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# Analysis of Knowledge-transfer in the Transition of Sports Goods Enterprises by evolutionary games theory

Chen You-Cheng and Guo Dong-Qiang
College of Business Administration, Huaqiao University, Quanzhou 362021, Fujian, China

**Abstract:** Currently, most sporting goods enterprises are in the adjustment period of transition. It is an inevitable trend for knowledge-transfer between newly created departments and parent departments in the process of transition. It found that there was little research on knowledge-transfer between departments of sporting goods enterprises by literature analysis. This article summarized the main transition types of sporting goods enterprise and studied the strategies between newly created parent departments and parent departments in the transition of sporting goods enterprises in the process of knowledge-transfer by using evolutionary game theory.

**Key words:** Sports goods, transition of enterprises, knowledge-transfer, evolutionary game theory

## INTRODUCTION

China Sporting Goods Industry Association released "China Sporting Goods Industry Developing White Paper (2012)" showed that the sales of domestic sporting goods listed enterprises on sports shoes and sportswear decreased by 29.69 and 19.28% in 2012. High inventory and product innovation recession become the problems of majority sporting goods enterprises. Therefore, transformation is the only way out for sporting goods enterprises. This process involves the introduction and migration of a wealth of knowledge. Therefore, the transformation process of sporting goods enterprises is also the process of knowledge-transfer. Knowledge-transfer processes are the game process between the knowledge-transfer and the transferred.

## RELATED THEORIES

**Knowledge-transfer:** Theoretical basis of knowledge-transfer was information theory of Krone, etc., since Teece has been proposed in (1977). Large numbers of research results studied on influencing factors of knowledge-transfer such as Ai *et al.* (2011). Some scholars studied on the process of knowledge-transfer, such as Yang (2011) and Peng and Zhao (2011). However, these studies mainly focused on the knowledge-transfer process, rules, influencing factors and methods. The influencing factors mainly studied on the borders, culture and processes of external factors on knowledge-transfer, not from the internal of enterprise in depth. There is little research on the transformation period of sporting goods enterprises in knowledge-transfer.

**Definition and classification on the transformation of sporting goods enterprises:** Latest researches on the transformation of enterprises for scholars were mainly from endogenous and exogenous. Endogenous transformation means to enhance the competitiveness of enterprises by constantly digging the potential of old fields or related fields, such as Valerdi and Blackburn (2010) analyzed that working system played an important role in promoting corporate behavior and guiding enterprises transition. Aier and Saat (2011) studied that the process of business planning affects the formation of enterprise architecture in the process of business transition. As Azadegan and Wagner (2011) studied enterprises how to promote upgrading in the international financial crisis.

The transformation of sporting goods enterprises refers to the expected to make important adjustments of the ways of management, marketing, production systems, information technology, human resources and achievement recent years in the face of environmental and industrial changes (changing at least four in five areas within the territory). Sporting goods enterprises take the following transformation strategy in the face of crisis in recent years, including production transformation, marketing transformation, information and techniques transformation and the ways of management transformation. Production transformation mainly refers to the fundamental change in the philosophy and way of business. Sporting goods enterprises adjust production strategies based on market demand so that the original subsidiary business rise to major business or look for new business opportunities. For example, such as sports

**Corresponding Author:** Chen You-Cheng, College of Business Administration, Huaqiao University, Quanzhou, 362021, Fujian, China

brands Peak, Anta, 361 degrees, Xtep started to shrink stores and transformation to the factory stores and clothing stores. Marketing transformation mainly refers to the transition from the traditional market to e-commerce. Anta enterprise clears inventory by the online sales. Major sports brands also made adjustments on sales channels, some companies such as Xtep, Paipai and Taobao, etc., cooperated with some leading e-commerce platform and established their own official website. Information and technique transformation refers to obtain profits and high monopoly by new technology or high-tech. Guohui Group first established the industry's academician workstation, dedicated to improving product technology and actively promoted the IT transformation. Way of management transformation refers to change the management of original backward way and produces management efficiency. For example, Anta made picking system for a change in the order management, used the model of production according to sales, optimized store management and enhanced data analysis capabilities.

