Analysis of competition and cooperation strategy of railway inland port and seaport

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August 2016
Word count: 4912 + 2 Tables *250+6Figures*250= 6912 **words**

Submission for presentation at the 96th Annual Meeting of the Transportation Research Board and Journal of the Transportation Research Board

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ABSTRACT

Recently, China government has constructed a number of inland ports to narrow the economic development gap between coastal developed areas and inland area. The function of inland port is similar to seaport; especially to those inland ports possess an international express railway could transport cargoes by freight train directly from inland region to abroad. Given that, there is a new decision problem urgent to solving for urban policy maker and related enterprises: what is the optimal strategy (competition /cooperation) for the inland port and seaport? In this sense, we aim to construct a competition-cooperation model to support the port operators and local government to make decisions on strategy level. First, with consider of multidimensional decision, a government-port double layer model is developed. Then, several propositions are proposed and analyzed based on the model solutions. In the real case study part, Chengdu railway inland port and Shenzhen seaport are chosen as the research objects, the economic impact on various decision strategies for port operators and local government are measured through a numerical analysis. The research results give out the cooperation strategy to both of the ports and local governments, as well as indicate that although sometimes the cooperation strategy may not supported by port operator, the choice of government cooperation is still beneficial to strength the port's service level and increase total profit.

KEYWORDS: inland port; cooperation-competition analysis; game theory; railway freight

INTRODUCTION

Background

Economic globalization highlights the significance of building a highly efficient, stable and multi-mode global transportation system. With the development of global economy, the international trades of hinterland region are increasing rapidly, more and more countries begin to construct the international railway stations in inland region, to enhance the logistics basic facility of inland region*(1-2)*. The design and set of such kind of international railway station is capable to open the direct logistics tunnel from abroad and inland region, play an important strategy role for country and region development. Given that, the international railway stations in inland region has also been seem as inland port in general. It is obvious the setting of inland port can promote regional logistics occurrence quantity and absorption quantity through convenient customs clearance of international logistics, effective convergence of various transport modes, the improvement of transportation level and the increases of the efficiency of the logistics, which thus increasing the inland economic level, geographical advantages, as well as reducing carbon emissions. Since the 90s of the last century, China has begun to establish the inland ports gradually. Until today, China has programmed nearly 50 inland ports, across almost all inland provinces and autonomous region, the local government of inland port also make full use of the geographical advantage of inland port through building logistics system of the hinterland, offering preferential policies and macro-control factors to support the development of inland ports to achieve the maximization of their own interests.

In China, the rapid development of inland ports has resulted in fierce competition between inland ports and seaports for the customer of the common radiation range, some develop into vicious competition. Disorderly competition between the inland ports and the seaports would led to waste of resources, which will affect the long-term development of the whole region economic. For the balance between inland ports and seaports, some specific methods should be taken. On one hand, local governments and the port operators need to improve competitiveness through efficient operation management, On the other hand, whether building strategic alliances with other local governments or ports to achieve the maximization of their interest should also be taken into account. In general, the current researches are still vague on relations between inland ports and seaports. Therefore, it is necessary to make an intensive study of the co-operation relationships between the inland ports and the seaports, which provide decision reference for port operators and local government to make port development strategy and improve management and operation of the port.

Literature review

Existing research for inland port mainly focus on the definition, function and location strategy of inland port and the impact on the environment of inland port settings. There are certain researches on the co-operation strategies among the seaport groups, which are mainly on qualitative analysis, but few of quantitative model research. Meanwhile, the existing research on seaport groups focus only on the strategy of port operators but ignored the effects of governments, In particular, there is no in-depth research on the co-operative strategies between inland ports and seaports.

The term "inland port" has many aliases, such as land port, anhydrous port and dry port. In 1992, the concept of dry port was first put forward by the United States container association, which was defined as an inland container transfer station far from the port. Along with the development of modern logistics, the definition and the functions of dry port have also occurred corresponding changes *(3-6)*. Particularly, the inland port in this paper refers to the port which transports cargo to the seaports in other counter directly by railway, such as Chengdu railway port, as shown in Figure 1.

