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A Study on After-competition Strategic Alliance of Creative Enterprises Based on Evolutionary Game Theory

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Abstract: Taking creative enterprises as the research objects, this study analyzes their mechanism of after competitive strategic alliance and the dynamic stability of strategy selection from the perspective of evolutionary game theory on creative enterprises' strategic alliance. The result shows that the evolutionary process of competition and cooperation behavior is mainly affected by three factors and they are respectively additional revenue that from choosing alliance, input costs of alliance and the successful probability of gaining benefits. It provides some useful references for building a stable and effective alliance mechanism of creative enterprises.

Key words: Creative enterprise, after-competitive strategy alliance, evolutionary

INTRODUCTION

With the trend of economic globalization, the creative industry as the most potential and influential sunrise industry in 21st century has become the focus of a new round competition in global economy. Rifkin (2000) claimed that culture industry would rise to the top of our economic life, information and services industries move to the second floor, manufacture industry to the third floor and agriculture at the bottom. After 2000, domestic scholars began to study evolutionary game and made great achievement. Some scholars tried to apply evolutionary game theory into biology, sociology and economics, others paid much attention to the evolutionary game of creative industry group, such as (Yang *et al*., 2009) who established a model of two players according to eagle-pigeon game, discussed parameters and analyzed the key factors which play a big role in the process of marketization in creative economy. Mao (2010) set up an evolutionary game model of enterprises in the creative industry cluster about innovation strategy competition selection process by the analysis method of evolutionary game theory and made evolution dynamic stability analysis about the strategy selection. However, the literature about the application of game theory to the field of creative enterprise strategic alliance is much less, lacking of micro-evidence based on enterprise organizations as the research object. In order to solve this problem, according to domestic research situation of creative enterprise competition strategic alliance, this paper will use evolutionary game theory to analysis competition strategic alliances of creative enterprises. In addition, this paper makes great innovation in research method and enriches the applications range of evolutionary game theory.

MECHANISM OF CREATIVE ENTERPRISES ABOUT AFTER-COMPETITION STRATEGIC ALLIANCES ANALYSIS

Strategic Alliance is also known as dynamic alliance or network organization which was first proposed by the U.S. DEC present Jane· Hopland and management scientist Roge.Nigel. According to members of the interactions and potential conflicts classification, strategic alliance can be divided into four types, such as after-competition alliance, competitive alliance, non-competitive alliance and before the competition alliance. After-competition alliance refers to the vertical value chain relationships within the industry. Creative enterprises refer to the businesses which product or sale creative products or providing ancillary services for production or sales of creative products. Li *et al*. (2005) from a new perspective of spirit economy to discuss creative enterprises, point out that creative enterprises are emerging with the growth of people spiritual needs and cultural consumption and they are specializing in providing and manufacturing spirit product.

The creative enterprises can be divided into two types, one is production enterprise and the other is kind of sales enterprise. Production class creative enterprises refer to the businesses which provide conception and good idea of creative products by themselves. Such type

enterprises are the main direct providers of innovative products, including the operation of books and news writing, filmmaking, literary and artistic creation, software development and other enterprises. Sales class creative enterprises are such businesses which are committed to selling creative products, including the operation of advertising, publishing, exhibitions, Internet and other enterprises. These enterprises promote creative products and turn ideas into wealth. After competitive alliances of creative enterprises refer to the relationship between the vertical value chain within the creative industries, such as the alliance relationship between producers and sellers of creative enterprises, the main goal of their alliance is to maintain strategic flexibility and create added value.

EVOLUTIONARY GAME MODEL

Core concepts of evolutionary game: The concept of ESS development and the dynamic of ESS constitute the main content of the development of evolutionary game theory: Replicator dynamics and optimal reaction dynamics. There are two different dynamic reaction mechanisms based on the participants' ability of learning and one is the game of a small group players with fast learning ability and its mechanism called "the optimal response dynamic mechanism" (the best response dynamics). The other is the repeated game of a large group players randomly paired with slow learning ability and its mechanism called "dynamic replication mechanism" (replicator dynamics). ESS (evolutionary stable strategy) with mathematics can be defined as: If for any strategy y#x, $\overline{\varepsilon_y}(0,1)$ for all $\varepsilon\left(0,\overline{\varepsilon_y}\right)$, the inequality of u[x, y+(1-) x]>u[y, y+ (1-) x] is established, then xΔ is an evolutionary stable strategy. Among them, X represents the strategy of incumbent and that is a mixed strategy or pure strategy. Y represents the strategy of entrant. In the same way, the above inequality is still established for both mixed strategy and pure strategy and x □ Δ (0, 1) represents entrant accounting for the proportion of the overall. In addition, let Δ^{ESS} to indicate the strategy set of evolutionary stable game.

