International Journal of u- and e- Service, Science and Technology
Vol.7, No.2 (2014), pp.157-166
http://dx.doi.org/10.14257/ijunesst.2014.7.2.15

Research on Interests Distribution Model of Industrial Technology Innovation Strategic Alliances

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Abstract

Industrial technology innovation strategic alliances are cooperative R&D organizations of benefit sharing and risk sharing, composed of enterprise, university and research institutions. Interests distribution mechanism of industrial technology innovation strategic alliances is one of the key factors affect its stable operation. This paper presents an interests distribution model based on the member's inputs of resources and risk compensation. Alliance members of greater contribution will get more revenue, while the higher risk-sharing members will get more compensation. Alliances will establish a more equitable interests distribution mechanism by taking into account both resource inputs and risk compensation of members. Based on the theoretical research, the paper also gives the results of empirical analysis.

Keywords: *Industrial technology innovation strategic alliance, interests distribution, risk compensation, resources inputs*

1. Introduction

As global competition intensifies, the scale, speed and scope of technological innovation continues to expand, companies face increasingly complex technical and economic issues [1]. Single enterprise is difficult to depend on its own strength to grasp the uncertainty of technological innovation. So many companies began to seek a wide variety of collaborative mode of technical innovation actively.

Industrial technology innovation strategic alliances (hereinafter referred to as alliances') are founded by enterprises, universities, research institutions and other organizations. It is a kind of cooperative technology innovation organization, which aims at meeting industry's development needs and common interests of all members. The target of alliances is to enhance the technological innovation capability of the industry [2]. Members of alliance usually sign a legally binding contract to obtain protection. The characters of alliances are joint development, complementary advantages, benefit sharing and risk sharing. In 2007, the first four industrial technology innovation strategic alliances were established under the guidance of the Ministry of Science. These alliances are mainly in the fields of iron and steel, coal, chemicals and agricultural equipment. Since then, more alliances in other areas established rapidly. According to incomplete statistics, as of 2011, more than one hundred alliances were established in some provinces and municipalities, such as Beijing, Liaoning, Jiangsu, Zhejiang, Hubei, Guangdong, Hebei, Gansu and Qinghai, *etc*. These alliances were built based on the competitive and leading industries of these regions.

ISSN: 2005-4246 IJUNESST
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With alliances building boom, the research on alliances is also increasingly become the focus of scholars' attention. Industrial technology innovation strategic alliances construct with the aim that members expect to obtain higher returns (such as more research achievements, technical level improvement, knowledge acquisition and profits growth, *etc*.) through collaborative research than a separate study. Members of alliances try to establish a mechanism of common inputs and interests sharing, build a community of interests and achieve the 'win-win' results from the cooperation. As alliances are constituted by a number of members, there are also some complexities and uncertainties (such as organizational structure, goals, resource allocation, and coordination, *etc*) in the running of alliances. This may result in the occurrence of alliances risk. Risks of alliances can be divided into two dimensions [3-6]: relationship risks and performance risks. For members to join the alliance, although it is possible to obtain higher achievements and benefits by independent discovery, to raise the technical level by learning, but may also face the risk of loss of talent, technology leaks, deviate from the strategic objectives of the organization, as well as unable to recover the investment because of failure of R&D. Therefore, industrial technology innovation strategic alliance should fully consider both alliance member's contribution and risk size in the establishment of the benefits distribution mechanism. In order to increase the sense of fairness, alliance members who undertake greater risk should be given more risk compensation. Whether the mechanism of interests distribution and risk compensation is reasonable or not, is the key factor which will affect the members' enthusiasm for cooperation, the stability of alliances running and prospects of alliances' development.

Ji Yihua, Wu Wei and Zhu Qinghua (1999) are the earliest scholars of the country to conduct a comprehensive study on the interests distribution mode of cooperative technology innovation. They put forward three ways of interest distribution of alliances, including a one-time payment, pay by commission and mixed payment [7]. Guo Fenglan (2004) made a mathematical analysis of interests allocation of Industry-University-Research institute (IUR) collaboration by using game theory. She established an optimization mathematical model of interests distribution [8]. Luo Li, Lu Ruoyu(2000) used the game theory to build a cooperative countermeasure model. They suggested that the best way of interests distribution is to allocate in accordance with the commission, and gave the quantitative ratio of commission [9]. Sun Dongchuan (2001) and Guiping(2003) applied Nash bargaining model in interests distribution of alliances. They suggested that, there are two principles ought to be followed. The one is, interests of each member should be exactly equal to the alliance's total revenue. The other one is, the interests gets from the alliance of each member shall be not less than the proceeds by its separate operation. Otherwise the alliance will lose the meaning of existence [10-11]. Luo Li(2001) and Jia Ping(2003) described the interests distribution model of alliances with Sharply value [12-13]. Cao Xiaohua(2010) introduced the Nash equilibrium theory to analyze the interests distribution program of the Automotive Technology Innovation Strategic Alliance. She built an interests distribution model of n (n>2) members of the alliance, and deduced asymmetric Nash equilibrium optimal allocation programs based on member's satisfaction [14].