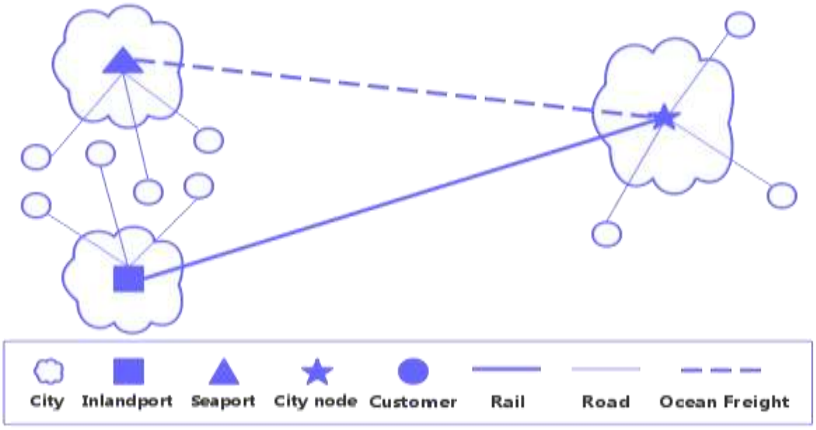


Figure1 Inland port transport model

In China, most of the inland ports are constructed and operated by the government. To improve the level of local economy, the government will offer subsidies to support the inland ports according to its actual operation situation. So at the beginning of the operation, inland port will reduce the price of services to attract supply of goods. For some research, the study on internal competition of the seaport group has be taken for many years aboard. Comparatively, we fails to find out the domestic and foreign research on the competitive pricing strategy between inland ports and seaports. The existing research on the co-operation strategies between the seaports mainly focus on qualitative analysis*(3-6)*.And few of research are on quantitative research, which analyze the relationship between the price and quality of port service mainly through the game theory. Game theory is study on decision-making body who in the face of certain environmental conditions, one or more times, simultaneously or successively, from to allow a series of behavior and strategy selection and implementation, each made corresponding results to explore the balance problem of the decision and its conclusion character synthetic economic reality, has extensive application and strong guidance on policy decision. Verhoeff*(14)* is the first to analyze the competitive relationship between ports by game theory, which lays the foundation for the further study of the game competition among ports*(15-19)*.In recent years, Anderson*(20)* analyzed the competition between Busan port and Shanghai port under the framework of the two-person game model. Qiu and Lu*(21)* have established the static and dynamic game model for the port competition respectively, and use the cases of Dalian port and Yingkou port to test the model results. Kaselimi*(22)* has built a two oligopoly game model of Hotelling demand structure based on customer choice, Which has analyzed the impact of the emergence of the terminal on the competition of the port group system. Other studies on the co-operation strategy among ports are based on statistics*(23)*, utility theory and multinomial Logit model*(24)*。

The goal of this paper is to contribute to filling this gap that research on the co-operation strategy on inland porrt and seaport, comprehensively considering of the multidimensional decision making of local government and port operators, and using dynamic game theory to analyze the strategy of competition between inland port , seaport and government. The remainder of the article is organized as follows. Section 2 introduces the model, and section 3 solves the model and describes some proposition. Section 4 make a numerical study for the model. Section 5 concludes this study.

BASIC MODEL

In this paper, the model structure is consisting of a simple double-layer model regional system of an inland port, a seaport and the government of the two ports. The local government of the city in the first layer can determine the regional logistics system especially the port's investment base on competition or cooperation strategy, which determines the service level of the port or inland port. The operators of the seaport and the inland port in the second layer choose the appropriate service price strategy to maximize their own interests. Figure 2 depicts the above model. $i, j \in \{1, 2\}, i \neq j$

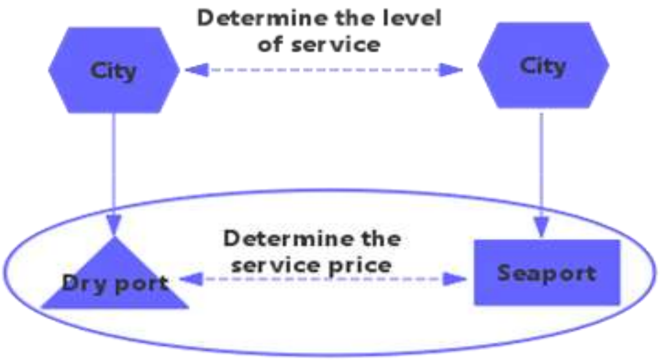


FIGURE 2 Basic model

Decision variables are defined as follows:

s_i represent the service level of the port which belongs to city i, Referring to the decision-making variables of the city government ,including Punctuality shipment and delivery, cargo transit time, rate of damage, settlement procedures, which related to the software and hardware facilities of the operation of the port and determined by the government's investment in logistics system.

p_{is} represents the service price of port i, which determined by the port operator.