The transfer motives of parent sector and learning intentions of newly created department decide to the extent of knowledge-transfer. Van Wijk *et al.* (2008) found that the influence is more prominent on national culture department than the external knowledge for newly created department and parent departments. How to weigh the relationship and choose rational model of knowledge acquisition will affect the transformation of sporting goods enterprises. Evolutionary game focuses on the adjustment process for the behavior of participants and repeated game between various groups. Evolutionary game provides powerful theory analytic tools for the research and treatment of complex systems.

## EVOLUTIONARY GAME MODEL ON THE TRANSFORMATION OF SPORTING GOODS ENTERPRISE KNOWLEDGETRANSFER

**Knowledge-transfer process on the transformation of sporting goods enterprise:** Newly created departments and parent departments will access to knowledge in accordance with the working relations in the sporting goods enterprise and the value of knowledge resources. First, knowledge resources of parent department divide into two categories according to the life cycle of the transfer. The first category is the non-transferability of knowledge. Such knowledge is core or specific knowledge of sporting goods enterprise. It is difficult to transfer and imitate in the short term. The transferring requires a great deal cost and can be considered non-transferable in the life cycle of sporting goods enterprise, such as technical know-how, core competitiveness and public image on the sporting goods enterprises. Objective restricting factors on the transfer of such knowledge is not dependent on the employees themselves, their implicit knowledge, professionalism and complexity as well as the heterogeneity of knowledge structure between newly created departments and parent departments. The second category is transferability of knowledge. Such knowledge refers to basic knowledge of sporting goods enterprises and a part of technical knowledge constituting its core competencies, such as management system and method, technical schedule, technical parameters and market information of sporting goods enterprise. Knowledge-transfer process will not only bring dominant value by absorbing direct knowledge from knowledge-transferee but also bring hidden value to the department. Firstly, we assume that sporting goods company proceeds transferring knowledge in the parent department (A) and newly created division (B). We use, respectively $G_1$, $R_1$and$G_2$, $R_2$ to represent non-transferable knowledge and transferable knowledge of Parent department (A) and newly created division (B). Learning ability coefficients of A, B, respectively represent with $\alpha(0<\alpha\leq 1)$ and $\beta(0<\beta\leq 1)$. $W_1$ and $W_2$ mean the implicit value generated by knowledge-transfer. Knowledge-transfer process of sporting goods enterprise can be expressed in Fig. 1.

Knowledge-transfer is bidirectional. Parent department (A) and newly created division (B) carry on multi-round knowledge-transfer in the sporting goods

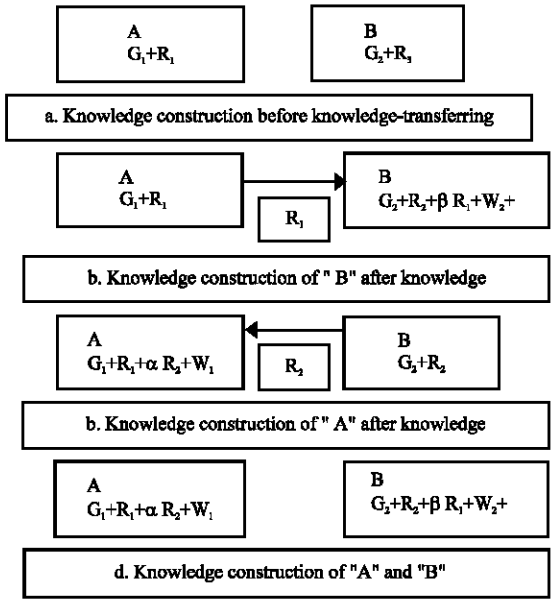


Fig. 1: Knowledge-transfer process on the transformation of sporting goods enterprise

enterprise. In order to analyze for convenience, it will be split into two processes, which are process A to B and process B to A.

