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Game analysis of knowledge integration perspective of manufacturing and logistics industry collaborative development

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ABSTRACT

This paper in view of the coordinated development of the organization's limited rationality, opportunism and the uncertainty of external environment factors, such as game analysis method is used to study the coordination mechanism and income distribution mechanism, to improve the stability of the alliance and effectiveness.

KEYWORDS

Manufacturing; Logistics industry; Collaborative development; Game theory.

INTRODUCTION

With the development of economic globalization and information technology, the increasingly fierce competition between enterprises, to be in the fierce competition, we must improve the organization's overall innovation ability to learn and learning ability of innovation by organizational communication, knowledge transfer and sharing, which provides possible for the collaborative development of organization. Drucker once said, "The knowledge has become the most important resources, rather than the fact that general resources are the unique feature of the new society"[1]. Thus, knowledge is important for the organizational growth and development. The organizations in the collaborative development process, particularly the role of knowledge integration.

Knowledge integration is by Grant formally proposed in 1996, he believes that "the first role and nature of the firm's corporate capabilities, is the integration of knowledge."[2]. Chinese scholars Lu Ruoyu and Chen LI believe that "knowledge integration is the enterprise to reorganize its internal knowledge, devoid of useless knowledge, and the enterprise employees and the organization of knowledge in the organic combined, make it has strong flexibility, orderly, systematic, when it is necessary to reconstruct the original knowledge system, and thus forms the enterprise new core knowledge system"[3]. So, based on the perspective of knowledge integration to analyze the coordinated development of manufacturing and logistics industry has a certain theoretical significance. Collaborative development can make more optimal allocation of resources; enhance the core competitiveness of the organization. However, due to the effect of various factors, existing in the development of collaborative cooperation risk and unstable situation.

Plenty of practical investigation and research, found that collaborative unstable or collapse as high as 70%[4,5]. Therefore, this article will use the game analysis method to study the mechanism of coordination in the process of collaborative and income distribution mechanism, to enhance the stability of the synergy and effectiveness.

MANUFACTURING AND LOGISTICS SYNERGY AND COMPETITION GAME ANALYSIS

In order to better analysis of cooperation and competition between enterprises behavior influence on their own, in this paper d ✓ Aspermont two-stage duopoly game model on the basis of the introduction of a third party, extended to three stages game model, the comparative analysis in the development of enterprise cooperation decision-making, competition, R&D and other factors on the enterprise product and the influence of corporate profits.

Model building

In order to verify the necessity of the coordinated development of manufacturing and logistics industry, this article assumes that the market has the same (similar) products in the three companies competing with each other. In order to in an impregnable position in the fierce market, three companies either through technical cooperation to reduce the cost, also can through their own research and development to reduce costs. In this paper, three-stage game model is used to analyze the competition and cooperation between the three companies. The first stage is the level of R & D investment enterprises based on cooperation. The second stage is the level of business investment in R & D decisions. The third stage is to choose the product output for the enterprise according to their needs.

First, assume that the demand curve for each enterprise faces is $Q = k - p$, the q for the product price, is constant, so the demand curve for all enterprises is $p = k - Q$, and $Q = q_1 + q_2 + q_3$, the subscript 1, 2, 3 on behalf of the three different companies.

$$p = k - q_1 - q_2 - q_3 \quad \textbf{(1)}$$

Second, assumption enterprises 1 and 2 in the second stage of research and development cooperation, in cooperation on the basis of joint R&D and sharing research results. Enterprises 3 development alone or not do not perform R & D. Three companies by production cost per unit of product research and development function is,

$$\begin{cases} c_1 = c_1^0 - x_1 - ax_2 - bx_3 \\ c_2 = c_2^0 - x_2 - ax_1 - bx_3 \\ c_3 = c_3^0 - x_3 - ax_1 - bx_2 \end{cases} \quad \textbf{(2)}$$

Where x_n (n =1, 2, 3) is enterprise 1, 2, 3, unit production costs decline, after the R & D investment. c_n^0 >0(n =1, 2, 3)is the unit cost for the enterprise1, 2, 3 in front of cooperation. $a \in [0, 1]$ for knowledge diffusion coefficient of cooperation, said the degree of knowledge transfer and sharing of cooperation between members. $b \in [0, 1]$ for knowledge diffusion coefficient of non-cooperation, said the degree of knowledge transfer and sharing of non-cooperation between members. And $a > b$.

