distributors, service providers and customers as well as relevant organizations to seek for global coopetition by using modern information technology.

Coopetition is a motive force to promote the formation and sustainable development of SIVC. It is difficult for pure forms of competition and cooperation to obtain a lasting competitive advantage in the rapidly developed information economy era. For the software enterprises, the uncertainty of their competitive environment is increasing little by little; risk controllable degree is weakened day by day; industrial chain is extended and integrated constantly; software products and services are more and more refined; life cycle is shortened; but systematization extent and complexity are on the rise. In

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consequence, it is an important way for SIVC members to accelerate the integration of resources by coopetition in order to expand their strengths in a relatively short period. With the emerging of new technologies, new models and new demands, the trend of SIVC to fast gather strength, seize technology opportunities and market by coopetition is more obvious. Since the opposite acting forces of competition and cooperation co-exist in SIVC, only balanced competition and cooperation can ensure steady operation of SIVC and that sound development of software industry is the focus of industrial circle and the government.

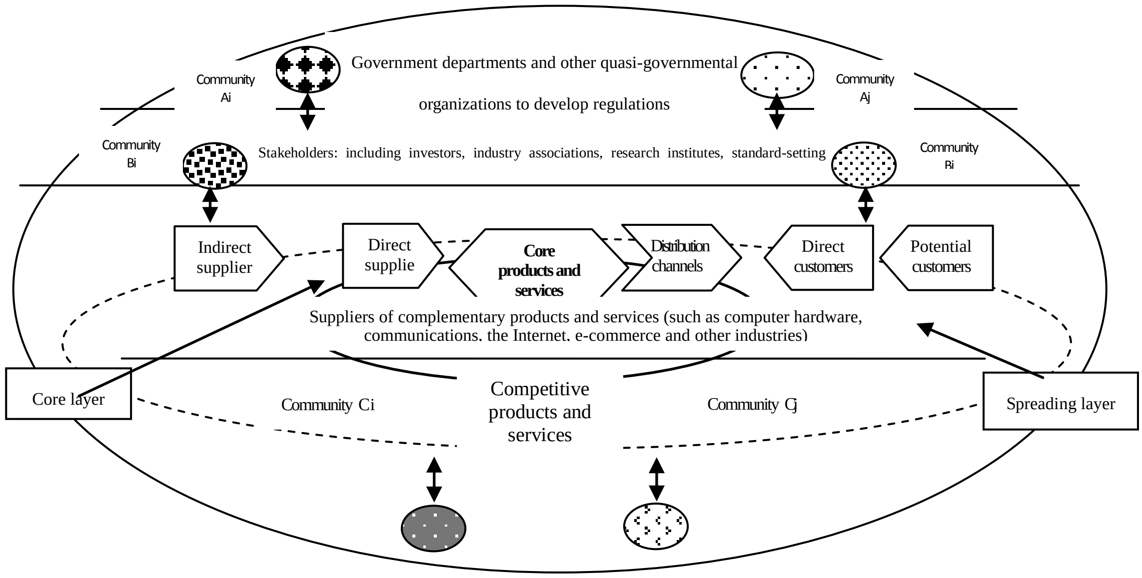
Business ecosystems proposed by James Moore built the analytical framework of commercial evolution and coopetition, emphasized niche co-evolution and mutualism. It was believed that the business ecosystem was an economic complex based on the interaction of organizations and individuals which provided products and services valuable to customers. Customers are members of the ecosystem. Organism members include suppliers, major producers, competitors, stakeholders [1]. A value chain is constituted by active interaction of these system members. And a value network is formed by interweaving of different value chains. Substances, energy and information flow and circulate among consortium members via the value network. Different from the food chain in the natural ecosystem, every link on the value chain are not simply predators and prey, but exchange of values and interests, *i.e.* symbiosis. Multiple symbiotic relationships form a value network of the business ecosystem. Business ecosystems break down the barriers limiting the traditional industries, which can not only grow within the limit of conventional industry but also integrate the contributors not interrelated before across the boundary of conventional industry by coopetition in order to create more efficient solutions for customers and establish the new business ecosystem.

