

Game analysis of knowledge sharing among strategic emerging industrial alliance enterprises

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Abstract

Strategic alliance is a kind of effective way to achieve knowledge sharing, promote firms innovation, and then enhance competitiveness. We construct a game model to seek and analyze influence factors of knowledge sharing among strategic emerging industrial alliance enterprises. Finally, our conclusions will offer several policy suggestions to promote inter-firm knowledge sharing efficiency and improve firm innovation capability.

Keywords

Strategic Alliance; Knowledge Sharing; Technical Innovation; Game Theory.

1. Introduction

In the era of knowledge economy, knowledge and capability are the focus of competition among enterprises. However, enterprises only rely on their own knowledge to innovate and cannot adapt to the international market competition needs, and the acquisition of external knowledge resources has become the key to the success of enterprise innovation and development. Therefore, enterprises carry out various forms of cooperation and form various kinds of strategic alliances for the complementarity between knowledge resources and innovation capability.

Enterprises as important and major participants of knowledge sharing, the lack of their knowledge information will not only lead to the blindness of decision-making, but also affect their technological innovation level, which will reduce the competitive advantage of the enterprises.

Strategic alliance is an important way to share knowledge and technology among enterprises (Maura S, Erik A, 2003, Zheng Xiangjie, Zhao Yan, 2013). Through the knowledge sharing among the enterprises to obtain the complementary knowledge resources that they needed, and make it part of their knowledge structure, integrating with existing knowledge to generate new knowledge of their own value. The structure of these new knowledge is more perfect, more able to adapt the requirements of dynamic environmental change, and they can effectively avoid the blindness of decision-making behavior, and can improve the efficiency of technological innovation. At present, it is an effective way for enterprises to carry out technological innovation and market innovation by relying on the alliance for knowledge sharing to achieve complementary resources, joint research and development and opening up new markets. Shorten the R&D cycle, achieve economies of scale, reduce R&D costs and risks have become an important goal of strategic alliance among enterprises (Lawson, B, &Samson, D, 2001)

Scholars agreed that strategic alliance can change the enterprise's own knowledge stored and technical level (Joanne Oxley, Tetsuo Wada, 2009), the expectation of excess profits brought about by knowledge sharing of enterprises promotes the establishment of alliance (Xiao Zhongsong, Jin Lingli, Nan Xu, 2008). The enterprise obtains the heterogeneous knowledge through the strategic alliance, enhances own innovation superiority, at the same time, produced the synergistic effect of the benefit of knowledge cooperation is greater than that of the enterprise's own knowledge and the total benefit (Lu Jin, 2006). The cost of strategic alliance, the possible loss of monopoly income, and the expected income of knowledge sharing among enterprises will have an important impact on knowledge sharing among enterprises (Zhao Huijuan, 2008). Each participating enterprise seeks a balance between the cost of cooperation and the expected return by comparing the costs and benefits (Ning Ye, Fan Zhiping, Feng Bo, 2006). Revenue, cost and decision-making in three ways will also affect the

behavior of R&D alliance (Wang Xueyuan, Cai Ye, Feng Bo, 2010). Through the introduction of knowledge management system and IT infrastructure and incentive mechanism can improve the knowledge sharing revenue (Yu Mingli, Jhin-Hua, Jhang-Li, 2010), when the members of the organization have been effectively supervised, their enthusiasm for knowledge sharing is relatively high (William R. King, Peter V, 2008).

The research on the knowledge sharing between the strategic alliance enterprises mostly focuses on the knowledge sharing among the alliance enterprises (Ruan Guoxiang, Ruan Pingnan, Song Jing, 2011) how to effectively share knowledge (Yung-Ming Li, Jhin-Hua Jhang-Li, 2010), the level of knowledge sharing (Ji Huisheng, 2010), as well as the specific cooperative behavior (Zhang Hongchao, He Ren, 2010) etc, however, these literatures seldom consider the influence of the unique knowledge of the enterprise on the income function. Moreover, their models also have little to do with the cost of inter enterprise alliance and knowledge sharing. Therefore, it is very difficult to promote the knowledge flow of enterprises to improve their innovation ability. In order to solve this problem, find the weak link of knowledge sharing among enterprises in strategic alliance, balancing the costs and benefits of knowledge sharing to build game model, according to the analyzes the influence of each factor of cost and benefit on the level of knowledge sharing, in order to provide a theoretical basis for effective knowledge sharing.