Assuming resources of enterprise n (n =1, 2, 3) into research and development is T (x_n), these inputs will decrease production of the product unit cost. Therefore the assumption is

$$T(x_n)=\frac{1}{2}t\ x_n^2 \text{ (n=1, 2, 3)} \quad \textbf{(3)}$$

The profit function for enterprise n is

$$\pi_n=(\mathrm{p}-\mathrm{c}_n)\mathrm{q}_n-T(\mathrm{X}_n) \text{ (n=1, 2, 3)} \quad \textbf{(4)}$$

Model solution

To ensure that all stages of the sub-game perfect Nash equilibrium, the paper uses the reverse solution solved.

The third stage: enterprise product competition

At this stage, companies seek to maximize their own interests to choose the most appropriate output production. Enable output to maximize their profits must meet the following criteria:

$$\frac{\partial \pi_n}{\partial q_n}=0 \text{ (n=1, 2, 3)} \quad \textbf{(5)}$$

It follows corporate equilibrium output is:

$$\begin{cases} q_1^*=\dfrac{k+c_3+c_2-3c_1}{4} \\ q_2^*=\dfrac{k+c_3+c_1-3c_2}{4} \\ q_3^*=\dfrac{k+3c_3+c_1+c_2}{4} \end{cases} \quad \textbf{(6)}$$

The second stage: R& D investment and the degree of cooperation

Assuming enterprise 1 and 2 in the second stage of research and development cooperation, joint investment and sharing of research and development results. The enterprise 3 is development alone or no research and development. Corporate profits derived from the equation (3)(4)(6)

$$\begin{cases} \pi_1^*=\left(\dfrac{k+c_3+c_2-3c_1}{4}\right)^2-\dfrac{t}{2}x_1^2 \\ \pi_2^*=\left(\dfrac{k+c_3+c_1-3c_2}{4}\right)^2-\dfrac{t}{2}x_2^2 \\ \pi_3^*=\left(\dfrac{k+3c_3+c_1+c_2}{4}\right)^2-\dfrac{t}{2}x_3^2 \end{cases} \quad \textbf{(7)}$$

In order to maximize the benefits of cooperation, the optimal R & D investment must meet the conditions for

$$\begin{cases} \dfrac{\partial(\pi_1+\pi_2)}{\partial x_1}=\dfrac{\partial(\pi_1+\pi_2)}{\partial x_2}=0 \\ \dfrac{\partial \pi_3}{\partial x_3}=0 \end{cases} \quad \textbf{(8)}$$

The equations (2) (6) (7) into (8), we can obtain the following equations

$$\begin{cases} \frac{1}{2}(3-b-a)q_1+\frac{1}{2}(3a-b-1)q_2-tx_1=0 \\ \frac{1}{2}(3-b-a)q_2+\frac{1}{2}(3a-b-1)q_1-tx_2=0 \\ \frac{1}{2}(-3-2b)q_3-tx_3=0 \end{cases} \quad (9)$$

Calculate the optimal investment for R & D:

$$\begin{cases} x_1^*=\frac{1}{2t}(3-b-a)q_1^*+\frac{1}{2t}(3b-a-1)q_2^* \\ x_2^*=\frac{1}{2t}(3-b-a)q_2^*+\frac{1}{2t}(3b-a-1)q_1^* \\ x_3^*=-\frac{1}{2t}(3+2b)q_3^* \end{cases} \quad (10)$$

By equation (10), we can conclude that the derivative of its optimal equilibrium output of each enterprise R & D investment:

$$\frac{\partial q_1^*}{\partial x_1^*}=\frac{2t}{3-a-b}>0,\ \frac{\partial q_2^*}{\partial x_2^*}=\frac{2t}{3-a-b}>0,\ \frac{\partial q_3^*}{\partial x_3^*}=\frac{2t}{-3-2b}<0$$

Therefore, we can conclude that, for the coordination of the enterprises, to increase R & D investment will increase their output. For collaboration outside of the enterprise, investment in research and development alone but will reduce the output of the enterprise. So collaboration between enterprises can maximize business benefits, achieve win-win results. In view of the logistics industry independent research and development ability is weak and the current situation of logistics industry logistics cost is high, the cooperation in research and development can make up for the inadequacy of their own, to promote the coordinated development of both better.

