

Research on the Optimal Pricing of Enterprise Logistics Transportation Network based on Game Theory

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Abstract: With the rapid development of China's economy. Logistics transportation has become the main way, which requires enterprises to establish their own logistics network. However, how to maximize the benefits is the goal of any enterprise, which requires the enterprise to establish the optimal logistics price. Game theory is a kind of behavior description of game between two sides, which is a tool of mathematical programming model to make the price of two sides. The optimal pricing of logistics transportation network based on game theory is a very scientific method, which needs a theoretical method based on scientific charging. Firstly, this paper analyzes the current situation of logistics transportation network. Then, this paper analyzes the game model of logistics transportation network optimal pricing. Finally, some suggestions are put forward.

1. Introduction

In the logistics transportation network, enterprises will develop a variety of transportation networks, which will improve their supply efficiency. However, with the selection of the fastest solution, multiple logistics carriers will choose the same route, which will increase the traffic volume between the two points. Therefore, the running cost time will be longer, which will lead to the decline of road service quality. By improving the efficiency of the whole logistics transportation network, enterprises must manage the traffic demand in the logistics transportation network. However, the price mechanism will become one of the important constraints of traffic demand management, which requires the optimal pricing of transportation network cost. Through closed-loop supply chain management, enterprises will achieve the comprehensive benefits of "economy and environment", which will help the sustainable development of enterprises. Through the closed-loop supply chain, enterprises will improve the efficiency of their logistics transportation network and reduce costs, which has become the inevitable trend of the future development of the supply chain.

2. The Importance of Game Theory

Game theory can formulate the pricing problem of logistics transportation network from a mathematical perspective, which plays a very important role, as shown in Figure 1.

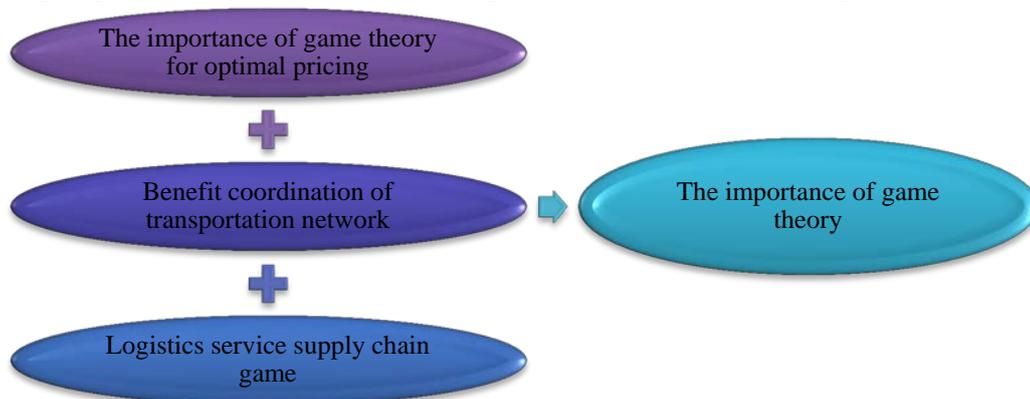


Figure 1: The importance of game theory

2.1 The importance of game theory for optimal pricing

The game theory method is a systematic mathematical model method, which will make the pricing of logistics transportation network from the mathematical point of view. Through the optimal scheme, we can achieve the optimal pricing of multi market transportation links, which will improve the efficiency of transportation network and reduce the cost of enterprises. Through the game theory, we take the upper and lower levels of the whole supply chain as the two sides of the game, which will determine the optimal pricing scheme according to our own optimal choice. Through the game theory, we can make the optimal pricing scheme of the upper and lower supply chain.

2.2 Benefit coordination of transportation network

From the perspective of supply chain management, we can find that different modes of transportation form the transportation network of an enterprise, which requires the formulation of intermodal benefit coordination. Intermodal collaboration can be divided into five stages, including spatial aggregation stage, integrated logistics service stage, logistics service supply chain stage, strategic alliance stage and joint-stock company stage, all of which will encounter pricing game problems.

2.3 Logistics service supply chain game

In five stages, we need the coordination of the whole supply chain. However, these research ideas are basically the same. First, enterprises need to build the main components of the intermodal system in this stage. Through the characteristic analysis, the enterprise can build the pricing game model of each stage, which will get the optimal pricing strategy of each subject. Second, according to the optimal pricing strategy, enterprises can formulate pricing mechanism, contract coordination mechanism, alliance revenue calculation, distribution scheme, etc., as shown in Figure 2.