We describe the needs of each port by means of a utility function. The customer's utility function is as followed:

$$U_i = \sigma_i(s_i - s_j) - (p_i - p_j), i, j \in \{1, 2\}, i \neq j \qquad (1)$$

σ_i represents the degree of customer preference to the port i , and related to the information transparency, the degree of green low carbon and the previous cooperation etc. p_i represents the sum of all the expenses of the customer. Assume that $i = 1$ represent the inland port, $i = 2$ represent the seaport.

For the seaport, the total cost is

$$p_2 = p_{2s} + p_{2d} \qquad (2)$$

While for the inland port, the total cost is

$$p_1 = p_{1s} + p_{1d} + p_{1t} + p_{1z} \qquad (3)$$

Among them, $p_{id} = \omega * d_i^2$ represent the transport costs for the cargos to the ports, ω and d represent the basic rates of cargos transport to the port and the distance between the customer and the port respectively.

The utility function possess these following properties: the utility of the customer to select the port i positively correlated with the port service level s_i and the price p_j , and is negatively correlated with the port service level s_j and the price p_i 。We reasonably assume that σ is subject to a uniform distribution from 0 to 1.

Respectively drawn by $U_1 > 0$ and $U_1 - U_2 \geq 0$, $U_2 > 0$ and $U_1 - U_2 \leq 0$, we can know:

$$\phi_1 = \phi_1 \left\{ \sigma \geq \frac{p_1 - p_2}{s_1 - s_2} \right\} = 1 - \frac{p_1 - p_2}{s_1 - s_2} \quad (4)$$

$$\phi_2 = \phi_2 \left\{ \sigma \leq \frac{p_1 - p_2}{s_1 - s_2} \right\} = \frac{p_1 - p_2}{s_1 - s_2} \quad (5)$$

Among them, ϕ_i represents the customer demand ratio for the port i. This function possess the following characteristics: the demand of inland port is positively related to the service level itself and the service price of the seaport, and is negatively correlated with the price itself and the level of the service of the seaport.

In the first model layer, the settings of inland port could promote regional logistics occurrence quantity and absorption quantity, and further promote economic development and regional advantages of inland areas, bringing the dominant and recessive income to the local government, including taxes, employment and retail. Therefore, the city government's profits function was defined as:

$$\Pi_i^G = \beta_i * \phi_i * D - x_i\left(s_i\right) = \beta_i * \phi_i * D - \delta_i s_i^2 \quad (6)$$

In which D represents the basic freight volume of the market. β_i represents the benefits of the port's unit of demand bring for the city i, while x_i is on behalf of the government investment costs to raise the service level in port i. According to the theory of Marginal Decline, it's assumed that the cost of investment is the quadratic function of service level, which means with the increase of the port service level, the cost of the marginal investment in the city is getting higher and higher. We use superscript "G" to represent the local government of the city.

In the second layer of the model, the objective for port operator is to select the appropriate service price to maximize its own profit. The port's profit function was defined as:

$$\Pi_i^P = p_{is} * \varphi_i - c_i = (p_{is} - v_i) * \varphi_i * D - f_i \quad (7)$$

In which c_i represents the operating cost of the port, mainly composed of fixed cost f_i and variable costs v_i. We assume superscript"P" represent the port operators.

This paper has built utility functions to solve the demand function of the port, and establish the profit function of the city government and the port. Based on the above basic model, it is to respectively explore the two situations, which are the port government and the port operators bare both inclined to compete or the city government choose s cooperation while port operators tends to compete. When the government or port operator each determine the level of service or service price, they should not only consider their own basic strength, but also take the competitive price and service level of the opponent into account, while decisions should also be ought to be adjusted continually as the dynamic change in the needs of the market and competitors' strategies. Therefore, in order to better simulate the basic model of the above decision-making process, sequential decision are defined as follows: firstly, the city government of the inland port and seaport decides the service level of the port, and then two port operators decide the service prices of the port.

