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## The cooperative decision analysis on members of industrial technology innovation strategic alliance-the perspective based on sunk cost

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### ABSTRACT

The activity is one of the most effective indicators monitoring the healthy development of industrial technology innovation strategic alliance. Also it is the key ruler to measure that whether alliances can complete the task of innovative national construction. In this paper, based on the perspective of sunk cost, we analyze the decision-making strategies of alliance cooperation by using the method of game theory. The results show that if all parties invest their resources which have a quite different sunk costs, is easier to occur moral hazard problem. At last, we give some reasonable suggestions to promote the development of alliance, the key is the organic combination of government policy, legislative system, two-part contract and partner selection mechanism.

### KEYWORDS

Industrial technology innovation; Strategy alliance; Cooperative; Decision; Sunk cost.



## INTRODUCTION

Industrial technology innovation strategic alliance has become the important carrier which implement national technology innovation project and construct technological innovation system in our country.

Industrial technology innovation strategic alliance (hereinafter referred to as the "alliance") is a new kind of technology innovation cooperation organization which is containing enterprises, universities, research institutions or other organizations, based on enterprise's development needs and common interests of the parties, to promote industrial technology innovation ability as the goal, in a legally binding contract for security, forming of the united development, complementary advantages, benefit-sharing and risk-sharing<sup>[1]</sup>.

The alliance between industry, universities and research institutions, and the government has gradually become the core of accession or integration heterogeneity innovation resources between different innovation main body, implementation technology accumulation and diffusion, technical improvement and innovation<sup>[2]</sup>. In 2013, the task groups, led by Chinese Pilot League Contact Group, rated the activity of 91 state-level pilot union. Evaluation index system includes online situation of a union council, organize technical seminars, actively carry out the league between exchanges, set up a website or web page, and in a timely manner to carry out propagation work on the industry oriented, annual work summary and work plan this year, participate in relevant policy research work, actively promote the league activities and play an exemplary role. It shows that most union is playing the role of leader or supporter in the field of technological progress by actively carry out pilot work, to develop exploration, and constantly strengthen the construction of its organization and operation mechanism, but there are also individuals, slacking off, can't carry out work according to the original target. From the field distribution, the next generation information technology industry included 14 leagues added an average of 66.1 points, the primary industry included 21 leagues added an average of 48.8 points, materials and equipment manufacturing industry included 34 leagues added an average of 47 points, energy conservation and environmental protection, energy sources, and bio-tech industrial included 26 leagues added an average of 45.9 points<sup>[3]</sup>. To a large extent, activity can be used as a crucial characterization of alliance development. These lower activity alliances if there is a similar development restriction factor? If there is, what's the internal mechanism and how to work? Some measures to improve the current condition of alliance? The purpose of this article is to find the reasons of the existence of this state, and seek to solve the problem of the state.

Members of the initial investment heterogeneous resources is the base of alliance cooperation. ZHOU Qing, etc (2014)<sup>[4]</sup> explored alliance relationships between the types of conflicts and its influencing factors. The study shows that alliance of the imbalance of the resources will intensify the process of conflict and relationship conflict. In this paper, imbalance is mainly refers to a dynamic unequal caused of tacit knowledge, complex technical issues, unstable human resources and specific assets and so on in the course of initial resource inputs, such as knowledge, technology, talent, capital, etc. Based on this argument, all partners between alliance invest their resources tend to have a quite different sunk costs, and also it is easy to appear ripped off or hitchhike phenomenon. It is one of the main influence factors that hinder the development of alliance which has lower activity.

