Knowledge Sharing Research of Auto Parts Industry’s Supply Chain Based on Evolutionary Game Theory

YunFu Huo¹, MoSong Cheng¹, Bo Lu¹,²,³ a*, ShuYun Pang¹, XiaoBo Gu³ and Xiaolin Song¹

¹ College of Economy and Management, Dalian University, Dalian, China, 116622
² School of Management, Chinese Academy of Sciences, Beijing, China, 100190
³ College of City and Environment, Jiangsu Normal University, Xuzhou, China, 221116

a Email: lubo_documents@hotmail.com

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Abstract. This paper establishes an evolutionary game model of knowledge sharing in auto parts industry’s supply-chain by applying the replicated dynamic equation. In knowledge economy era, with the development of enterprise, the role of knowledge is becoming more and more important. As a result, enterprises gradually realized that knowledge has become an important resource of earnings. For the supply chain in enterprise, it has become a kind of widespread consensus that the whole supply chain competitiveness is more important than a single enterprise's competitiveness. The application of evolutionary game theory produces the stable strategy of enterprise’s knowledge sharing that the improvement of supply chain’s competitiveness requires the auto parts enterprises to form better knowledge sharing environment by strengthening its ability of absorption and transformation, reducing the cost of knowledge sharing, enhancing the synergy by cooperation and completing the mechanism of rewards and punishments.

Introduction

At the beginning of China’s traditional auto parts industry’s development, the enterprises’ mainly unitary attached to the complete vehicle corporations, lack of product innovation and industrial upgrade. The most efficient way to solve China’s auto parts corporations’ problem of rough management, insufficient production capacity and no systematic process management [1] is to strengthen the using of knowledge which includes professional skilled knowledge, business management experience, system solutions etc. However, the knowledge between supply chain members may cause the enterprises’ benefits, risk and trust.

Currently, many scholars have been carried out relevant research in supply chain’s knowledge sharing. Chai Guo-rongetc thinksthe initial knowledge sharing and knowledge creation’s income among cluster firms has great influence on cluster’s whole knowledge sharing environment. [2]Tan Zheng-da operates the evolutionary game model get the key factor of the effectiveness to knowledge sharing was industrial cluster’s environment, corporations’ absorption and transformation and knowledge’s diversity etc. [3] Feng Chang-li applies the evolutionary game model got the analysis result that reducing sharing cost, improving knowledge sharing ability,
perfecting supervision and management mechanism can actively promote the knowledge sharing in corporations’ supply chain. [4]

**Supply chain’s knowledge sharing model based on evolutionary game theory**

The evolutionary stable strategy means game players’ behaviors can finally form a balance through constantly changing and studying. This strategy has certain stability that the system can self-recover after relevant influence.[5]

**Variable hypothesis.** On the base of auto parts industry’s features, this paper sets the following variables to establish the evolutionary game model: $K_i$: the corporation’s knowledge sharing quantity, $\lambda_i$: knowledge’s absorption and transformation ability, $C_i$: the cost of knowledge sharing, $R_i$: the risk of knowledge sharing, $T_i$: rewards and punishment coefficient, $\alpha$: $\alpha>1$, coordination coefficient

**Evolutionary game model.** By taking rewards or punishment measures to the corporations active participate in knowledge sharing or not, we can get the following corporation’s income matrix of knowledge sharing:

<table>
<thead>
<tr>
<th>A</th>
<th>Knowledge Sharing</th>
<th>No Knowledge Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B</strong></td>
<td>Probability: $y$</td>
<td>Probability: $1-y$</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>$\alpha \lambda A K_B - C_A + T_1 + \pi_1$</td>
<td>$\pi_1 - C_A - R_A$</td>
</tr>
<tr>
<td>Probability: $x$</td>
<td>$\alpha \lambda B K_A - C_B + T_1 + \pi_2$</td>
<td>$\lambda B K_A - T_2 + \pi_2$</td>
</tr>
<tr>
<td>No Knowledge Sharing</td>
<td>$\lambda A K_B + \pi_1 - T_2$</td>
<td>$\pi_1$</td>
</tr>
<tr>
<td>Probability: $1-x$</td>
<td>$\pi_2 - C_B - R_B$</td>
<td>$\pi_2$</td>
</tr>
</tbody>
</table>

The replicated dynamic equation of corporation A:

$$F(x) = \frac{dx}{dt} = x(\pi A_1 - \pi A) = x(1-x)[y(\alpha - 1) \lambda A K_B + (T_1 + T_2) + R_A] - (C_A + R_A)](2)$$

While $F(x)=0$, $x_1=1, x_2=0$. $y = \frac{C_A + R_A}{(\alpha - 1) \lambda A K_B + (T_1 + T_2) + R_A}$.

