Research on the Stability of School Enterprise Alliance Cooperation Considering Trust and Risk Factors

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Abstract. The trust factors and risk factors of both sides in the process of school enterprise alliance cooperation are included in the school enterprise alliance cooperation game, the evolutionary game model both sides are constructed, and the equilibrium solution of the evolutionary game is obtained. The influence of trust factors and risk factors on the stability of school enterprise alliance cooperation is studied through example simulation. The research shows that higher initial participation willingness of colleges and universities can promote the stability of cooperation between the two sides; The higher the trust, the higher the cooperation income, and the higher the cooperation stability of the school enterprise alliance; The greater the risk factor, the greater the punishment of the main body's behavior of breaking away from the alliance, and the higher the cooperation stability of the school enterprise alliance.

Keywords: School enterprise alliance · Cooperation stability · Evolutionary game model · Equilibrium solution

1 Introduction

Innovation is an important factor to improve economic and social benefits, promote social scientific and technological progress, and an effective driving force to promote the all-round development of society. With the gradual deepening of social division of labor, innovation subjects have problems such as limited funds and insufficient independent innovation ability. It is difficult for a single organization to carry out scientific and technological innovation, and the organizational model of multi-agent cooperative innovation came into being. Colleges and universities are important research positions for innovation [1], and the birthplace of original innovative knowledge. The enterprise is an important transformation position for innovation [2], and the key to the marketization of innovative products. Therefore, school enterprise cooperative innovation is an important way to effectively integrate information and knowledge, and occupies a core position in the national innovation system [3]. However, there are great differences in organizational

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structure, culture and ability among innovation subjects, which leads to strong coordination complexity and high innovation risk. The cooperation stability of school enterprise alliance has also been affected to varying degrees. The lack of cooperative stability of school enterprise alliance is not conducive to the development of scientific and technological innovation, which has seriously restricted the development of school enterprise cooperative innovation [4]. Yang [5] established a dynamic collaborative mechanism model under the school enterprise collaborative innovation mode by using the multi-agent method. Chen [6] analyzed the limited rationality of the participants, incomplete symmetry of information and other factors, established a gray symmetric evolutionary chain model, and discussed the stability of industry university research collaborative innovation. However, the more microscopic factors for the stability of school enterprise alliance need to be explored.

In view of this, this paper starts with the trust factors and risk factors of colleges and enterprises, constructs an evolutionary game model between colleges and enterprises considering two factors, and further explores the cooperation stability of school enterprise alliance under the influence of micro factors through numerical simulation.

2 Model Construction and Solution

2.1 Model Construction

Based on the current situation of the industry university research cooperative alliance established by universities and enterprises, this paper makes a preliminary evaluation of the stability of the university cooperative alliance, comprehensively considers the strategic choices of universities and enterprises in the cooperative game, and makes the following assumptions: H1: the main body of the game. This paper studies the University (A) and enterprise (B) in the school enterprise cooperation alliance. Both types of subjects have two strategic choices, namely "cooperation" and "non-cooperation". x and y respectively represent the probability that colleges and universities (A) and enterprises (B) choose the "cooperation" strategy, and $1-x$ and $1-y$ respectively represent the probability that colleges and universities (a) and enterprises (b) choose the "non-cooperation" strategy, where $x, y \in [0, 1]$. H2: benefits and costs. Considering the reality, universities (a) and enterprises (b) will have their own benefits before cooperation, which are recorded as S_A and S_B respectively; The excess return generated in the cooperation is recorded as $S_A^a S_B^b$, where a and b respectively represent the trust of colleges and universities (A) and enterprises (B) in each other, that is, the higher the trust, the deeper the cooperation, the greater the excess return. Use θ to represent the excess return distribution coefficient of university (A), then $1-\theta$ is the excess return distribution coefficient of enterprise (b), where $\theta \in [0, 1]$. Cooperation costs are recorded as C_A, C_B. H3: escape punishment. During the normal operation of the school enterprise cooperative alliance, one party may choose to leave the alliance because of other interests, and terminate the cooperation, which will bring losses to the other party. Therefore, this behavior will be punished. It is assumed that the subjects who leave the cooperative alliance will receive other benefits, which are recorded as R_A, R_B. . The punishment will be based on the risk factors of both parties. The risk factor refers to the degree of aversion of the subject to the risk of cooperation failure. The greater the risk factor of the subject, the more punishment the