At present, studies of scholars at home and abroad on the coopetition mechanism mainly focus on corporate strategy, industry clusters, technological innovation and other aspects. Traditional resource-based view theory and strategic analysis method are limited to the enterprise level around the internal resources of enterprises and the ability to integrate external resources [2], unable to respond to highly dynamically changed external environment. Poter's theory of cluster competitive advantage is more appropriate for the limited competition of the market environment with excessive supply [3]. In the context of white-hot virtual organization and global competition, Nalebuff's coopetition theory of value network, Moore's business ecosystem and Iansiti's win-win thinking broadened the visions of virtual cluster coopetition study [4-7], "members of business ecosystem support their new products, meet the demands of their customers and carry out the new innovation jointly through coopetition"[1]. Most of existing studies of cluster coopetition models are Lotka-Volterra models established on the basis of Logistic equations[8]. In this study, the theory of business ecosystem is used to explore how business ecosystem coopetition is dynamically changing on the basis of Tilman's theory when SIVC has different parameters such as competition coefficient and cooperation coefficient, and analog simulation is carried out. Such exploration has a certain guiding significance to make in-depth research on coopetition behaviors in SIVC and healthy development of business ecosystem in the software industry.

2. Coopetition Characteristics of SIVC Business Ecosystem

2.1. Construction of SIVC Business Ecosystem

SIVC is a business ecosystem whose core layer is composed of direct suppliers centering on the core software products and services and distribution channels, spreading layer is composed of indirect suppliers, customers and providers of complementary products and services. SIVC business ecosystem consists of the core layer, spreading layer, as well as peripheral government departments and other quasi-governmental organizations to develop regulations, software industry associations at all levels, investors related industries (such as manufacturing industry, computer hardware, communications and other information service industries) and competitors, as shown in Figure 1. In the SIVC business ecosystem, the community is used to cope with the increasingly dynamically changing environment with infinite competition. Characteristics of community structure to some extent can weaken the vulnerability of cluster network.



2.2. Features of SIVC Business Ecosystem

2.2.1. Diversity of SIVC Business Ecosystem Constitution: Diversity is the key to the survival of ecosystems, namely interdependence of various species constitutes the entire system, and diversity is also a major feature SIVC business ecosystem. By virtue of specialization and resource complementarity, interaction in the R&D investment, software development, production and technical cooperation, SIVC members form a co-petition relationship. The core layer, spreading layer and peripheral support institutions (such as venture investment, banks and other financial or non-financial institutions, universities and research institutes, intellectual property institutions, service companies, *etc.*) are inextricably linked, as shown in Figure 1. These companies each occupy an ecological niche of the business ecosystem.

In addition, key members of SIVC business ecosystem play a very important role for maintaining the health of system. Key members play a crucial role in the system against external interference, the diversity it supports plays a role of buffering the uncertain environment with which SIVC copes and is in favor of creating the value of business ecosystem. Its key members can protect the structure, productivity and diversity of the system.

2.2.2. SIVC Business Ecosystem Paying More Attention to Customers: Customers in SIVC business ecosystem are also known as “plankton” and placed in a prominent position, mainly because customers in the era of Internet are more rational, no longer passive recipients of software vendors, and they make decisions on selecting software products and services after full communications with the related software clusters and experience. Internet provides a new platform for open innovation that enables consumers’ passion for innovation and the ability to innovate to demonstrate a greater energy and commercial value. Democratizing innovation represented by “user creation” has become a new trend. Through virtual clusters, businesses can obtain leading users with expertise with a lower cost. Users are involved in improving the product rather than just make their own demands, thus effectively participating in corporate product development[9]. The tasks to be performed by the employees are outsourced to non-specific public on a voluntary basis through a network taking the Internet as the platform, which is “crowdsourcing”[10].