First, it transfers knowledge from department A to department B. On the one hand, department B absorb resource value$_{\alpha R1}$from knowledge-transfer of department A. On the other hand, knowledge-transfer of department A generates tacit value $W_2$, as shown b in Fig. 1. Secondly, it transfers knowledge from department A to department B. On the one hand, department A absorb resource value$_{\alpha R2}$ from knowledge-transfer of department B. On the other hand, knowledge-transfer of department B generates tacit value $W_1$, as shown c in Fig. 1. Again, after knowledge-transfer of two departments complete, constituting knowledge value of all branches is as shown d in Fig. 1. Obviously, after such a simple knowledge-transfer, the value of sector A and B has been increased compared to prior knowledge-transfer and achieve value-added the transfer of Knowledge resource.

The above results are obtained under ideal conditions. That is, knowledge-transfer within the sporting goods enterprise will not only gain income but also cause losses by knowledge spillovers (C1, C2) and loss of market share (L1, L2), such as the knowledge loss caused by the loss of main business.

**Game Model for Knowledge-Transfer of Sporting Goods enterprise in transition:** This article will consider sporting goods enterprise in the sector as a decision-making body. Every department can choose whether to transfer or not and form strategic set of decision-making body. Assuming internal departments of sporting goods enterprises are rational, the aim to carry out knowledge-transfer is to choose an ultimate strategy which will bring them the greatest revenue. We choose two departments of the game. Every department chooses whether to transfer or not from two opposing strategies, so there will be four strategies combinations. In addition to taking the non-transferability of knowledge (G1, G2) and transferability of knowledge (R1, R2) of sector A and B into account in the life cycle of sporting goods enterprise, we also consider tacit knowledge (W1, W2) generated by departmental operations as well as negative side effects from transferee due to knowledge. Gaining matrix can be obtained at this time, as shown in Table 1.

When two sides take strong knowledge-transfer strategy, gains of two sides sector were $G_1+R_1\alpha R_2+W_1-C_1-L_1$ and $G_2+R_2+\beta R_1+W_2-C_2-L_2$ When sector B take strong knowledge-transfer strategy on the assumption of full market, sector A remains the gains of $G_1+R_1+W_1$. Similarly, when sector A take strong knowledge-transfer strategy, sector B still get the required knowledge and the gains of $G_2+R_2+W_2$.

We assume that the probability is x for sector A to choose strong knowledge-transfer, the probability is y for sector B to choose strong knowledge-transfer. Based on the above assumptions, we can get the expected utility of sector A from strong knowledge-transfer:

$$f_A^1 = y(G_1 + R_1 + \alpha R_2 + W_1 - C_1 - L_1) + (1-y)(G_1 + R_1 - C_1 - L_1) = G_1 + R_1 - C_1 - L_1 + y\alpha R_2 + yW_1 \quad (1)$$

Expected utility of sector A from weak knowledge-transfer is:

$$f_A^2 = y(G_1 + R_1 + W_1) + (1-y)(G_1 + R_1) = G_1 + R_1 + yW_1 \quad (2)$$

The average expected utility of sector A is:

$$\overline{f_A} = xf_A^1 + (1-x)f_A^2 = x(G_1 + R_1 - C_1 - L_1 + y\alpha R_2 + yW_1) + (1-x)(G_1 + R_1 + yW_1) = xy\alpha R_2 + yW_1 + G_1 + R_1 - xC_1 - xL_1 \quad (3)$$

Then replicated dynamics equation of sector A from knowledge-transfer is:

$$f_A(x) = \frac{dx}{dt} = x(f_A^1 - \overline{f_A}) = x(G_1 + R_1 - C_1 - L_1 + y\alpha R_2 + yW_1 - xy\alpha R_2 - yW_1 - G_1 - R_1 + xC_1 + xL_1) = x(1-x)(y\alpha R_2 - C_1 - L_1) \quad (4)$$