ASSUMPTIONS

Players: The players can be divided into two categories, namely the production creative ventures and sales creative ventures. Suppose that production creative enterprises and sales creative enterprises are limited rational and they have certain statistical analysis skills. Production creative enterprises and sales creative enterprises will play a game of competition strategic alliance. The competition strategic alliance of these two type enterprises can be seen as strategic responses of creative enterprises to enhance their competitive strength and adapt to market economy environment. Considering the relative adaptability of themselves, enterprises will select and adjust their strategies in time.

Behavioral strategies: Suppose that the behavioral strategies of production creative enterprises and sales creative enterprises are (union, nonunion), when they operate independently, the normal payoff of each type enterprises is R_1 and R_2. Assume that the two players formed a competitive strategic alliance and got ahead, the two sides would get extra income ΔR with the probability of μ. Moreover, let it be supposed that these two categories of creative enterprises through bargaining and their own contribution to production affect the outcome and the evolutionary distribution of returns are: The net income of production creative enterprises is S_1 and the sales creative enterprises is S_2 ($S1+S_2 = 1$). The cost of production creative enterprises for choosing union is C_1 and the cost of sales creative enterprises is C_2.

The proportion of each side's behavioral strategy: The ratio of production creative enterprises for choosing union is X, otherwise is 1-X. The ratio of sales creative enterprises for choosing union is Y, otherwise is 1-Y.

Payoff matrix

Fitness analysis: Based on the above assumptions, when production creative enterprises choose the strategy of alliance, their fitness is:

$$\begin{aligned} A1 &= y\,(R1+s1\,\mu\Delta R-C1+(1-y)\,(R1-C1) \\ &= yR1+ys1\,\mu\Delta R-yC1+R1-C1-yR1+yC1 \\ &= ys1\,\mu\Delta R+R1-C1 \end{aligned}$$

when, production creative enterprises do not choose the strategy of alliance, their fitness is A2 =y R1+ (1-y) 1 = R1. The average fitness of production creative enterprises is Table 1:

$$\begin{aligned} A &= xA1+(1-x)A2 = x(ys1\,\mu\Delta R+R1-C1)+(1-x)R1 \\ &= xys1\,\mu\Delta R+xR1-xC1+R1-xR1 \\ &= xys1\,\mu\Delta R-xC1+R1 \end{aligned}$$

Table 1: Payoff matrix of production creative enterprises and sales creative enterprises

Production creative enterprises	Sales creative enterprises: Alliance	Sales creative enterprises: Non-alliance
Alliance	$R_1+ s_1\mu\Delta R-C_1$, $R_2+ s_2\mu\Delta R-C_2$	R_1-C_1, R_2
Non-alliance	R_1, R_2-C_2	R_1, R_2

According to the definition of the replicator dynamics differential equation and the replication dynamic thought of biological evolution, the players who adapt the relative low-income strategy will change strategies and imitate the players who choose the high-income strategy. Therefore, the proportion of players who adapt different strategies will change in the total population. The changing speed of special strategies ratio is positively relate to average income. So we can get a replicator dynamics differential equation for production creative enterprises when choosing strategies for union:

$$\begin{aligned} dx/dt &= x(A1- A) \\ &= x\,[ys1\mu\Delta R+R1-C1-(xys1\mu\Delta R-xC1+R1) \\ &= x\,[ys1\mu\Delta R-C1-xys1\mu\Delta R+xC1\,] \\ &= x\,[ys1\mu\Delta R(1-x)-(1-x)C1\,] \end{aligned}$$