Table 1. Payment matrix of school enterprise alliance cooperation game

		Enterprise	
		Cooperation (y)	Non-Cooperation ($1-y$)
University	Cooperation (x)	$S_A + \theta S_A^a S_B^b - C_A$ $S_B + (1-\theta) S_A^a S_B^b - C_B$	$S_A + \varphi_A P - C_A$ $S_B - \varphi_A P - C_B + R_B$
	Non-Cooperation ($1-x$)	$S_A - \varphi_B P - C_A + R_A$ $S_B + \varphi_B Z - C_B$	S_A S_B

other party will receive due to withdrawal. Assuming that the risk factors of colleges and universities (A) and enterprises (B) are divided into φ_A and φ_B, therefore, the punishment of both parties due to withdrawal is $\varphi_B P$ and $\varphi_A P$, where P is the punishment base, $\varphi_A, \varphi_B \in [0, 1]$. The payment matrix of school enterprise alliance cooperation game is shown in Table 1.

Suppose that college a chooses "cooperation" and " non-cooperation ", the expected return is U_{A1} and U_{A2} respectively, and the expected return is $\overline{U_A}$; The expected return of enterprise B choosing "cooperation" and "non-cooperation" is U_{B1} and U_{B2} respectively, and the expected return is $\overline{U_B}$. According to the game payment matrix in Table 1, the replication dynamic equation is as follows:

$$F(x) = x(1-x)(U_{A1} - U_{A2}) = x(1-x)[y(\theta S_A^a S_B^b - \varphi_A P + \varphi_B P - R_A + C_A) + \varphi_A P - C_A]$$

$$F(y) = y(1-y)(U_{B1} - U_{B2}) = y(1-y)[x((1-\theta) S_A^a S_B^b - \varphi_B P + \varphi_A P - R_B + C_B) + \varphi_B P - C_B]$$

2.2 Model Solution

According to the replication dynamic equation of the school enterprise alliance cooperation game, let $F(x) = 0$, $F(y) = 0$, we can find five local equilibrium points: E_1 (0, 0), E_2 (0, 1), E_3 (1, 0), E_4 (1, 1). The stability conditions are $\varphi_A P - C_A < 0$, $\varphi_B P - C_B < 0$, and $\theta S_A^a S_B^b + \varphi_A P - R_A > 0$, $(1-\theta) S_A^a S_B^b + \varphi_B P - R_B > 0$. Among the four partial equilibrium points of the school enterprise alliance cooperation game, there are only two stable points E_1 and E_4, corresponding to that both colleges and enterprises choose cooperative behavior and neither choose cooperative behavior.

3 Dynamic Analysis

According to Fig. 1 and Fig. 2, in the school enterprise cooperation alliance, the initial willingness threshold of colleges and universities is higher than that of enterprises. This is because the concept of innovation driven development is deeply rooted in the hearts of the people, and enterprises are more willing to cooperate with colleges and universities to form an innovation alliance; The willingness of colleges and universities has a great impact on enterprises. When the willingness of colleges and universities to cooperate