SOLVING MODEL

Basing on the competition-competition two-stage dynamic game model under complete information, we can adopt reverse-deduction method, namely to seek out the equilibrium solution of the port operators' service prices in the second stage firstly, and then analyze the equilibrium solution of the port's service level in the first stage .

In the second stage of the game, the service level s_1 and s_2 of the inland port and the seaport has been determined, and at this time to determine the optimal price p_{1s}, p_2 of the inland ports and the seaports. According to the first order condition $\frac{\partial \Pi_1^P}{\partial p_{1s}} = 0$, $\frac{\partial \Pi_2^P}{\partial p_{2s}} = 0$ we can know that the equilibrium price of services of the inland port and the seaport are:

$$p_{1s}^* = \frac{1}{3}\left(2s_1 - 2s_2 - p_{1d} + p_{2d} + 2v_1 + v_2 - p_{1t} - p_{1z}\right) \qquad (8)$$

$$p_{2s}^* = \frac{1}{3}\left(s_1 - s_2 + p_{1d} - p_{2d} + v_1 + 2v_2 + p_{1t} + p_{1z}\right) \qquad (9)$$

At this point, it has obtained the port equilibrium price function with given service level of two ports, next we will further deduce the equilibrium solution of port service level under different government strategies. The respective profits of the two city governments and the total profit of the two city governments were defined as follow:

$$\Pi_1^G = \beta_1 D - \frac{\beta_1 D(s_1 - s_2 + T)}{3(s_1 - s_2)} - \delta_1 s_1^2 \qquad (10)$$

$$\Pi_1^G = \frac{\beta_2 D(s_1 - s_2 + T)}{3(s_1 - s_2)} - \delta_2 s_2^2 \qquad (11)$$

$$\Pi_{1+2}^G = \frac{(\beta_1 - \beta_2) D(s_1 - s_2 + T)}{3(s_1 - s_2)} - \delta_1 s_1^2 - \delta_2 s_2^2 \qquad (12)$$

In the formula, $T = p_{1d} + p_{2d} + v_1 - v_2 + p_{1t} + p_{1z}$.

Now, enter the first stage of the game, the government of the two cities has expected the optimal service price of two ports, and will set their respective level of investment in accordance with the expected price, which determines the level of service in the port. We use subscript "N" and "C" to represent the competitive and cooperative strategy respectively.

(1) The government choose to competitive strategy

According to the first order condition $\frac{\partial \Pi_1^G}{\partial s_1} = 0$, $\frac{\partial \Pi_2^G}{\partial s_2} = 0$, it can be concluded that the equilibrium service level s s_{N1}^*, s_{N2}^* of the inland ports and the seaports in this stage are:

$$s_{N1}^* = \sqrt[3]{\frac{\delta_2^2 \beta_1^3 DT}{6\delta_1(\delta_1\beta_2 - \delta_2\beta_1)^2}} \qquad (13)$$

$$s_{N2}^* = \sqrt[3]{\frac{\delta_1^2 \beta_2^3 DT}{6\delta_2(\delta_1\beta_2 - \delta_2\beta_1)^2}} \qquad (14)$$

(2) The government choose to cooperative strategy

According to the first order condition $\frac{\partial \Pi_{1+2}^{G}}{\partial s_1} = 0, \frac{\partial \Pi_{1+2}^{G}}{\partial s_2} = 0$, it can be concluded that the equilibrium service level s_{C1}^{*}, s_{C2}^{*} of the inland port and the seaport are:

$$s_{C1}^{*} = \sqrt[3]{\frac{(\beta_1 - \beta_2)\ \delta_2^2 DT}{6\delta_1(\delta_1 + \delta_2)^2}} \quad (15)$$

$$s_{C2}^{*} = \sqrt[3]{\frac{(\beta_2 - \beta_1)\ \delta_1^2 DT}{6\delta_2(\delta_1 + \delta_2)^2}} \quad (16)$$

By analyzing the equation (13), (14), (15) and (16) above, we get the following proposition.