$$x(1-x)(ys1\mu\Delta R-C1) \quad (1)$$

According to the dynamic Eq. (1), let F(x) = dx/dt = 0, we can get possible equilibrium points: x = 0, x = 1 and y_A = C1/(s1μΔR). But these three points are not Evolutionarily Stable Strategy (ESS), an evolutionary stable strategy in the evolutionary game refers to a stable state that must have the function of resistance to disturbance. That is to say, the point y_A should have such features, besides representing the stable state, if y is derivation from y_A, replication dynamic will still make y back to y_A. The mathematical implication is that when $y<y_A$, dx/dt >0; when $y>y_A$, dx/dt <0, that is to say, the differential coefficient of the stable point F(X) is less than zero. In other words, the tangent slope of F(X) and the horizontal axis intersects is negative. That meet: $F(y_A) = 0$ and $F'(y_A)<0$. So, F′(x) = (1-2x) (ys1μΔR-C1). If y_A = C1/(s1μΔR), F′(x) = 0, that means all points of X axis in a stable state; If y_A# C1/(s1μΔR), we can get two possible stable points x = 0, x = 1. At the moment there are two cases: When $y>y_A$, F′(0)>0, F′(1)<0, so x = 1, that is ESS; when $y<y_A$, F′(0)<0, F′(1)>0, so x = 0, that is ESS.

The following Fig. 1 shows the phase diagram of production creative enterprises' replication dynamic in three cases.

Similarly, we can draw the fitness of sales creative enterprises when they choose union strategy: B1 = xs2μΔR+R2-C2. When they do not choose union, the fitness is : B2 = R2.So the average fitness of sales creative enterprises is:

$$B = yB_1+(1-y)B_2 = yxs2\mu\Delta R-yC_2+R_2$$

We can get a replicator dynamics differential equation for sales creative enterprises when choosing union strategies:

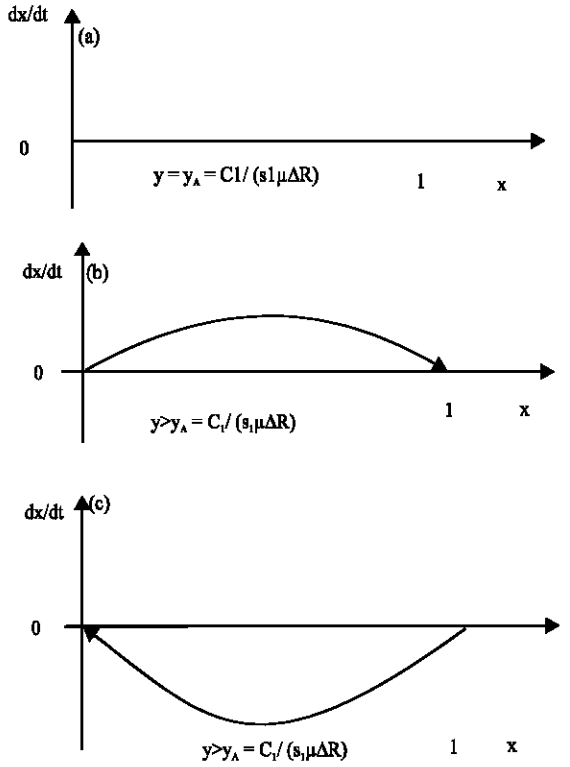

Fig. 1(a-c): Three kinds of phase diagram of production creative enterprises

$$dy/dt = y(B1-B) = y(1-y)(xs2\mu\Delta R-C2) \quad (2)$$

According to the dynamic Eq. 2, let F(y) = dy/dt = 0, we can get possible equilibrium points: y = 0, y = 1 and x_B= C2/(s2μΔR). Because F′(y) = (1-2y)(xs2μΔR-C2), if x_B= C2/ (S2 μ R), then F′ (y) = 0 which means that all points in the Y axis are stable; If x_B# C2/(s2μΔR), we can get two possible equilibrium points: y = 0, y = 1. At this time there are two cases: When $x>x_B$, F′(0)>0, F′(1)<0, so y = 1, that is ESS; when $x<x_B$, F′(0)<0, F′(1)>0, so y = 0, that is ESS.

The following Fig. 2 shows the phase diagram of production sales enterprises' replication dynamic in three cases.