2.2.3. Complex Value Network Form of SIVC Business Ecosystem: SIVC business ecosystem have blurred boundaries, showing a network-like structure, mainly reflected in two aspects, firstly each business ecosystem contains a number of subsystems, while it per se is a part of a larger business ecosystem, namely its boundaries are set according to the actual needs; secondly, a member can simultaneously exist in multiple business ecosystem subsystems. The core layer and spreading layer in Figure 1 constitute a huge community, and communities are not entirely excluded or independent, but cross-linked to each other to form a complex value network form. In the trend of software outsourcing and software and hardware compatibility, the vendor of a certain community in SIVC is usually vendor of another, for example, Apple and Samsung are competitors in many areas such as notebook computers, smart phones, tablet PCs, MP3 players, *etc.*, but Samsung is also a major vendor for displayer and memory of Apple, besides, there is a complex patent licensing relationship between the two.

SIVC business ecosystem can analyze and predict behavior pattern of customers, regroup and rearrange market segmentation demands so as to promote further and deepening division of SIVC and horizontal expansion of communities, meanwhile, contact between communities will be more frequent and complicated.

2.2.4. High Degree of Collaboration of SIVC Business Ecosystem: SIVC business ecosystem emphasizes on division of labor on the basis of software industry value network, and usually horizontal division is made within a community and coordination degree between communities is lower. SIVC makes overall arrangement dynamically according to the customer demand. Software production communities and service communities are regrouped to form new communities whose inner horizontal division degree is high. In the meantime, when customers need gathering, communities will cooperate with each other.

2.2.5. Higher Endogenic Incentives of SIVC Business Ecosystem to Seek for Win-win: Since randomness of software consumer demand leads to impossibility to develop products and services by one or several software companies, the endogenic incentives of a certain community of SIVC business ecosystem is insufficient. If the customer demand in the entire SIVC business ecosystem is dominantly arranged, together with integrated small and medium communities of the system, coopetition symbiosis between communities will produce higher endogenic incentives and form a win-win situation.

2.3. Analysis on SIVC Coopetition

SIVC coopetition activities are not limited to the software industry, but also involved in a wider range of technical and industrial ecosystem. Dynamics of SIVC coopetition features high strength and high speed. Similar companies within the software industry cooperate and compete with each other, besides, the software industry cooperate and compete with other associated industries. On the one hand, the competitive position of software products and services depends on its competitive advantages; on the other hand, the market structure of associated industries on which they depend can also be determined by the competitive position of software products and services. SIVC coopetition is essentially manifested as the network competition of associated industries, at the same time, the result of the associated industry coopetition makes the hardware and software boundaries blurred.

Symbiotic condition of coopetition is to get a moderate co-evolved "win-win" competition through common adaptation and common development[11]. As one of the important motive forces for cluster evolution and development, SIVC coopetition is a crucial element affecting the innovation capacity of the cluster. Members of the business ecosystem support new products and meet the customers' demand through coopetition, and carry out the next round of innovation jointly [1]. If SIVC is controlled by a kind of technology for a long term, it will affect the evolution tendency of gene diversity, structural complexity and function improvement of the entire business ecosystem. Each technology is evolved following its own development track. When market demand forces a breakthrough of technology bottlenecks, heterogeneous, complementary capabilities, knowledge and expertise will produce a breakthrough innovation. In SIVC business ecosystem, an extensive connection is established between a community and customers, between customers, and between communities. Members of the system take customers as the center, and pay attention to improving the overall collaborative cluster innovation capacity to effectively reduce systemic risk and enhance efficiency of evolution. Trans-boundary utilization of multiple technologies among communities not only realizes polymerization using of existing technologies but also enables non-associated technologies to connect to form a new technology, such as Internet of things, cloud computing, mobile Internet technology. "Structural tension" formed based on complementation constitutes internal driving mechanism of coopetition between communities.