Proposition 1. When the local governments choose to competitive strategy, the equilibrium service level between the inland port and the seaport are mutually-promoting. When the governments choose the cooperative strategy, the equilibrium service level between the inland port and seaport are negatively related.

Proposition 1 indicates when the governments choose to competitive strategy , the inland port will enhance its service level to attract more customer as well as preventing the decline of profits while the seaport deciding to gain the competitive advantage by raising its service level. While in the government cooperative strategy, when the seaport improves its service levels, the inland port may reduce its services level. In this way, the inland port and seaport can reduce investment cost under the precondition of not losing the overall profit and will obtain the overall interests of maximum.

Put $s_{N1}^{*}\ s_{N2}^{*}$、 $s_{C1}^{*}\ s_{C2}^{*}$ into（8） and（9） respectively, it can obtain the table 1.

TABLE 1 Price list of port equilibrium services under different government strategy

	$S = "C"$	$S = "N"$
p_{1s}^{*}	$p_{C1s}^{*} = \frac{1}{3}\left(2\sqrt[3]{\frac{(\beta_1 - \beta_2)(\delta_1 + \delta_2)}{6\delta_1\delta_2}DT} + Q\right)$	$p_{N1s}^{*} = \frac{1}{3}\left(2\sqrt[3]{\frac{(\beta_1\delta_2 - \delta_1\beta_2)}{6\delta_1\delta_2}DT} + Q\right)$
p_{2s}^{*}	$p_{C2s}^{*} = \frac{1}{3}\left(\sqrt[3]{\frac{(\beta_1 - \beta_2)(\delta_1 + \delta_2)}{6\delta_1\delta_2}DT} + R\right)$	$p_{N2s}^{*} = \frac{1}{3}\left(\sqrt[3]{\frac{(\beta_1\delta_2 - \delta_1\beta_2)}{6\delta_1\delta_2}DT} + R\right)$

Among them, $Q = p_{2d} - p_{1d} + 2v_1 + v_2 - p_{1t} - p_{1z}$、 $R = p_{1d} - p_{2d} + v_1 + 2v_2 + p_{1t} + p_{1z}$.

By analyzing Table 1, we obtain the following proposition.

Proposition 2. only if $\beta_1^3(\delta_1 + \delta_2)^2 \le (\delta_1\beta_2 - \beta_1\delta_2)^2(\beta_1 - \beta_2) \le \beta_2^3(\delta_1 + \delta_2)^2$ the governments choose to cooperative strategy can promote the service level of two ports at the same time; while as long as $\beta_1\delta_1 \le \delta_2\beta_2$,it will raise the service price of two ports.

Proposition 2 indicated that local governments choose cooperative strategy to some extent is similar to oligopoly, governments and port operators can get high monopoly profits to support the long-term operation of the port. Local governments in the choice of cooperation will not necessarily improve the service level of the two ports meanwhile. They may choose to improve the service level of inland port (seaport) while reducing service level of seaport (inland port) for maximum profits; while only if $\beta_1\delta_1 \le \delta_2\beta_2$, it will encourage the port operators to raise the service price to make monopoly profits.

Proposition 3. When governments choose cooperative strategy, the rising of inland port’s service level will raising service price, while seaport is the opposite; When governments choose to competition strategy, the service level of the seaport will have a direct impact on the equilibrium service price of the inland port, but having the positive or negative impact depends on the size of β δ .

Proposition 3 indicated that even if governments choose cooperative strategy, if local government improves the service level of the seaport (inland port), the inland port (seaport) will choose to reduce the price of services for reducing the loss of profit. While local governments choose competitive strategy, if the local government has improved the services level of seaport through investment under $\beta_2\delta_1 \le \delta_2\beta_1$, the inland port may choose to rise in price rather than cut down to maximize its' own interests.

Proposition 4. We focus on the analysis of the impact of p_{1t} p_{1z} on service level, service price, and demand of the inland port.

1. When governments choose to cooperative strategy, the improvement of p_{1t} p_{1z} can raise the service levels of inland port, but which is the opposite when choose to competitive strategy; what's more, when $(\beta_1 - \beta_2)(\delta_1\beta_2 - \beta_1\delta_2)^2 \le \beta_1^3(\delta_1 + \delta_2)^2$ the service levels under the circumstances of competition are more sensitive to the improvement of p_{1t} p_{1z}.