Similarly, expected utility of sector B from strong knowledge-transfer is:

$$f_B(y) = \frac{dy}{dt} = y(f_B^1 - \overline{f_B}) = y(1-y)(x\beta R_1 - C_2 - L_2) \quad (5)$$

The two-dimensional nonlinear dynamical system can be drawn from the (4), (5) which is formed by both transfer sides:

Thus we can obtain four equilibrium points:

$$\begin{cases} \frac{dx}{dt} = x(1-x)(y\alpha R_2 - C_1 - L_1) \\ \frac{dy}{dt} = y(1-y)(x\beta R_1 - C_2 - L_2) \end{cases} \quad (6)$$

Table 1: Game payoffs matrix of knowledge-transfer within the sector of sports goods enterprise

| | | Sector B | |
|---|---|---|---|
| Strategy 2 | Strategy 1 | Strong knowledge-transfer (y) | Weak knowledge-transfer (1-y) |
| | Weak knowledge-transfer (1-x) | $G_1+R_1+W_1$, $G_2+R_2-C_2-L_2$ | $G_1+R_1$, $G_2+R_2$ |

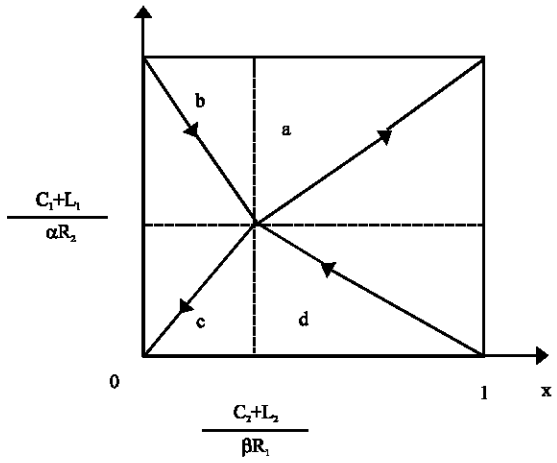


Fig. 2: Evolutionary game tracks of two sectors

$$E_1(0,0), E_2(1,0), E_3(0,1), E_4(1,1)$$

From the dynamics system described by the differential equations, we know that local stability of Jacobian can get its stability of equilibrium points. Therefore, we get two equilibrium points of evolutionary stable strategy.

In this asymmetric replication game, when the initial state falls in the area of region, that is the beginning of the game, both of more than:

$$\frac{C_2 + L_2}{\beta R_1}$$

of sector A and more than:

$$\frac{C_1 + L_1}{\alpha R_2}$$

of sector B choose the policy of strong knowledge-transfer. And then the game evolves into stable strategy x = 1 and y = 1, i.e., strong knowledge-transfer is an inevitable choice for both groups. When the initial state falls in the area of b or d, the final equilibrium state depends on adjusting speed of both sides in the game. When the initial state falls into the area of c, then weak knowledge-transfer is an inevitable choice for two groups.

## CONCLUSIONS AND IMPLICATIONS

Based on the basic principle of evolutionary game theory, this article analyzes the game trajectory of knowledge-transfer between newly created department and parent department. It can give the following revelation:

- The initial status of system will affect knowledge-transfer of sporting goods enterprise and related with the payoff matrix of game parties. At present, many domestic sporting goods enterprise don't pay attention to assess the revenues and costs of knowledge-transfer when they try to explore market and establish new department. It is worth to raising the attention of sporting goods enterprise
- The essence of consumer surplus is the value given by sporting goods enterprise by means of lowering prices. The development of sports goods enterprises must take the welfare of consumers as the center, increase consumer surplus and reduce consumer perceived cost of the goods, thereby increase customer satisfaction
- At present, the investment of science and technology is far below the international renowned brands in China. It is easy to reduce the efficiency of knowledge-transfer. Sporting goods enterprise should enhance its technology patents after the economic crisis and upgrade into the higher of value chain, such as the field of brand design, the research of core technology and sales channels

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