## ALLIANCE OF HETEROGENEOUS RESOURCES AND SUNK COST

In the new classical economics, the sunk cost related to actions is fixed, and no impact on current or future decisions. If we regard resources input as a specific action of the alliance, and regard profit distribution after cooperation as a decision-making based on current or future. According to traditional view, then the sunk cost related to resources input should not affect profit distribution of the alliance, in other words, deciding the distribution of profits is static accounting cost, namely the one-off real spending or cost. In most pilot alliance practice, however, if only consider static accounting cost of resources, without considering the sunk cost of resources, will not only hinder the stability of the alliance daily operation, but also to a great extent, becoming one of the important cause of conflict. Sunk cost is one kind of cost that can not be fully compensation after invest. TANG Jijun, etc (2008)<sup>[5]</sup> defined sunk cost as the margin between purchase price in the first assets market and transfer price in the secondary (reselling price or salvage value). Limited-rational economic agents and uncertain environment is the important condition which produce the sunk cost. One of the most important feature is a legally binding contract in forming a alliance. In before signing the contract, alliance members will put the limited information and previous experience as the basis of the present and future decisions, either due to the incompleteness of self knowledge or unavailability of related information. With the change of the technical and market environment, the salvage value of some fixed assets will no doubt be reduced, to produce the so-called sunk cost.

Investment of specific assets, either tangible or intangible, is the realistic condition which produce the sunk cost<sup>[6]</sup>. Drawing on the typology of Williamson ( 1985 ), alliance investment of specific assets are mainly include: ( 1 ) Set up regional specificity. Steel circulating process technology innovation strategic alliance, for example, in CAOFEIDIAN, completed the first domestic large steel enterprises demonstration project which contains three main functions: iron and steel products manufacturing, energy efficient transformation, and processing large social waste. ( 2 ) Physical asset specificity. Agricultural equipment industry technology innovation strategic alliance joint promotion of large tractor, rice and wheat combine harvester, etc., these material assets design applies only to a specific transaction purposes. ( 3 ) Human asset specificity. In order to meet the requirements of the development of the industry, TD industry alliance in 2013 work summary mentioned that the union to attract a batch of including intellectual property, communications technology development,

industry research and other professional talents to join by gathering all kinds of resources. ( 4 ) other special-purpose assets. Such as the investment in relationship in order to sell products to specific customers, as the termination of relationship and unable to salvage its value. In other way, the existence of transaction cost will also produce sunk cost. In particular, when the transaction costs increase the purchase price or lower the reselling price, "lemon" problem because of information asymmetry is easy to produce sunk cost in the process of specific assets trading<sup>[7]</sup>. In the alliance, the members make industrial technological innovation based on project, which need to invest in innovation and has a uncertain risk. when individual interests and overall interests conflict caused of information asymmetry, it is easy to produce "ripped off" and "moral hazard" problem. This will seriously reduce the salvage value of the initial investment capital, thus forming sunk cost. Moreover, government regulation, contract commitment, tax policy and depreciation system, etc., are likely to produce sunk cost<sup>[8]</sup>.

In summary, sunk cost of resources that alliance members initial invest refers to a margin between the salvage value of resource factors and the initial value, in which the most important condition is that the input resources such as capital, technology, equipment, personnel and so on, are faced with bounded rationality of investment subject and uncertainty of the environment at the beginning of the alliance. Alliance with enterprise as the main body, stresses the common input, benefit-sharing, risk-sharing; on the basis of contractual relationship, pays attention to establish long-term, stable relations of cooperation between the members; with the breakthrough of industrial generic technology innovation or establish industry standards as the goal, emphasizes the large-scale commercial applications of technical achievements; it also has distinctive characteristics of strategic, cooperation liberalization, enterprise as main body, industrialization, etc<sup>[9, 10]</sup>. Interaction between alliance members rely on capital, technology, equipment, personnel and other resources, although the size of the resource inputs will directly determine alliance income distribution to a certain extent, however, based on the initial conditions, game process between members will also affect income distribution of the alliance.

**THE OPTIONAL ADVANTAGE OF LOWER SUNK COST**

Income distribution is a kind of game between alliance members. In this paper, the risk of sunk cost as a correction factor introduced into payoff function, to analyze the alliance members different behavior of inner motivation.