2. When p_{1t} p_{1z} go up, inland port operators may not reduce the service price of inland port. When governments choose to cooperative or competitive strategy, only if $\frac{2}{3}(DKT)^{\frac{2}{3}} DK - 1 \le 0$ or $\frac{2}{3}(DK_1T)^{\frac{2}{3}} DK_1 - 1 \le 0$, the rise in p_{1t} p_{1z} would lead to the reduction of service price by inland port operators.

In the formula, $K = \frac{(\beta_1 - \beta_2)(\delta_1 + \delta_2)}{6\delta_1\delta_2}$ $K_1 = \frac{(\delta_2\beta_1 - \delta_1\beta_2)}{6\delta_1\delta_2}$

3. When p_{1t} p_{1z} go up, the customer demand for inland port operators will not necessarily reduce. When local governments choose to cooperative strategy, only if $T \le \frac{1}{6}(R - Q)$, the rise of p_{1t} p_{1z} will increase the demand for inland port;

Proposition 4 indicated that the rise of p_{1t} p_{1z} will increase the loss of customer demand for inland port, then at this point, local government would like to attract more customers by improving the service level of the port. Only when p_{1t} p_{1z} rising to a "critical point", the inland port operators will reduce its service price. In conclusion, the rise of p_{1t} p_{1z} will have a certain impact on the port operators within the inland port and seaport, but only when p_{1t} p_{1z} increase more obviously will the inland port operators take measures to consolidate their profit.

NUMERICAL STUDY

From the above analysis, the equilibrium solution of the dynamic game on the service level and service price between inland port and seaport are acquired. This section take Chengdu Railway Port and Shenzhen seaport as the research objects. Chengdu railway port officially put into operation in 2010 and now has gradually become China's leading inland port. Chengdu railway port has open railway freight with Shanghai port, Lianyungang port, Tianjin port, Qingdao port and other ports. The opening of Chengdu-Europe express freight train, which spanning a total length of nearly 10000 kilometers, the line began in Chengdu, through Kazakhstan, Russia, Belarus and in Lodz end, realize that the southwest China can directly transport goods to Europe by railway. The shipping time reduce greatly compared with ocean shipping, so the Chengdu railway port has become a convenient channel for China's foreign trade.

We can separately obtain the equilibrium service level, service price and profit value among the competition and cooperation between the government and the port operators by setting the reasonable parameters values of the model. And then to further discuss the following issues:

(1) The influence of the parameter T on the service level and the service price of the port under local government's competitive and cooperative strategy

(2) The influence of the parameter T on the profit of the local governments and the port operators under the government's competitive and cooperative strategy.

In the process of solving the utility function, we have assumed $s_1 > s_2$, while ϕ_1 ϕ_2 represent the customer demand for the proportion of the ports, so it need to meet:

$$s_{C1}^{*}-s_{C2}^{*} = \sqrt[3]{\frac{(\beta_1-\beta_2)(\delta_1+\delta_2)}{6\delta_1\delta_2}DT} > 0 \quad (17)$$

$$s_{N1}^{*}-s_{N2}^{*} = \sqrt[3]{\frac{(\beta_1\delta_2-\delta_1\beta_2)}{6\delta_1\delta_2}DT} > 0 \quad (18)$$

$$\phi_1 = 1-\frac{p_1-p_2}{s_1-s_2} \in [0,1] \quad (19)$$

$$\phi_2 = \frac{p_1-p_2}{s_1-s_2} \in [0,1] \quad (20)$$

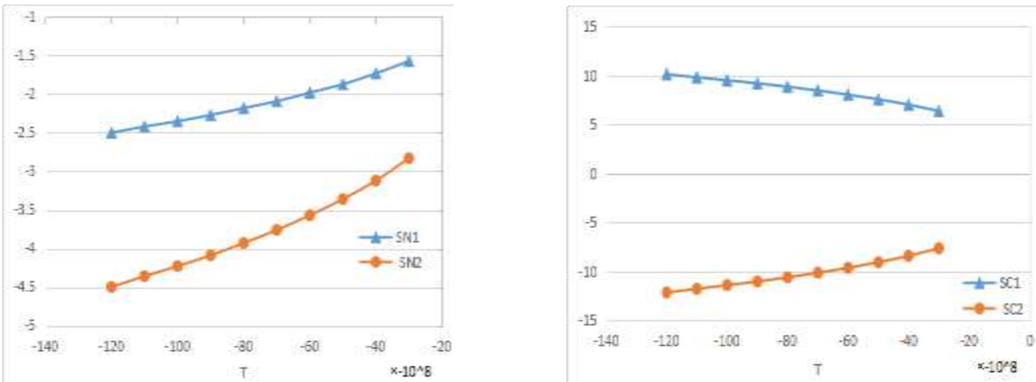
That means it need to meet the inequations $\beta_1 < \beta_2, \beta_1\delta_2 < \beta_2\delta_1$ and $s_1 - s_2 < T < 0$