Thus, the two replicator dynamics equation of the system as shown in the following dynamic Eq. 3 and the differential equations describe the group dynamic about the evolution of enterprises' competition and cooperation. The evolution process of the two sides playing game is also described by this differential Eq.:

$$\begin{cases} dx/dt = x(1-x)\,(ys_1\ \mu\ R-C_1) \\ dx/dt = x(1-x)\,(ys_2\ \mu\ R-C_2) \\ y > y_A = C_1/(S_i\mu\Delta R) \end{cases} \quad (3)$$

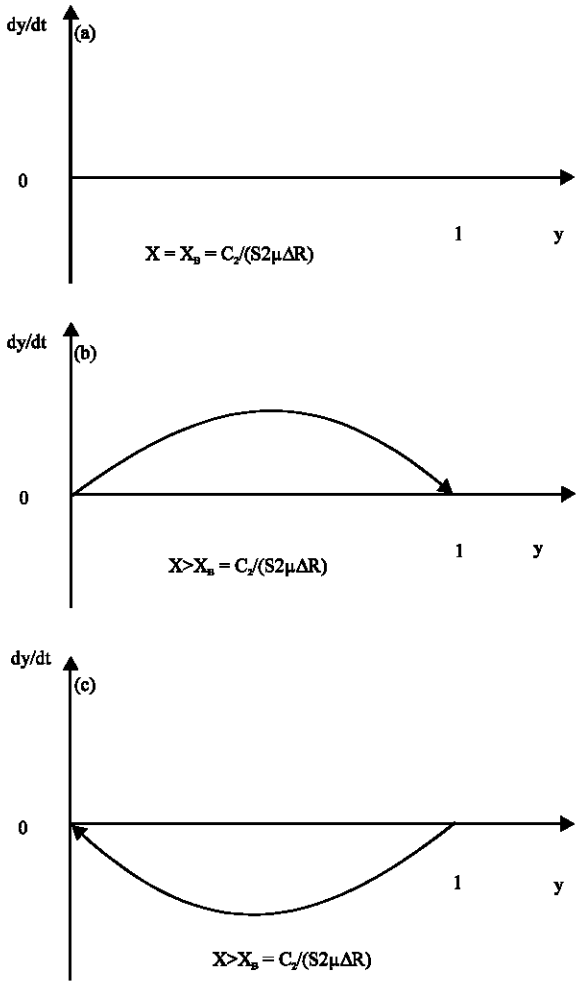

Fig. 2(a-c): Three kinds of phase diagram of sales creative enterprises

We can find the possible equilibrium points (x, y), they are (0,0), (0,1), (1,0), (1,1) and [C2/(s2μΔR), C1/(s1μΔR)]. Then we get the stability of the system equilibrium points through analysis the system of the local stability of the Jacobian determinant: Both (0, 0) and (1,1) are asymptotically stable points; (0,1) and (1, 0) are instability points; [C2/(s2μΔR), C1/(s1μΔR)] is a saddle point. The game plane phase Fig. 3 as follows.

When x>C2/(s2μΔR) and y>C1/(s1μΔR), F (x, y) is in the third region, both sides of the game will choose strategic alliance and the ESS of this game is that x* = 1, y* = 1; When x>C2/(s2μΔR) and y>C1/(s1μΔR), F (x, y) is in the first region, non-alliance is the best choice of the two sides and the ESS of this game is that x* = 0, y* = 0; when x>C2/(s2μΔR) and y>C1/(s1μΔR) [equal toμ<2 C1/(s1μΔR) and μ>2 C2/(s2μΔR)], F (x, y) is in the fourth region, at this time the equilibrium point of this game