3. Simulation and Analysis of SIVC Coopetition Co-existence Model

3.1. SIVC Coopetition Co-existence Model

Multi-species competitive symbiosis dynamic model proposed by Timlan [12-13]:

$$\frac{dp_i}{dt} = c_i p_i (1 - D - \sum_{j=1}^{i} p_j) - m_i p_i - \sum_{j=1}^{i-1} p_i c_i p_j \tag{1}$$

In formula (1), pi, pj are shares of species i, j; ci is relocation diffusion ratio of species i; D is the proportion of habitat destruction in total habitat; mi is the average mortality rate of species i; t is time. Tilman used mode (1) to simulate the effect of habitat destruction on the mammals in tropical rain forest and temperate forest. The result showed that destruction of living environment led to extinction of species with strong competitive capacity earlier in the cluster. SIVC coopetition co-existence model was proposed in combination with this mode and features of SIVC coopetition:

$$\frac{dp_i}{dt} = c_i p_i (1 - D - p_i - \sum_{j=1}^{i} a_j p_j) - m_i p_i - \sum_{j=1}^{i-1} c_j p_j a_j p_i \tag{2}$$

In formula (2), i=1, 2, …, n; j = 1,2 ,…n-1, the first one on the right is the market share of community i, the second one is the mortality rate of community i, the third one is the occupation rate of community i's market by community j; ai is the competition coefficient of community i, ci is the cooperation coefficient of community i, the meanings of pi, mi are the same as formula (1).

3.2. Model Simulation and Analysis

To facilitate study, take n=5 to simulate the coopetition symbiosis dynamic cases of 5 communities in SIVC.

3.2.1. Situations with Different Competitiveness: Assuming competitiveness is decreased gradually, and the other parameters are the same, *i.e.*, ci, mi, pi (0) are the same, ci=0.1, mi=0.02, pi (0) = 0.1, ai> ai + 1, the simulation result is shown in Figure 2. Community 1 competes with and excludes other 4 communities, and the exclusion degree is increased successively with weakening of the competitiveness. The process of exclusion has a short-lived symbiosis in the early stage, but finally shares of the other 4 communities are all lower than 0.1. Community 1 is balanced when t=100, with the share maintained at 0.8. When the competitiveness, mortality and initial share are the same, competitiveness plays a decisive role in the survival of a community. It conforms to the objective reality when a community with stronger competitiveness excludes those with a lower competitiveness.