First, we assume that the alliance with only two members of A and B, and the initial investment including capital, technology, equipment and personnel. There is no sunk cost, namely  $\delta = 0$ , where the parameter  $\delta$  represents the strength of forming sunk cost. A and B can choose strategy sets of  $\{cooperation\}$  or  $\{betrayal\}$ . If both sides choose cooperation, the payoffs of A is  $S_A$ , the payoffs of B is  $S_B$ ; If both sides choose betrayal, the payoffs of A is  $M_A$ , the payoffs of B is  $M_B$ ; If A choose cooperation, and B choose betrayal, then the payoffs of A is  $R_A$ , the payoffs of B is  $P_B$ ; Conversely, if B choose cooperation, and A choose betrayal, then the payoffs of B is  $R_B$ , the payoffs of A is  $P_A$ . The existence of alliance on the basis of the contract, in which both sides agreed that the betrayer must pay a penalty for breach of contract. Here we assume that the penalty due to breach of contract happens to guarantee both sides don't fall into prisoner's dilemma of  $\{betrayal, betrayal\}$ . The payoff matrix is shown in Figure 1:

B:

		Cooperation	Betrayal
A:	Cooperation	$S_A, S_B$	$R_A, P_B$
	Betrayal	$P_A, R_B$	$M_A, M_B$

**Figure 1 : The payoff matrix of zero sunk cost**

There is a unique Nash equilibrium of the game, that is  $\{cooperation, cooperation\}$ . The practical implication is that if the sunk cost does not exist, or near a rate of zero, the members of alliance are choose cooperation, and that is not easy to appear ripped off or hitchhiker, etc.

Here we assume that the initial investment of A has completely sunk costs, namely,  $\delta^A = 1$ , the initial investment of B has zero sunk cost, namely,  $\delta^B = 0$ . Accordingly, the reality interpretation of that is that the sunk cost risk of investment resources of B is very low, such as capital, and the sunk cost risk of investment resources of A is very high, such as special workshop and equipment. When both sides choose cooperation, with the specific asset, A can access to additional revenue of  $s$ . In other cases, as long as at least one betrayal, the salvage value of specific assets are lower, which means that the losses of  $m$ . Here the payoff matrix is shown in Figure 2:

		B:	
		Cooperation	Betrayal
A:	Cooperation	$S_{A+s}, S_B$	$R_{A-m}, P_B$
	Betrayal	$P_{A-m}, R_B$	$M_{A-m}, M_B$

**Figure 2 : The payoff matrix of complete sunk cost**

Form the payoff matrix, when one member invest initial resources which has sunk cost, the other cooperation or not will directly impact on the payoffs. And when  $(m-s)$  is large enough, A was ripped off B. Because B wants to share in  $s$ . In other words, one member, which invest initial resources which has lower risk of sunk costs, has more advantages in the limited condition.

**POSSIBLE SOLUTIONS**

Solution 1: Increase the cost of B's breach. Admittedly, based on the contract, both sides may reach an agreement that if B choose betrayal, so he should compensate A certain loss, such as pay liquidated damages, etc. Equivalent, A may also promised B part of earnings from  $s$ . This would be the equivalent of rewarding B for the cooperation. But it works in what circumstances? Here the payoffs matrix contained deposit  $Q$  is shown in Figure 3:

		B:	
		Cooperation	Betrayal
A:	Cooperation	$S_{A+S}, S_B$	$R_{A-m+Q}, P_B-Q$
	Betrayal	$P_{A-m}, R_B$	$M_{A-m}, M_B$

**Figure 3 : The payoff matrix of deposit**

Here form the payoff matrix, if  $(P_B - Q) > S_B > M_B$ , then B only choose betrayal; if  $(R_{A-m+Q}) > (M_{A-m})$ , A will, to a certain extent, endure B's betrayal, and here for A alliance is "chicken ribs". It is also we see some of the alliance in the state of " activity is low, but also be there". If  $(S_{A+S}) > (R_{A-m+Q})$ , and  $S_B > (P_B - Q)$ , both sides will go to cooperation that is a win-win situation. This is why the government introduced various policy measures to promote the development of the alliance.