Taking Chengdu Railway Port $(i=1)$ and Shenzhen seaport $(j=2)$ as the research objects, Specific parameters of the model are set as shown in Table 2.

TABLE 2 Model parameters setting

Parameter	parameter values
The basic freight volume of the market (D)	30×10^{6} *TEU*
Profit coefficient of local government relating to Chengdu railway port's unit demand (β_1)	300$ / TEU
Profit coefficient of local government relating to Shenzhen seaport's unit demand (β_2)	280$ / TEU
The investment cost coefficient of local government on Chengdu railway port service level (δ_1)	1×10^{-6} / $
The investment cost coefficient of local government on Shenzhen seaport service level (δ_2)	1.5×10^{-6} / $
Fixed operating cost of Chengdu railway port (f_1)	$2\times10^{7}$$
Fixed operating cost of Shenzhen seaport (f_2)	$2\times10^{7}$$
Variable operating costs of Chengdu railway port (v_1)	$4.0\times10^{-6}$$ / TEU
Variable operating costs of Shenzhen seaport (v_2)	$5.0\times10^{-6}$$ / TEU

As mentioned before, we deigned a parameter T to stand for the difference of the costs between inland ports and seaports. After measuring the relationship of T and the service level, price of each strategy carefully, the numerical results are shown in figure 3-6.



(a) Competition Strategy (b)Cooperation Strategy

FIGURE 3 The effect of T on service level s_i

As it shown in Figure 3(a), with the increasing of T, s^*_{N1}, s^*_{N2} are increasing accordingly, reveals that when local government choose competitive strategy, in order to compete for more sources of supply, the two local government will both increase investment to improve the service level of the inland port and seaport. In figure 3(b), with the increasing of T, s^*_{C2} is also increasing, s^*_{C1} is decrease, it indicates the ports are tend to provide homogenization service when choose the cooperation strategy.

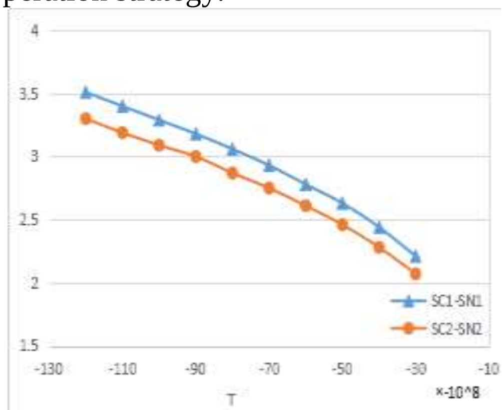


FIGURE 4 The effect of T on the difference of service level

Figure 4 shows the difference of service level of two ports, the rates are decreasing by increasing of T, reveals that the service of two ports will turn to the same level regardless what kind of strategy is chosen.

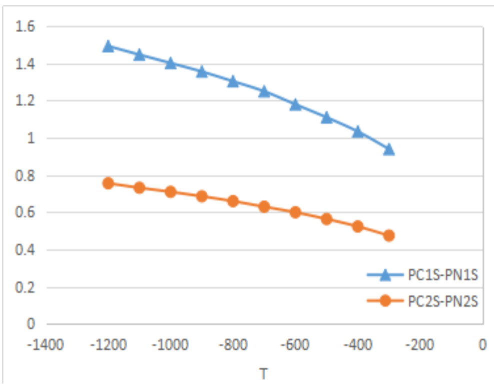


FIGURE 5 The effect of T on service price p_{is}

Figure 5 shows the price decreasing by increase of T **,** compare with the choice of competition for local government, the choice of cooperation may increase the level of services and services price at the same time. However, it is required to meet certain conditions ($\beta_2^3\left(\delta_1+\delta_2\right)^2 \leq \left(\beta_1-\beta_2\right)\left(\delta_1\beta_2-\beta_1\delta_2\right)^2 \leq \beta_2^3\left(\delta_1+\delta_2\right)^2$).