2. Basic hypothesis

The establishment of the model requires some assumptions, in order to facilitate the analysis of the problem, we assume:

- (1) Enterprise profit maximization, which is the enterprise can be regarded as rational economic man.
- (2) Suppose there are n ($n \geq 2$) enterprises in the alliance, there has heterogeneity of knowledge among enterprises, the knowledge shared by the alliance is the sum of the knowledge that each enterprise is willing to share, and can be fully acquired by the alliance. Set s_i as the amount of knowledge that enterprise i is willing to share, so the total amount of knowledge is:

$$S = \sum_{i=1}^n s_i$$

- (3) Suppose the enterprise has its own knowledge stored is H_i , the amount of knowledge that is not shared with the alliance is h_i . So

$$H_i = s_i + h_i$$

- (4) Assume the benefit of the knowledge sharing alliance is E_i , affected by the amount of knowledge stored by the enterprise itself and the amount of knowledge shared by the alliance, the function expression is:

$$E_i = A(t)_i h_i^\alpha + B(t)_i S^\alpha$$

Therein, $A(t)_i$ is the level coefficient that the enterprise will use their own knowledge to gain the innovation capability at the time t , $B(t)_i$ is the level coefficient that the enterprise will share the knowledge of the alliance to gain the innovation capability at the time t , and α is the elastic coefficient of enterprise i transforming knowledge into income, and $0 < \alpha < 1$.

- (5) There is no cost to form alliances among enterprises, the loss of knowledge sharing only comes from the knowledge sharing and the knowledge monopoly income. That is, the loss of enterprise i is determined by the spread of its own knowledge sharing. Assume the cost function:

$$C_i = A(t)_i H_i^\alpha - A(t)_i h_i^\alpha$$

Therefore, the total profit function of alliance enterprise i is:

$$\pi_i = E_i - C_i = A(t)_i h_i^\alpha + B(t)_i S^\alpha - [A(t)_i H_i^\alpha - A(t)_i h_i^\alpha]$$

3. Model analysis

From the total profit function, we can get the necessary conditions for enterprises to form alliance to share knowledge is:

$$B(t)_i S^\alpha - [A(t)_i H_i^\alpha - A(t)_i h_i^\alpha] \geq 0$$

That is to say, when the income from the alliance knowledge sharing alliance is not less than the benefit loss of its own knowledge sharing, enterprises are willing to share knowledge. Solve the inequality we can get:

$$S \geq \left[\frac{A(t)_i}{B(t)_i} (H_i^\alpha - h_i^\alpha) \right]^{\frac{1}{\alpha}}$$

Alliance enterprise i will consider the level of knowledge sharing of other enterprise to choose their own optimal strategy (s_i, h_i) , maximizing their total profit π_i . That is;

$$Max\pi_i = Max \left\{ A(t)_i h_i^\alpha + B(t)_i S^\alpha - [A(t)_i H_i^\alpha - A(t)_i h_i^\alpha] \right\} \tag{1}$$

$$\text{Because } H_i = s_i + h_i \tag{2}$$

Then get Lagrange function

$$L_i = A(t)_i h_i^\alpha + B(t)_i S^\alpha - [A(t)_i H_i^\alpha - A(t)_i h_i^\alpha] + \lambda(H_i - s_i - h_i) \tag{3}$$

λ is Lagrange coefficient. The first order derivative condition of the optimal solution of (3) is

$$\frac{\partial L_i}{\partial s_i} = B(t)_i \alpha S^{\alpha-1} - \lambda = 0 \tag{4}$$

$$\frac{\partial L_i}{\partial h_i} = 2A(t)_i \alpha h_i^{\alpha-1} - \lambda = 0 \tag{5}$$

From (4) and (5), we can get equilibrium condition

$$\frac{A(t)_i h_i^{\alpha-1}}{B(t)_i S^{\alpha-1}} = \frac{1}{2} \quad i=1, 2, \dots, n \tag{6}$$