The (2) into (6) and a derivative, can be obtained,

$$\begin{cases} \frac{\partial(q_1^*+q_2^*)}{\partial a}=\frac{1}{2}(x_1+x_2) \\ \frac{\partial q_3^*}{\partial a}=-\frac{1}{4}(x_1+x_2) \end{cases} \quad (11)$$

Because $x_1+x_2>0$, So $\frac{\partial(q_1^*+q_2^*)}{\partial a}>0, \frac{\partial q_3^*}{\partial a}<0$.

From this we can conclude that, for cooperation in the enterprise, the higher the degree of collaborative development process of knowledge transfer and sharing of their products on the market share, the more able to provide a competitive advantage. As for cooperation outside of the enterprise, the advantages of cooperation will become competitors restricting its development disadvantage.

The first stage: enterprise investment decision making

Assume that at this stage companies competing with each other, no cooperation. There is only one Shared coefficient of θ among enterprises. The three companies to research and development production cost per unit of product function to:

$$\begin{cases} c_1^{\wedge}=c_1^0-x_1-\theta x_2-\theta x_3 \\ c_2^{\wedge}=c_2^0-x_2-\theta x_1-\theta x_3 \\ c_3^{\wedge}=c_3^0-x_3-\theta x_1-\theta x_2 \end{cases} \quad (12)$$

$$\begin{cases} q_1^{\wedge} = \dfrac{\theta + c_3 + c_2 - 3c_1}{4} \\ q_2^{\wedge} = \dfrac{\theta + c_3 + c_1 - 3c_2}{4} \\ q_3^{\wedge} = \dfrac{\theta + 3c_3 + c_1 + c_2}{4} \end{cases} \quad (13)$$

The equation (12) into (13), the derivative of θ yields:

$$\frac{\partial\left(q_1^{\wedge} + q_2^{\wedge}\right)}{\partial\theta} = x_3 \quad (14)$$

Comparison of equations (11) and (14), we can see:

When $x_3 > \frac{1}{2}\left(x_1 + x_2\right)$, $\frac{\partial\left(q_1^{\wedge} + q_2^{\wedge}\right)}{\partial\theta} > \frac{\partial\left(q_1^{*} + q_2^{*}\right)}{\partial a} > 0$;

And when $x_3 < \frac{1}{2}\left(x_1 + x_2\right)$, $\frac{\partial\left(q_1^{*} + q_2^{*}\right)}{\partial a} > \frac{\partial\left(q_1^{\wedge} + q_2^{\wedge}\right)}{\partial\theta} > 0$.

Therefore, we conclude that, when the market is higher than the competitor's R & D investment earnings when corporate R & D cooperation in investment income, in order to obtain the maximum benefit, companies will choose non-cooperative strategy. But if the market in corporate R & D investment income is less than cooperative in corporate R & D investment earnings, companies will choose cooperation strategies.

From the above analysis we can draw the following conclusions:

First, take the cooperation between enterprises to increase their R & D investment will increase its output. Collaborative development of manufacturing and logistics industry on the one hand can make up for weak self-developed logistics shortcomings; on the other hand, can reduce the cost of the logistics industry.

Second, the enterprise cooperation can increase the degree of knowledge transfer and sharing. The coordinated development of manufacturing and logistics information can make the two complement each other, sharing, achieve a win-win result.

Third, cooperation between enterprises, can obtain relative to the case of no cooperative enterprise competitive advantage. The coordinated development of manufacturing and logistics industry can improve their own competitiveness, in the fierce market environment for the survival and development.

THE GAME ANALYSIS OF THE COORDINATED DEVELOPMENT OF ENTERPRISE INCOME DISTRIBUTION

The purpose of the cooperation between enterprises is the ability to get on its own cannot obtain benefits. So must properly deal with the income distribution issues of cooperation, otherwise the enterprise will collapse, in cooperation or retaliation. Common income distribution has the following three ways. One is a fixed pattern. That business has agreed to cooperate in good before their distribution of benefits; a revenue sharing model. That is, in proportion to the agreed corporate earnings obtained from the respective section, revenue sharing, risk sharing; a mixed mode. That cooperation enterprises, both can get a portion of a fixed income, you can also benefit from the profits in proportion to the.