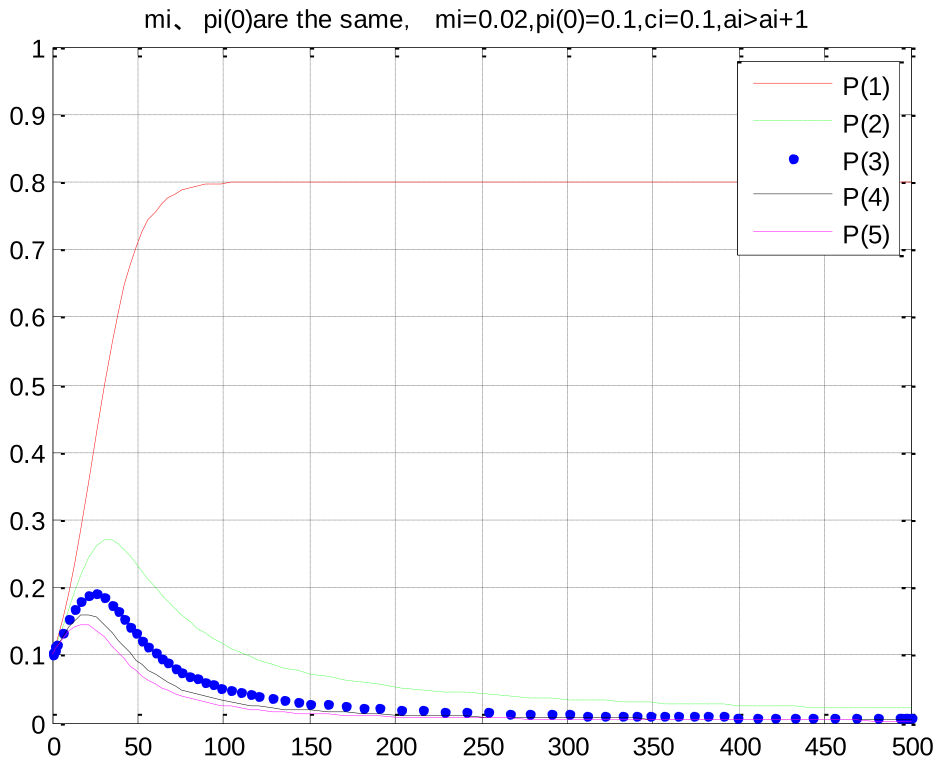


Figure 2. Coopetition of 5 Communities with Different Competitiveness

3.2.2. Situations with Different Abilities to Cooperate: Assuming the ability to cooperate is decreased gradually, and other parameters remain unchanged, *i.e.*, ai, mi, pi(0) are the same, ai=0.3, mi=0.02, pi(0)=0.1, ci>ci+1, the simulation result is shown in Figure 3. Communities 1, 2 coexist with shares increased rapidly, and they will be stabilized after t=20 and t=40 respectively. But communities 3, 4, 5 are under competition and excluded with lowered shares, and become extinct after t=60 and t=200. Competitiveness, mortality and initial share are the same, when there is a difference between abilities to cooperate, communities with strong ability to cooperate will be winners finally, while those with poor ability to cooperate will hardly survive. This suggests that survival of a community not only depends on the competitiveness but also is closely related to its ability to cooperate, even more important.

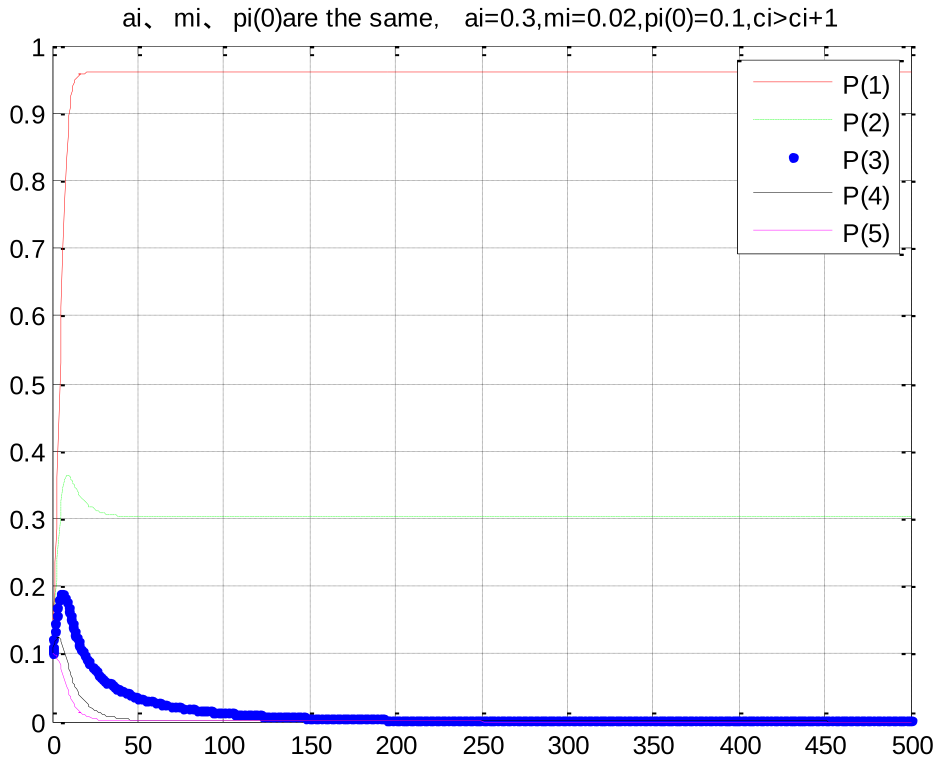


Figure 3. Coopetition of 5 Communities with Different Abilities to Cooperate

3.2.3. Situations with Changing Competitiveness and Ability to Cooperate: Assuming the competitiveness is increased gradually, at the same time the ability to cooperate is decreased gradually, and other parameters are the same, *i.e.*, mi, pi(0) are the same, mi=0.02, pi(0)=0.1, ci>ci+1 and ai<ai+1, the simulation result is shown in Figure 4. For competition of communities with strong ability to cooperate and weak competitiveness, the result shows that those with strong ability and weak competitiveness will win; while those with weak ability to cooperate and strong competitiveness will become extinct. Communities 1- 3 raised their shares rapidly initially. Communities 4, 5 still become extinct finally although they have the strongest competitiveness, because their abilities to cooperate are the weakest.