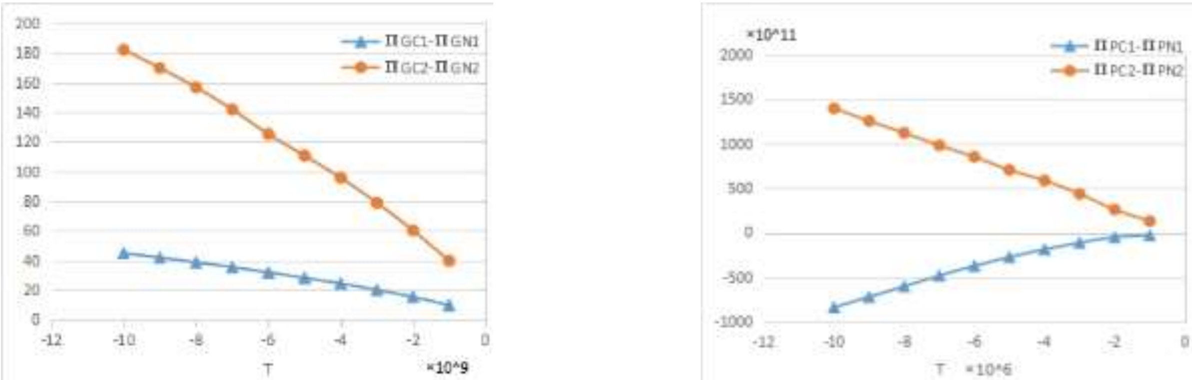


FIGURE 6 The effect of T on profits of local governments and port operators

As it shown in Figure 6, the left chart depicts the profits change with T for local governments, yet the right chart depicts the impact of T on ports operator. It is obvious that the local governments of Chengdu railway port and the seaport get more profits from the cooperation model than the competition model (the curve in the figure is greater than 0)and when T is reduced, it means p_{1d} , p_{1t}, p_{1z} decrease or p_{2d} increases, would increase the profits margin of local government between competitive and cooperative strategy. Furthermore, it can be find out $\Pi_{C1}^G - \Pi_{N1}^G < \Pi_{C2}^G - \Pi_{N2}^G$ from the figure, therefore, we can know that Shenzhen government is more willing to choose cooperative strategy than Chengdu government, so before cooperation, the Chengdu government can ask the Shenzhen government for some compensation after cooperation.

Meanwhile, it is also find that the government's cooperation strategy may not be supported by local port operators. In this numerical study, although the Shenzhen port operator can obtain more profits in the government cooperative strategy than the government choose the competitive strategy, yet Chengdu railway port operators have lost profits. Unless compensated, Chengdu railway operators will not support the government to adopt a cooperative strategy. The opposition of Chengdu railway port operators to the government cooperation strategy also from the side to prove that the competition between inland port and seaport would be more intense in the future, which is the significance of this study.

CONCLUSIONS

The rapid development of inland ports inevitably caused the furious conflict of interest between the inland ports and the seaports. In this paper, by setting up a double layer dynamic game model of city government-ports , and dividing into two basic situation which are the port government and the port operators bare both inclined to compete or the city government chooses cooperation while port operators tends to competition, and analyzing the optimal strategy for each decision maker in equilibrium state. Numerical analysis is carried out on the background of the actual situation of Chengdu railway port and Shenzhen seaport. The results indicates that governments choose cooperative strategy will improve the service level of port, and earn monopoly profits, so governments have a tendency to choose the cooperative strategy, which may not get the support of all port operators. The outstanding contribution of this paper is to fill the gap between the domestic and international research on co-operation theory between inland port and seaport, the model analyzes the equilibrium strategy of local government and port operators by using the model to fit the actual. The results of theoretical and numerical studies will enrich and develop the theory of co-operation theory between inland port and seaport, which provide decision reference for local government and port operators to make port development strategy and improve port management and operation.

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