Model building

Assume that there are two enterprises in the market, manufacturing enterprises a and logistics b. Manufacturing companies a for cooperation initiative party logistics companies b to cooperate responder. Game Model is divided into two phases, the first of the two sides to determine the uniform distribution coefficient; the second stage in the context of unified distribution coefficients were both efforts to determine their own level. In this model, the distribution of benefits of the hybrid, the logistics enterprises responder b in the cooperation will not only get a portion of a fixed income, you can also benefit from the profits in proportion to the.

Assuming that two companies cost function is:

$$C_k = c_k e_{k,}(k = a, b) \quad (15)$$

Where c_k indicates that the corresponding cost factor, e_k represents real cooperative efforts of enterprises in the process of cooperation made. Assuming the cost function is an increasing function of the level of effort, that $C'(e_k) > 0$ and $C_k''(e_k) > 0$, $k = a,b$. Assuming the net output of the joint venture,

$$R_T = \sum_{k=a}^{b} R_k(r_k e_k), (k = a,b) \quad \textbf{(16)}$$

Where R_T represents corporate cooperation earnings obtained after subtracting the cost of the remaining dominant. r_k represents manufacturers and logistics companies' contribution to the efforts of partner organizations, by the size and the relative importance of their core technical capabilities of cooperative research and development organization of the decision. Enterprises can increase the level of effort to increase revenue; therefore, $R_T = \sum_{k=a}^{b} R_k(r_k e_k)$ is strictly monotonically increasing function, is that $R_T'(e_k) > 0$, $k = a,b$. Manufacturing and logistics industry cooperation is to achieve complementary advantages, improve the competitive ability, therefore this article think the effort will not have negative effects on net output R_T, is that $R_T''(e_k) = 0$, $k = a,b$. Assuming that two companies profit function is as follows:

$$\begin{cases} \prod_T = R_T - C_a - C_b \\ \prod_a = wR_a - R_0 - C_a \\ \prod_b = (1-w)R_b + R_0 - C_b \end{cases} \quad \textbf{(17)}$$

The w is interest distribution coefficient, R_0 is fixed fee of manufacturing enterprise a to logistics enterprise b. In order to further analysis, this article assumes that:

$$R_T = R_a + R_b = r_a e_a + r_b e_b \quad \textbf{(18)}$$

$$C_k = \frac{1}{2}(c_k e_k)^2, \; k = a,b \quad \textbf{(19)}$$

The (18), (19) into (17) can be obtained:

$$\begin{cases} \prod_T = r_a e_a + r_b e_b - \frac{1}{2}(c_a e_a)^2 - \frac{1}{2}(c_b e_b)^2 \\ \prod_a = w r_a e_a - R_0 - \frac{1}{2}(c_a e_a)^2 \\ \prod_b = (1-w) r_b e_b + R_0 - \frac{1}{2}(c_b e_b)^2 \end{cases} \quad \textbf{(20)}$$

Model solution

To ensure that all stages of the sub-game perfect Nash equilibrium, we use the inverse solution to solve.

Second stage: the unified under the premise of both distribution coefficients were determined effort own level.

At this stage, manufacturing companies and logistics companies to maximize their own interests and select the appropriate conditions for production and cooperation. Interest distribution coefficient w have identified in the first phase, so at this stage as a constant. Make the enterprise profit maximization effort level must meet the following conditions:

$$\begin{cases} \dfrac{\partial \prod_a}{\partial e_a} = wr_a - c_a^2 e_a = 0 \\ \dfrac{\partial \prod_b}{\partial e_b} = (1-\mathrm{w})\,\mathrm{r}_b - c_b^2 e_b = 0 \end{cases} \tag{21}$$

$$\begin{cases} e_a^* = wr_a \Big/ c_a^2 \\ e_b^* = (1-\mathrm{w})\,\mathrm{r}_b \Big/ c_b^2 \end{cases} \tag{22}$$

And then to their respective distribution coefficient derivative, it is concluded that:

$$\begin{cases} \dfrac{\partial e_a^*}{\partial w} = \dfrac{r_a}{c_a^2} > 0 \\ \dfrac{\partial e_b^*}{\partial (1-W)} = \dfrac{(1-w) r_b}{c_b^2} > 0 \end{cases} \tag{23}$$

From this we can see that each enterprise the effort level and their respective distribution coefficient proportional relationship. That the distribution of income in cooperation, the more the greater the degree of effort enterprise, and vice versa.