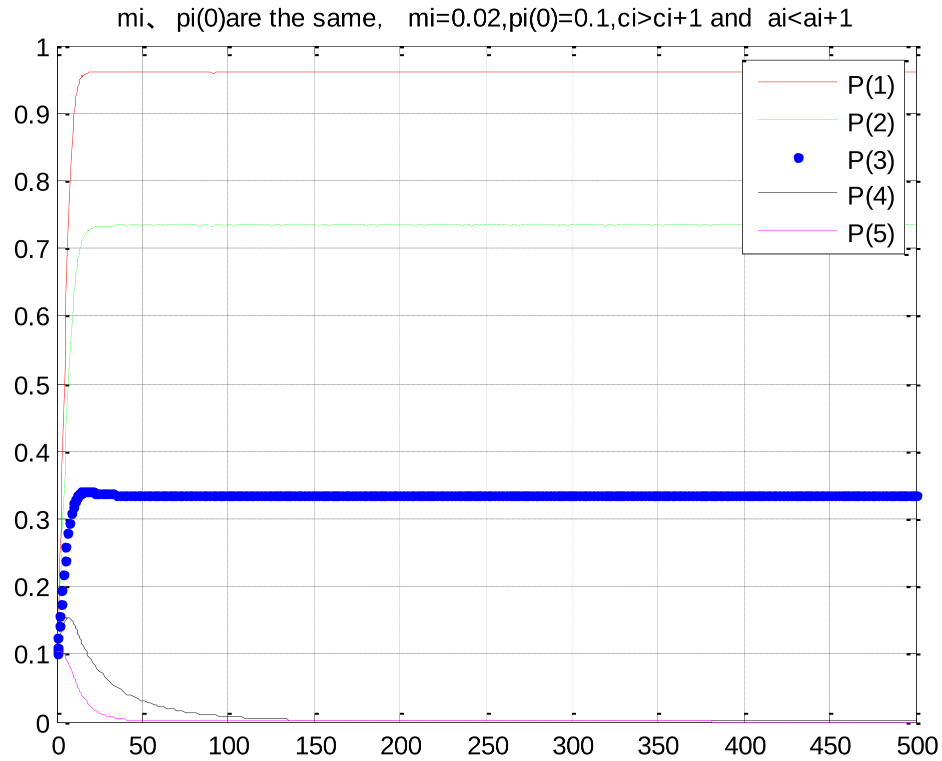


Figure 4. Coopetition of 5 Communities with Different Competitiveness and Abilities to Cooperate: Gradually Increased Competitiveness and Decreased Abilities to Cooperate

Assuming the ability to cooperate is increased gradually, at the same time competitiveness is decreased gradually, and other parameters are the same, *i.e.*, mi, pi(0) are the same, mi=0.02, pi(0)=0.1, ci<ci+1 and ai>ai+1, the simulation result is shown in Figure 5. The result of coopetition shows that all of them coexist, and the shares are higher than the initial shares when balanced. 5 communities raised their shares rapidly initially to exceed 0.3. When balanced, communities 1, 2 with stronger competitiveness still have significant competitive advantages with the shares above 0.3, but the final shares of communities 4, 5 with weaker competitiveness are 0.1 higher than the initial shares due to compensation of strong ability to cooperate.

Thus it can be seen from the simulation that, communities with weak competitiveness must have strong abilities to cooperate to compensate in order to achieve stability and symbiosis, but the communities with weak abilities to cooperate cannot be compensated through strong competitiveness.