The stable point of evolutionary game stable strategy needs certain stability besides $F(x)=0$ that while $x>x_1 (i=1,2)$, $F(x)<0$ and while $x<x_1$, $F(x)>0$, which also meanwhile $F(x)=x_1$, $F'(x_1)<0$.

$$F'(x)=(1-2x)[y(\alpha - 1) \lambda A K_B + (T_1 + T_2) + R_A] - (C_A + R_A)](3)$$

If $x_1=1$ is the stable strategy, then $F'(x_1)<0$, while $y > \frac{C_A + R_A}{(\alpha - 1) \lambda A K_B + (T_1 + T_2) + R_A}$.

If $x_2=0$ is the stable strategy, then $F'(x_2)<0$, while $y < \frac{C_A + R_A}{(\alpha - 1) \lambda A K_B + (T_1 + T_2) + R_A}$.

$x$ shows the corporations’ knowledge sharing probability. So to get better cluster’s knowledge sharing result, $x=1$ should be the evolutionary stable strategy.

This image based on the analysis above.

$L_1$ is $y=\frac{y^*}{x_*}x + 1$, ($x \in (0, x^*)$) $L_2$ is $y=\frac{y^*}{x_*}(x - 1)$, ($x \in (x^*, 1)$)

For the points on the area A compared with the point of the straight line $L_1$, we can get $y > y^*$ (The same situation in area $C$ $x > x^*$). For area B, we also can get $x > x^*$, $y > y^*$ obviously. At
this point, the knowledge sharing must become evolutionary game stable strategy. Therefore, A, B, C area proportion is the probability of a supply chain knowledge sharing.

![Evolutionary game model of knowledge sharing](image)

**Figure.1 Evolutionary game model of knowledge sharing**

**Solutions**

As analysis model above, to make more corporations in supply chain to participate in knowledge sharing, $x^*$ and $y^*$ need to be minimum by reducing $(CA+RA)$ or improving $\alpha$, $\lambda_A$, $K_A$. Corporation A and Corporation B has symmetry, so this paper only analysis Corporation A.

Solution A: based on reducing the value of $(CA+RA)$.

Reducing sharing cost C. The corporations need to overcome territory restriction by using information technology, building virtual classroom, applying video phone to realize its cross-regional virtual industrial cluster and reduce the knowledge communication and sharing cost.

Reducing sharing risk R by enhancing rewards and punishment. The auto parts industry needs one certain industrial association or governmental supervision sectors to strengthen the punishment to unhealthy behaviors.

Solution B: based on improving the value of $\alpha$, $\lambda_A$, $K_A$

Improving corporations’ knowledge quantity. Auto parts corporations need to establish their own knowledge base and make the externalization of tacit knowledge by accumulating clients’ management experience and setting emergency solutions etc. Feng think knowledge’s hidden degree and sharing’s effects are negative correlation.[6]

Improving the ability of absorption and transformation. China’s auto parts industry should improving employee’s professional skills and foreign language skills. Zhangthink member corporations can absorption high-level relevant knowledge [7]. But Cheungthink cultural difference do not has great influence to member corporation’s knowledge sharing tendency. [8]

Strengthen cooperation by improving $\alpha$’s value. Cheng think member corporations should cooperate closely to improve the effects of knowledge sharing [9]. Ajmaletc think the trust between cooperation members has great value to the tacit knowledge sharing [10].

**Conclusions**

This paper establishes an evolutionary game model of knowledge sharing in auto parts industry’s supply-chain by applying the replicated dynamic equation. Based on the analysis above, we think the auto parts industry supply chain should establish knowledge base, communicate actively, pay
more attention to talent strategic project, apply modern information technology more efficient and set certain industrial association to strengthen knowledge sharing.

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**References**