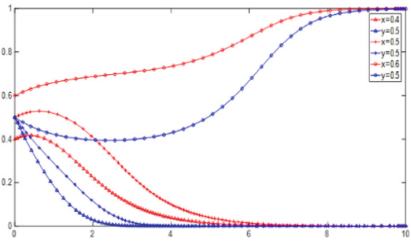

Fig. 1. Influence of x change on game strategy

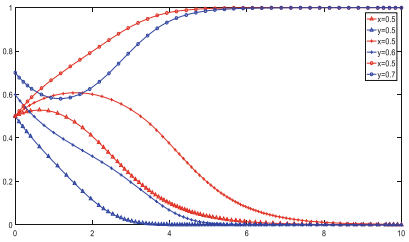

Fig. 2. Influence of y change on game strategy

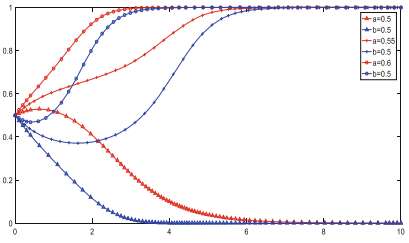

Fig. 3. Influence of University trust on game strategy

increases, the willingness of enterprises to cooperate increases rapidly. It can be seen from Fig. 3 and Fig. 4 that in the school enterprise cooperation alliance, the trust of both colleges and enterprises can positively promote the achievement of the cooperation situation. When the trust of both sides is greater, the stability of the alliance is significantly improved, and the willingness of both sides to cooperate is stronger. It can be seen from Fig. 5 and Fig. 6 that in the school enterprise cooperation alliance, the risk factors of colleges and enterprises can positively promote the achievement of the cooperation situation. This is because with the increase of the risk factors of both sides, the disgust of one party to the other party's separation from the alliance is stronger, the punishment for the other party's separation from the alliance is greater, and the binding force on the other party is greater. Therefore, the stability of the school enterprise cooperation alliance is improved.

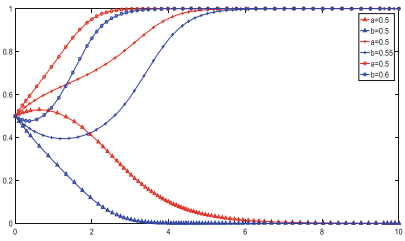

Fig. 4. Influence of enterprise trust on game strategy

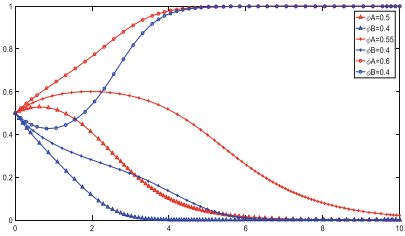

Fig. 5. Influence of University risk factors on game strategy

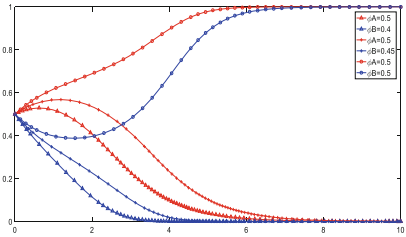

Fig. 6. Influence of enterprise risk factors on game strategy

4 Conclusions

This paper studies the stability of school enterprise cooperative alliance, and analyzes the influence of trust and risk factors between colleges and enterprises on the stability. Through the evolutionary game model and simulation, we can see that if we want to achieve the long-term stable development of the school enterprise alliance, we need to control the degree of trust and risk factors of both sides. The conclusions are as follows: (1) the stronger the initial willingness of colleges and universities to cooperate, the more stable the school enterprise cooperation alliance is. Therefore, the school enterprise cooperation alliance should stimulate the willingness of colleges and universities to cooperate, and stimulate colleges and universities to participate in cooperation by setting incentives and increasing the proportion of early-stage R & D funds. (2) The degree of mutual trust between universities and enterprises is promoting the stability of school enterprise cooperation alliance. Therefore, the university enterprise cooperation alliance should cultivate the sense of trust of both sides. Colleges and universities

should regularly report the research progress to enterprises, improve the willingness of scientific researchers to share knowledge and technology, and let authoritative and influential scientific researchers participate in innovation projects to increase the trust of enterprises; Enterprises should give priority to expressing their sincerity for cooperation, and actively disclose the internal information of the enterprise and the progress of the transformation of achievements, such as actively disclosing the information of patent applications, so as to reduce the possibility of stealing technological achievements and improve their credibility. At the same time, they should actively sign a responsibility distribution contract with colleges and universities, so as to guide colleges and universities to reduce concerns and improve the trust of colleges and universities.

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