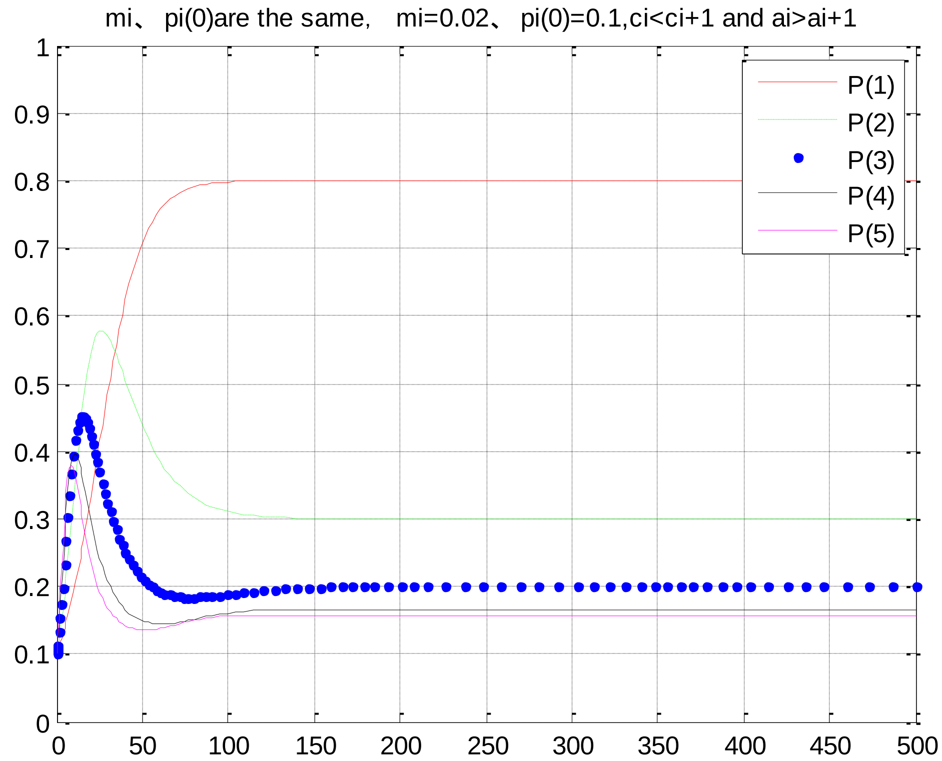


Figure 5. Coopetition of 5 Communities with Different Competitiveness and Abilities to Cooperate: Gradually Increased Abilities to Cooperate and Decreased Competitiveness

4. Demonstration

Founded in April 2005, ChangFeng Open Standards Platform Software Alliance is an innovation-type industry alliance supported by Beijing Municipal Committee of Science and Technology and other related government departments, jointly established by software and information services companies, research institutions, institutions of higher learning, users and third parties, the first members of 22 as of now have reached 127. Refer to Table 1 for the specific composition.

Table 1. Member Composition of ChangFeng Open Standards Platform Software Alliance

S/N	Type of community	Quantity
1	Application system integration vendors	58
2	Scientific research institutions, colleges and universities	13
3	Third-party organizations	9
4	Basic software vendors	8
5	Consultation and supervision institution	7
6	Basic hardware vendors	6
7	Incubators	1

As a successful example in the practice of SIVC, ChangFeng Open Standards Platform Software Alliance is aimed at gathering industry resources, improving the overall competitiveness of industry, setting up information sharing and exchange platform for technical depth cooperation and business cooperation expanding starting from benefits and win-win of members. The alliance has the typical characteristics of a business ecosystem, with diversified members that interdepend with each other and share resources to serve users better in the process of long-term coopetition. According to the above elaboration, users are referred to as “plankton”, but 10 users are not included in Table 1, the simulation result of symbiosis model is shown in Figure 6. Where, initial shares of 7 communities are different, $p_i(0)>p_{i+1}(0)$, and $c_i<c_{i+1}$, application system integration vendors are superior in size, make $q=0.3$, values of q are different for different ecosystem structures. The result of coopetition is overall stability and symbiosis. 7 communities raised their shares rapidly initially to exceed 0.1. When balanced, communities 2 - 5 with stronger competitiveness have significant competitive advantages with the shares above 0.3, but the shares of communities 6, 7 with stronger abilities to cooperate remain unchanged due to low initial share without significant competitive advantages, and community 1 that is superior in size has a low ability to cooperate.