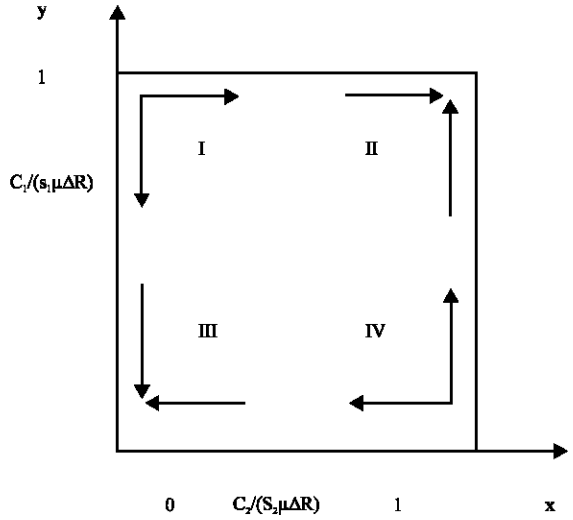

Fig. 3: A plane phrase diagram of the game

depends on the value of μ which denotes the success possibility of gaining extra benefits for alliance. If μ value tends to satisfy C1/(s1μΔR)>1/2 and C2/(s2μΔ)>1/2 equal to μ2 C1/(s1μΔR) and μ<2 C2/(s2μΔR), the game will enter the third area eventually and the ESS of this game is that x* = 1, y* = 1, alliance is the best choice of the two players. If μ value tends to satisfy C1/(s1μΔR)<1/2 and C2/(s2μΔR)<1/2[equal to μ>2 C1/(s1μΔR) and μ>2 C2/(s2μΔR)], the game will enter into the first region and the ESS of this game is that x* = 0, y* = 0, so non-alliance is the best choice of the two sides. Similarly, when x>C2/(s2μΔR) and y>C1/(s1μΔR) [that is equal toμ>2 C1/(s1μΔR) and μ<2 C2/(s2μΔR)], F (x, y) is in the second region, at this time the equilibrium point of this game depends on the value of μ which denotes the success possibility of gaining extra benefits for alliance. If μ value tends to satisfy μ<2 C1/(s1μΔR) and μ<2 C2/(s2μΔR), the game will enter the third area eventually and the ESS of this game is that x* = 1, y* = 1, alliance is the best choice of the two players. If μ value tends to satisfy μ>2 C1/(s1μΔR) and μ>2 C2/(s2μΔR), the game will enter into the first region and the ESS of this game is that x* = 0, y* = 0, so non-alliance is the best choice of the two sides.

CONCLUSION

This study uses evolutionary game theory to analyze the evolutionary process of creative enterprises' competition and cooperation behavior and finds out the factors which affect the process. The results show that there are there factors to influence the strategy selection process of production creative enterprises and sales creative enterprises (1) The extra revenue ΔR for alliance.

The higher the value of ΔR is, the more they are willing to alliance. But due to the input costs and the external environmental factors, the ΔR value should large enough to carry union (2) The probability μ which denotes the possibility of extra benefits that alliance strategy can bring. The higher the μ value is, the larger extra benefits they will get and the more they are willing to alliance. When the μ close to 1, they will get the maximum extra value; (3) The input cost C1 and C 2 for alliance. The less the cost is, the more they are willing to union. These factors are not isolated and they are both opposite and unified. Only if s1 μΔR- C1>0 and s2μΔR- C2 >0, they may choose alliance.

Through the above analysis we can see that, there are several solutions to promote the creative enterprises choosing union strategy. (1) Set up specialized agencies and build a service platform. Specialized agencies and service platform can provide intermediary services such as information, communication, display, trade and design for small groups and individuals with different kinds of creative talents. These creative enterprises can find suitable partners through this platform and contribute to transforming creative achievements into creative products, thus realize the market value of the creative products; (2) Establish a reasonable mechanism for the benefits distribution. We should maximize curb the two parties gaining opportunistic earnings, so creative enterprises can get actual benefits by sharing resources in varying degrees. Make sure that the creative enterprises for alliance that have more adequate resources than not for alliance to meet the needs of consumers, so as to stimulate the enthusiasm of creative enterprises to join strategic alliance. (3) Construct creative industry parks. Some cities of China are emerging several creative industry parks; they put production creative enterprises and sales creative enterprises in the same space and this approach not only reduce the cost of development but also induce the formation of many new combinations in mutual interspersed penetration. (4) The steps of creative enterprises from R and D, design, manufacturing to sales operations constitute a complete market system of creative industries and each step of the process needs professional personnel. At present two kinds of talents lack the most, one is the talents for creating, the other is the talents for making creative ideas industrialization and marketization. If we have a security system of creative talents, our dream will truly realize from "Made in China" to "Created in China".

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