The existing research of benefit allocation problem mainly focus on qualitative research, the quantitative research is less. Researches on distribution model are mostly tend to the use of game theory. This article gives an interests distribution model based on the valuation of input of members, and then introduces the risk factor to improve the

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model. Its purpose is to enable members who undertake greater risk can get more risk compensation.

2. Types of Interests and Principles of Distribution

2.1. Types of Interests

The interests of the industrial technology innovation strategic alliances can be divided into direct interests and indirect interests. Direct interests can be obtained directly from operation of alliances. Indirect interests can be obtained only under the influence of some external environmental factors. Gaining direct interests is the purpose of the establishment of industrial technology innovation strategic alliance, whereas the degree of indirect interests will affect the sustainable development of alliances.

The direct interests of alliances can be divided into the following three types:

1) New product. For enterprises in alliances, new products developed by the alliance can be quickly turned into profits through their marketing channels. So the new product can be used as a form of direct interests to allocate to members of the alliance.

2) Technological patents. The main purpose of the establishment of alliances to is to develop the key generic technologies of industry. Therefore, a large number of patents are bound to produce in the running of alliances. These patents are developed jointly by alliance members and should be shared by them. However, different types of alliance members will apply the technological patents in different ways. Companies may improve their production efficiency by implement of patents to earn high profits. Universities and research institutions usually gains through technology transfer.

3) Profits. The profits include the sales revenue of the alliance's product and technology transfer income. Monetary benefits are usually easy to be distributed among the alliance members.

The indirect interests of alliances also can be divided into the following three types:

1) Technological achievements. The cooperative R&D activities in alliances include basic research, laboratory research, pilot, national testing center inspection, competent authorities for approval and the mass production stage, etc. Many technological achievements will be produced during the process. These technological achievements include technical know-how, production secrets and management experience. Although these gains will not directly manifested in the accounts of alliances, but are still the important achievements of alliances.

2) Goodwill. The good image of one alliance will bring goodwill and reputation to its members. Members will be proud of joining the alliance, and the goodwill of the alliance will bring intangible benefits for its members at the same time.

3) Capacity of sustainable development. Alliance members may improve their technical level and capabilities of energy-saving and emission-reduction through cooperative innovation. The capacity of sustainable development may be transformed into business opportunities, and contribute to alliances' revenue.

As indirect interests are difficult to carry out a quantitative assessment in short term, the interests distribution model discussed in this paper is mainly for direct income.

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2.2. Principles of Interests Distribution

Interests distribution of industrial technology innovation strategic alliance ought to be abided by the following principles:

1) Distributed in accordance with the contribution of members. Alliance members should be proportional to income and input. Who input more, the greater the income. Who input the less, the less revenue. In consideration of the contribution of alliance members, we should not only consider the financial contribution, but also consider those contributions of knowledge resources. Alliances need to conduct a comprehensive and reasonable assessment of member's input as a basis for the distribution of interests.

2) Distributed in accordance with the risk assumed by the members. There are many uncertain risks during the running of alliances. In the design of interests distribution model, the risks undertake by each member should be taken into account. Members bear higher risk should be given more compensation. This will help to encourage members to take risk tasks actively.

3) Members should be fully involved in the distribution process. Due to the different needs of different members, interests distribution completely mechanically according to a fixed proportion is unreasonable. This will lead to lower satisfaction of alliance members. Alliances should encourage each member to participate in the process of interests distribution and take full account of their needs.

4) Mutual benefit and common development of all the members. Due to the diversity of the revenue types of alliances, it is difficult to predict all possible types in advance. So the contract signed at the beginning usually could not defined all possible forms of interests distribution, which may lead to conflict of interests among members. For those revenue not explicitly specified in the initial contract, the alliance should allocate them in line with the principle of mutual benefit and common development of all the members.

3. The Model of Interests Distribution of Industrial Technology Innovation Strategic Alliance

3.1. Basic Assumptions

In order to build the model, some assumptions and derivations are given below:

1) Revenue of completed project will be allocated, and the revenue of unfinished projects will be carried forward to the next year.

2) Set there are n members in one industrial technology innovation strategic alliance, N ($N = \{1, 2, ..., n\}$) is a collection of all the members of the alliance.

3) Let m represents the number of completed projects in a given year of the alliance, M ($M = \{1, 2, \ldots, m\}$) is a collection of completed projects in the year.