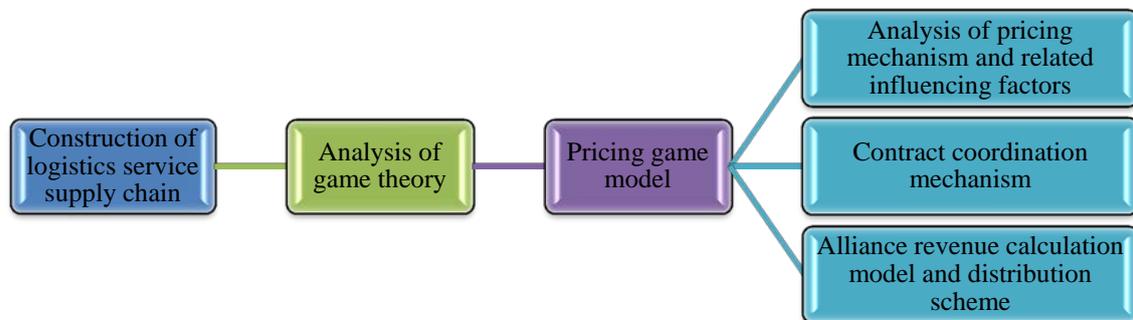


Figure 2: Logistics service supply chain game

3. Optimal Pricing of Logistics Transportation Network based on Game Theory

3.1 Game model under centralized decision (C)

Manufacturers and retailers jointly decide the wholesale price and retail price, which will maximize the total profit of the system. Through the formation of strategic alliance between manufacturers and retailers, enterprises will achieve a win-win goal, which is inseparable from information sharing, cooperation and coordination. At this time, in order to maximize the total profit of the supply chain system, we only need to maximize the total profit.

Therefore, we get the first-order conditional model, as shown in formula 1.1.

$$\pi = \alpha(p_r - C_m - C_r)p_r^{-\beta} \quad 1.1$$

By $\frac{\partial \pi}{\partial p_r} = 0$, we can get the formula 1.2 and 1.3.

$$p_r = \frac{\beta(c_m + c_r)}{\beta - 1} \quad 1.2$$

$$Q = \alpha(c_m + c_r)^{-\beta} \left(\frac{\beta}{\beta - 1}\right)^{-\beta} \quad 1.3$$

So, the calculation formula of total profit is as follows 1.4.

$$\pi = \frac{\alpha}{(\beta - 1)(c_m + c_r)^{\beta - 1}} \left(\frac{\beta}{\beta - 1}\right)^{-\beta} \quad 1.4$$

3.2 Game model under decentralized decision (D)

Under the decentralized decision-making mode, all levels of the supply chain take the maximization of their own revenue as their own goal, which will be their final decision. Therefore, through Stackelberg game model, we can describe and make decision-making process. This time, the enterprise transportation network is divided into two ways. This paper only analyzes the optimal pricing of highway transportation and railway transportation.

Under decentralized decision, the profit function of an enterprise is shown in formula 2.1.

$$\pi_m^D(p, z) = (p - w_r - w_t)(a - bp) - (w_r + w_t)z - e \int_z [1 - F(x)] dx \quad 2.1$$

The profit function of public and railway transport enterprises is formula 2.2 and formula 2.3 respectively.

$$\pi_r^D(w_r) = (w_r - c_r)(a - bp + z) \quad 2.2$$

$$\pi_t^D(w_t) = (w_t - c_t)(a - bp + z) \quad 2.3$$

By using the reverse induction method, we can determine the agreement freight rate Q and the market freight rate P with the maximum expected value of revenue function. By solving the corresponding P, Z values, we can get the optimal decision under the given agreement freight rate, such as formula 2.4, 2.5 and 2.6.

$$p^D(w_t, w_r) = \frac{a + b(w_r + w_t)}{2b} \quad 2.4$$

$$q^D(w_t, w_r) = \frac{a - b(w_r + w_t)}{2} + z^D \quad 2.5$$

$$z^D(w_t, w_r) = F^{-1}\left[\frac{e^{-(w_r + w_t)}}{e}\right] \quad 2.6$$

According to formula 2.4, 2.5 and 2.6, we can determine the market freight rate and the agreed freight volume. Therefore, in the first stage, the problems of public and railway transportation enterprises are solved separately. We can get the W value corresponding to $\max \pi_r^D(w_r)$ and $\max \pi_t^D(w_t)$, as shown in formula 2.7.

$$\max \pi_i^D(w_i) = (w_i - c_i) \left[\frac{a - bw_i}{2} + z^D \right], \quad i \in \{r, t\} \quad 2.7$$

Through the above model, we can get the following theorems. Under the decentralized decision-making mode and centralized decision-making mode, the supply chain of road and railway intermodal logistics service will meet the following relationships, including market freight rate, agreed freight volume and total profit of the supply chain.

$$p^{D*} > p^{c*}, q^{D*} > q^{c*}, \pi^{D*} < \pi^{c*}$$

Conclusions

In the competitive market economy, enterprise logistics has become an important part of improving customer service, which needs to integrate a variety of modern technologies, such as big data mining technology, Internet of things technology, remote monitoring technology and so on. Modern logistics has the advantages of intelligence, information, real-time, visualization and specialization. Enterprises need to fight for the right to operate, which needs to reduce the overall freight rate. Therefore, when optimizing the pricing of logistics transportation network, enterprises can consider alliance, which will reduce the unilateral pressure and profit distribution. By strengthening the strategic planning of modern logistics, enterprises can give full play to the advantages of the shortest transportation channel, which will strengthen their own capacity reform. Therefore, enterprises need to establish a strong logistics system, which will improve the anti risk ability. By constantly seeking new profit growth points, enterprises will establish multi-modal logistics services.

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