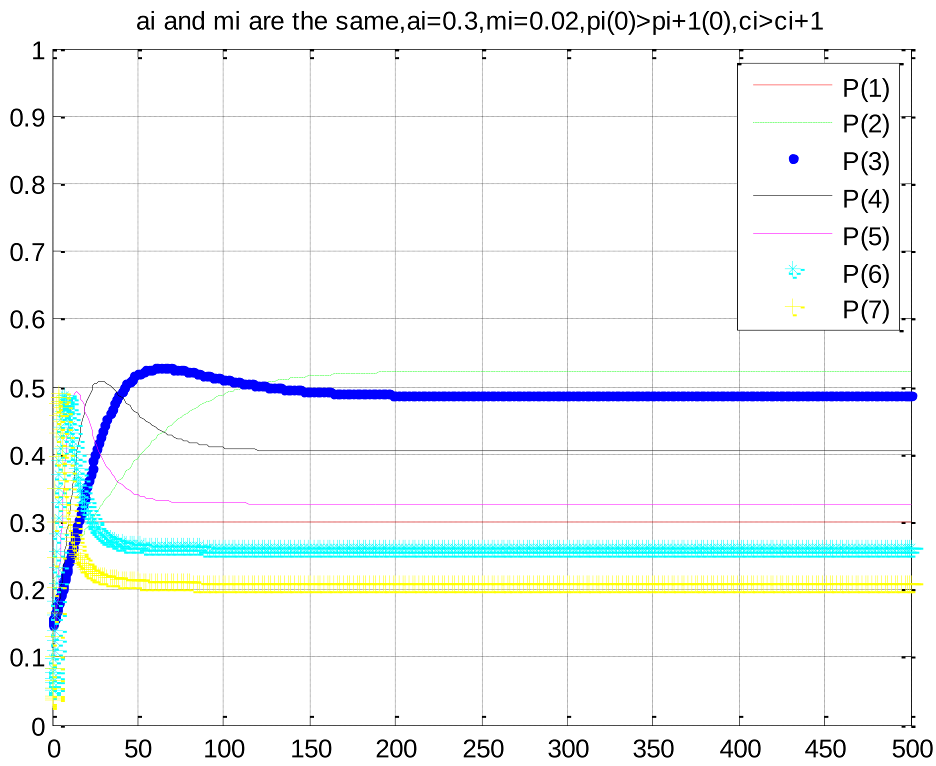


Figure 6. Coopetition of 7 Communities in ChangFeng Open Standards Platform Software Alliance

5. Conclusion

SIVC sets up the value network, attracts more members to optimize their ecological niches so as to form an interdependent, symbiotic win-win business ecosystem through coopetition. It is found through model simulation that, to meet the conditions for coopetition symbiosis of SIVC, the combined action of ability to cooperate and competitiveness of a community is needed, moreover, the competitiveness falls short of then effect when the ability to cooperate changes slightly no matter how much it changes. It is also discovered in empirical stimulation of ChangFeng Alliance that, initial share of the community is also an important factor influencing the competitiveness, namely symbiosis may be realized only through ecological niche evolution and innovation in SIVC business ecosystem. Active involvement is a must in case of technological innovation so as to get the initial share, otherwise the competitiveness will be lost. The software companies are born to be poor in competitiveness, but entering SIVC may boost their competitiveness and abilities to cooperate and get innovation and market competitive advantages. By paying attention to the sustainable development of business ecosystem, a mutualistic symbiosis and co-evolution cluster with a common future will be formed.

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