For the coordinated development of the whole, every enterprise to equilibrium conditions for the level of:

$$\begin{cases} \dfrac{\partial \prod_T}{\partial e_a} = r_a - c_a^2 e_a = 0 \\ \dfrac{\partial \prod_T}{\partial e_b} = r_b - c_b^2 e_b = 0 \end{cases} \tag{24}$$

Solving drawn:

$$\begin{cases} e_a^T = r_a \Big/ c_a^2 \\ e_b^T = r_b \Big/ c_b^2 \end{cases} \tag{25}$$

Comparison of equations (22) and (25), concluded that cooperation in various enterprises in pursuit of profit maximization and the effort level is below the required maximum effort level overall revenue, namely $\begin{cases} e_a^T > e_a^* \\ e_b^T > e_b^* \end{cases}$, Ultimately makes the overall revenue can not be optimal. In other words, enterprises seeking to maximize returns, sometimes only consider their own earnings, while ignoring the interests of the whole, so the cooperation between enterprises can only get suboptimal solution, which is the essence of competitive cooperation. Therefore, in order to prevent acts of enterprises only consider their own interests would hinder the achievement of the overall objectives of the organization, some suitable incentives or disincentives still necessary, the only way to achieve win-win, to lay a better foundation for future cooperation.

The first stage: to determine the optimal allocation coefficient

Has been out in front of the cooperation of each enterprise in the optimal effort level, and then seeks the optimal partition coefficient w^*.

The (22) into (20), get in various enterprises, under the optimal effort level of the organization's overall revenue $\prod_T = \frac{wr_a^2}{c_a^2} - \frac{w^2 r_a^2}{2c_a^2} + \frac{r_b^2}{2c_b^2} - \frac{w^2 r_b^2}{2c_b^2}$. The optimal distribution coefficient w^* should satisfy the following conditions:

$$\frac{\partial \prod_T}{\partial w} = \frac{r_a^2}{c_a^2} - \frac{wr_a^2}{c_a^2} - \frac{wr_b^2}{c_b^2} = 0 \quad \textbf{(26)}$$

The optimal distribution coefficient w^* is obtained $w^* = \frac{r_a^2 c_b^2}{r_a^2 c_b^2 - r_b^2 c_a^2}$.

By the analysis of the above, we can draw the following conclusion:

First of all, the cooperation of enterprises, with core technology advantage, benefit sharing is higher than that of the other party. Advantage of manufacturing in terms of research and development production was obviously higher than that of the logistics industry, so the income is also higher. And logistics industry in the aspects of warehousing, transportation costs are significantly lower than the manufacturing sector, has certain advantages, so in this respect, the benefits of the logistics industry should be higher.

Second, the enterprise in order to make the cooperation more harmonious get along, to avoid the lack of core technology advantages of enterprises in a passive position, the enterprise should agree on income distribution at the beginning of the cooperation, for cooperation in the enterprise did not trouble back at home, your own contributions to the optimal effort level.

Finally, as a result of the existence of opportunism and limited reason, so at the beginning of the cooperation agree on income distribution problem, which can ensure cooperation have certain efficiency, and maintain the stability of the cooperation between enterprises.

CONCLUSIONS

Game theory analysis method in this article, from the coordinated development of synergy and competition as well as the income distribution in two aspects to study the coordinated development of manufacturing and logistics industry, it is concluded that the coordinated development of manufacturing and logistics industry can achieve a win-win result, improve their competitive advantage, in the fierce market environment for the survival and development; Companies at the beginning of the cooperation agree on income distribution problems, can guarantee the efficiency of cooperation, and maintain the stability of the cooperation between enterprises.

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