Analytic results show that the sunk exerted certain influence on payoffs of the game. Specifically, if the sunk cost risk of investment resources of one side, which such as special equipment, is higher than the other, and it is easy to appear that the lower ripped the higher off. In practice, the alliances of energy conservation and environmental protection, energy

sources, and bio-tech have lower activity, lack of trust between the members, and the performance is not stable, etc. It explains these phenomena in reason from a certain perspective.

Solution 2: Increase liquidity of resources with high sunk risk. Here we adjust the assumed parameter  $\delta$  of Figure 2.

Here it can be adjusted to  $0 < \delta < 1$ , and then  $(S_A + \delta * S) < (S_A + S)$ . It suggests that the increased resource liquidity of the members which have high sunk risk, is beneficial to the members under the market mechanism to carry on the reasonable resource allocation.

B:

		Cooperation	Betrayal
A:	Cooperation	$S_A + \delta * S, S_B$	$R_{A\_m}, P_B$
	Betrayal	$P_{A\_m}, R_B$	$M_{A\_m}, M_B$

**Figure 4 : The payoff matrix of incomplete sunk cost**

Other possible solutions, such as partner selection mechanism, social reputation mechanism and so on. Here we won't go into much detail here.

### CONCLUSION AND SUGGESTION

In the process of alliance operating, the initial investment of resources have heterogeneity, in which these heterogeneous resources have different sunk risk. In the process of income distribution cooperation decision-making, there is an immense risk of being ripped off or hitchhiked among members which have high sunk risk of initial resources. Then both sides fall into the Prisoners' Dilemma of noncooperation. The three primary solutions:

(1) Increase the cost of B's breach. (2) Increase liquidity of resources with high sunk risk. (3) non-economic means, such as partner selection mechanism, social reputation mechanism and so on.

In summary, for the problem of ripped off or hitchhiked caused of that the initial resources have a quite different sunk costs, only by adopting effective and decisive measures to reduce the resources elements of rational expectations precipitation cost, can achieve the sharp rise in the goal of China's industrial competitiveness.

One is to establish and improve the functions of the government mechanism into full play. Industrial technology innovation strategy alliance is shouldering the important mission to promote the competitiveness of the whole industry in China, and the government plays a key role in it. On the one hand, the government should further improved the legal system standard on the market of intellectual property and resource factors. Only through the law to perfect market, ripped off and free-rider behavior are effectively inhibited fundamentally. On the other hand, The government should give alliances which have high sunk risk of initial investment resources more subsidies and preferential policy, such as the alliance of traditional equipment manufacturing field.

The second is within alliances should further perfect the contract mechanism. Due to the incomplete contract itself, we need to improve according to the changing environmental conditions. For example, we can introduce a two-part contracts in which that set up a mechanism of coordination after the event on the basis of the original contract. To reduce the bargaining cost, we also can give specific restrictions to the content of the coordinate contract, such as only on the basis of the original distribution proportion for additional 20% of redistribution, etc. Moreover, we should exert the legally binding effects of contracts in which for the behavior of rip off and hitchhike should given clear and severe punishment.

The third, enhance the mobility of resources. we should quickly improve the modern market system, in addition to the traditional physical capital and human capital market, especially should strengthen the financial capital markets. Through establishing and perfecting the physical assets and intangible assets formation of the modern market system, increase transparency in the market, protect resources sufficient liquidity, this will help to ensure that the alliances run well.

Fourth, optimize alliance partner selection process, establish and improve the good social reputation mechanism. By optimizing the alliance partner selection process, the partners that have heterogeneous resources which can better share and integration each other were selected scientifically. To produce the desired result of  $1 + 1 > 2$ , effective one way is to do big "cake", reducing conflicts caused by sunk cost occurring in the process of alliance cooperation. Good social reputation

mechanism is the medicine of the moral risk effectively, because at that time means that betrayers face from tougher moral constraints from society and industry.

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