4) Set that both tangible and intangible resources inputted by members of the alliance can be evaluated. The tangible resources include financial resources (funds) and material resources (such as land, R&D equipment, raw materials, *etc*.).The intangible resources include human resources (such as R&D personnel, management personnel, *etc*.), technical resources (technology patents and technology innovative capacity), the management resources (such as company culture, company policies,

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governance structure and incentive system, *etc*.), social relations resources (external collaboration capacity). Assume that the total value of resources input to project *j* by member *i* is R_{ij}, the total value of resources input to the alliance by member *i* is R_i. Then the total value of resources input to project *j* is

$$R_j = \sum_{i=1}^{n} R_{ij} .$$

The total value of resources put into the alliance by all the members in the given year is

$$R = \sum_{i=1}^{n} R_i .$$

5) Let *C* represents the total costs of the alliance's research and development activities in the given year. Obviously, we know that $C \leq R$. The investment of unfinished project will not include in the total cost of R&D activities in this year. It will be carried over to next year.

6) Let C_g represents the total fixed costs of the alliance, C_j represents the total costs of project *j*, C_{jb} represents the variable costs of project *j*, C_{jg} represents the shared fixed costs of project *j*, and then we have that

$$C = C_g + \sum_{j=1}^{m} C_{jb} , \; C_j = C_{jg} + C_{jb} ;$$

7) Let *V* represents the total revenue of the alliance, V_j represents the total revenue of project *j*. The total fixed costs can be shared in accordance with the proportion of one project's income in total revenue. Then we can get the expression of C_j :

$$C_j = \frac{V_j}{V} C_g + C_{jb} .$$

8) Let E_j represents the net profit of project *j*, and then we have

$$E_j = V_j - C_j .$$

9) Let C_{ijg} represents the shared fixed costs of member *i* in project *j*, then we have

$$C_{ijg} = \frac{R_{ij}}{R_j} C_{jg} .$$

10) Let C_{ijb} represents the shared variable costs of member *i* in project *j*, we know that it is equivalent to R_{ij} (the total value of resources input to project *j* by member *i*), so we have

$$C_{ijb} = R_{ij} .$$

3.2. Interests Distribution Model without Considering Risk Compensation

Based on the hypothesis and deduction above, we can get the expression of net profit of member *i* get from project *j*:

$$E_{ij} = E_j \frac{C_{ijg} + C_{ijb}}{C_j} . \qquad (1)$$

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We put the expressions of E_j, C_{ijg}, C_{ijb} and C_j by the above derived into (1), then the interests distribution model without considering risk compensation can be expressed as follow:

$$E_{ij} = (V_j - \frac{V_j}{V} C_g - C_{jb}) \frac{\frac{R_{ij} V_j}{R_j V} C_g + R_{ij}}{\frac{V_j}{V} C_g + R_j} \quad (2)$$

3.3. Interests Distribution Model Considering of Risk Compensation

To compensate the risks of the members, we must assess the level of the risks firstly. According to the definition of risk, the level of risk is essentially a function of the probability and loss severity of adverse events. That is, the greater the probability of risk occurrence and more severe the loss, the higher level of the alliance's risk.

Let *P* represents risk probability, *L* represents loss severity, the subscript *f* denotes the risk event occurs, the subscript *s* represents the risk event does not occur, and then we have

$$P_f = 1 - P_s, \quad L_f = 1 - L_s.$$

As the risk factor K_f is the likelihood estimation of the probability and loss severity of risk events, so there is[15]:

$$K_f = 1 - P_s L_s = 1 - (1 - P_f)(1 - L_f) = P_f + L_f - P_f L_f.$$

Let K_{ij} represents the risk factor of member *i* in project *j*, then the total risks of all of the members in project *j* is

$$K_j = \sum_{i=1}^{n} K_{ij}.$$

The shared proportions of member *i* in total risk of project *j* is

$$K_{ij}' = \frac{K_{ij}}{K_j}.$$

It is easy to draw that

$$\sum_{i=1}^{n} K_{ij}' = 1.$$

The difference between shared proportions of member *i* and the average sharing of risk in project *j* is

$$\Delta K_{ij} = K_{ij}' - \frac{1}{n}.$$

Obviously there is

$$\sum_{i=1}^{n} \Delta K_{ij} = 0.$$

When $\Delta K_{ij} \geq 0$, it shows that the sharing of risk of member *i* in project *j* is higher than the alliance's average level. In this case, member *i* should be given positive risk

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compensation. When $\Delta K_{ij} < 0$, it shows that the sharing of risk of member *i* in project *j* is lower than the alliance's average level. Then member *i* should be given negative risk compensation. The risk compensation given to the members of higher risk level than average comes from the members of lower risk level than average.