When the i value from 1 to n , we can get n equilibrium equations. Assume that s_i^* is the level of knowledge that each firm is willing to share, and then the Nash equilibrium is

$$s^* = (s_1^*, \dots, s_i^*, \dots, s_n^*), \quad S^* = \sum_{i=1}^n s_i^*$$

From (6), we can get the following equations:

$$h_i = \left[\frac{B(t)_i}{2A(t)_i} \right]^{\frac{1}{\alpha-1}} S = \left[\frac{B(t)_i}{2A(t)_i} \right]^{\frac{1}{\alpha-1}} (s_i + \sum_{j \neq i} s_j) \tag{7}$$

Then, just put (7) into the (2), we can get the (8):

$$s_i^* = \frac{H_i - \left[\frac{2A(t)_i}{B(t)_i} \right]^{\frac{1}{1-\alpha}} \sum_{j \neq i} s_j}{1 + \left[\frac{2A(t)_i}{B(t)_i} \right]^{\frac{1}{1-\alpha}}} \tag{8}$$

so we can be seen from the (8), given the choice of other companies, the number of enterprises to choose knowledge sharing is mainly from ① H_i , the amount of knowledge stored, ② α , the elastic

coefficient of enterprise i transforming knowledge into income, ③ $\sum_{j \neq i} s_j$, knowledge which is expected to be shared by other enterprises, ④ $A(t)_i$, the level coefficient that the enterprise will use their own knowledge to gain the innovation capability at the time t , ⑤ $B(t)_i$, the level coefficient that the enterprise will share the knowledge of the alliance to gain the innovation capability at the time t . More specific, the larger H_i amount of knowledge stored, the more willing to share more knowledge; The larger α , the smaller s_i^* , it is indicated that the larger the elastic coefficient of knowledge into profit, the less willing to share knowledge; the more knowledge is expected to be shared by other enterprises, the less willing to share their own knowledge. At the same time, the enterprise can get the knowledge information shared by all other alliance enterprises, so there is a free rider behavior among enterprises, it's not conducive to the maintenance of the alliance; the greater coefficient $A(t)_i$ that the enterprise will use their own knowledge to gain the innovation capability, the less willing that enterprises share their own knowledge and can generate greater business value; however, the greater the capability level coefficient $B(t)_i$ that the enterprise will share the knowledge of the alliance to gain the capability, the more enterprises are willing to share their knowledge.

4. Conclusion and enlightenment

Through the model analysis, we can get the necessary condition that the knowledge sharing among enterprises and the amount of knowledge that enterprises are willing to share when they seek to maximize their own profits. The level of knowledge that an enterprise is willing to share is determined by the amount of knowledge stored of the enterprise itself, the elastic coefficient of knowledge into profit, the expectation of knowledge sharing in alliance enterprise, the level coefficient that the enterprise will use their own knowledge to gain the innovation capability at the time t and the ability of the enterprise to share the knowledge acquisition income.

Alliance is an effective way to realize knowledge sharing among enterprises, reduce costs, share risks and open up markets, it has gradually been widely used in high-tech enterprises. Meanwhile, we should see that it is necessary to establish knowledge sharing among enterprises. These articles are from the perspective of game theory, build the income model of knowledge sharing among enterprises, analyze the profit and loss of alliance enterprises, discuss the influence factors of knowledge sharing in alliance enterprises and provides scientific basis for enterprises to develop alliance strategy to promote better development of enterprise.

As an enterprise, on the one hand, they should increase their own knowledge stored, strive for more alliance opportunities, to enhance the level of knowledge sharing among alliance enterprises and enhance the enterprise innovation performance effectively; on the other hand, it is necessary to improve the learning ability of the enterprise and improve the level of knowledge into commercial value, this not only requires the enterprises to actively study the technical knowledge of the alliance partners, but also to excavate the potential of the diversity of technological knowledge into commercial value, to realize the promotion of enterprise competitive strength. For the relevant departments, on the one hand, they should actively take measures to disclose information, and encourage enterprises to participate in knowledge and information sharing, curb free rider behavior through industrial policy and reward and punishment mechanism. On the other hand, due to the greater the innovation capability level coefficient $A(t)_i$ of enterprises to use their own knowledge, the more reluctant to share knowledge and information that they have can generate huge commercial value. Therefore, in order to improve the ability of transforming knowledge into business value, the relevant government departments should create a good knowledge sharing platform for enterprises and ensure the effectiveness of knowledge sharing, to improve the level of economic development of related industries and regions.

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