According to above assumptions, V_j represents the total revenue of project *j*. Let B_{ij} represents the risk compensation value, then there is

$$B_{ij} = \Delta K_{ij} \times V_j \times \alpha \ . \tag{3}$$

where α ($\alpha \le 1$) represents risk adjustment coefficient[16]. The coefficient can adjust the amount of risk compensation. Its level is usually determined in consultation by members of the alliance.

By (2) and (3), the interests distribution model considering of risk compensation can be given as follow:

$$\begin{aligned} E_{ij}^{\ r} &= (V_j - \frac{V_j}{V} C_g - C_{jb}) \frac{\frac{R_{ij} V_j}{R_j V} C_g + R_{ij}}{\frac{V_j}{V} C_g + R_j} + B_{ij} \\ &= (V_j - \frac{V_j}{V} C_g - C_{jb}) \frac{\frac{R_{ij} V_j}{R_j V} C_g + R_{ij}}{\frac{V_j}{V} C_g + R_j} + \Delta K_{ij} \times V_j \times \alpha . \end{aligned} \tag{4}$$

4. Empirical Analysis

Assume that one industrial technology innovation strategic alliance has three members: A, B and C. The three members developed two projects jointly in 2012. The first project has finished during that time while the second project has not finished. Then only the revenue of the first project will be distributed.The revenue of the second project will carry over to the next year. We have known, the total fixed costs of the alliance in 2012 is 500 thousands Yuan, and the total revenue of the first project is 15 million Yuan. The value of resources input of A, B and C are showed in Table 1. The risk ratio shared by member A, B and C is 4/15, 7/15 and 4/15 respectively. The risk adjustment coefficient is 0.4.

Table 1. **The Value of Resources Input to First Project**

currency unit: thousands Yuan

	Total value of resource input	Value of material resources input	Value of financial resources input	Value of human resources input	Value of technology patent input	Value of technology innovation resources input	Value of management resources input	Value of social relations resources input
A	1800	500	300	50	300	300	50	300
B	2400	600	200	200	600	450	100	250
C	2000	400	100	200	500	500	100	200
Total	6200	1500	600	450	1400	1250	250	750

Then we can calculate the available profit of member A, B and C by (4). The results have already considered member's risk compensation:

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$$E_{A1}^{f} = (15000 - \frac{15000}{15000} \times 500 - 6200) \times \frac{\frac{1800 \times 15000}{6200 \times 15000} \times 500 + 1800}{\frac{15000}{15000} \times 500 + 6200} + (\frac{4}{15} - \frac{1}{3}) \times 15000 \times 0.4 = 8300 \times 0.29 - 400 = 2007$$

$$E_{B1}^{f} = (15000 - \frac{15000}{15000} \times 500 - 6200) \times \frac{\frac{2400 \times 15000}{6200 \times 15000} \times 500 + 2400}{\frac{15000}{15000} \times 500 + 6200} + (\frac{7}{15} - \frac{1}{3}) \times 15000 \times 0.4 = 8300 \times 0.387 + 800 = 4012$$

$$E_{C1}^{f} = (15000 - \frac{15000}{15000} \times 500 - 6200) \times \frac{\frac{2000 \times 15000}{6200 \times 15000} \times 500 + 2000}{\frac{15000}{15000} \times 500 + 6200} + (\frac{4}{15} - \frac{1}{3}) \times 15000 \times 0.4 = 8300 \times 0.323 - 400 = 2281$$

As we can see from the above calculation process, total net profit of the project is 8300 thousands Yuan, the three members firstly share the net profit of the first project according to their resources input, and then get their risk compensation according to their shared proportions of the risk. Because the shared risk proportion of member B is higher than average, B will get risk compensation of 800 thousands Yuan. Whereas A and C are required to come up with 400 thousands Yuan respectively as the risk compensation of B. Because the risk sharing of the two members below average. The results reflect the interests distribution principle of coexistence of gains and risk.

5. Conclusion

In this paper, an interests distribution model of industrial technology innovation strategic alliance is discussed. The model considers both resources input and risk compensation of alliance members. This distribution mode makes alliance members who share higher risk will get more compensation. This will help to build a more equitable interests distribution mechanism of alliances. Through the establishment of a fair interests distribution mechanism, alliances will be able to motivate their members to participate in cooperative technology innovation activities actively, and will help to ensure the stability and performance improvement of alliances.

Acknowledgements

The author greatly acknowledges the financial support from Soft Science Program of Science and Technology Department of Zhejiang Province (grant number: 2013C35036): Research on Interests Distribution Mechanism of Collaborative Innovation from the Perspective of Cooperative Game — Taking Industrial Technology Innovation Strategic Alliance of Zhejiang as an Example.

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