A Games Study of Supply Chain Decision Making with Logistics Capacity Constraints

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***Abstract* — In this paper we focus on the two-echelon supply chain composed of one logistics service provider and the logistics service platform business and adopt the Nash game method. We consider: i) the optimum state of the system revenue under a) centralized decision and b) Nash game decision, and ii) the logistics capacity constraints with the choice to a) to investment in production or b) subcontract to junior logistics service subcontractor. The results indicate that the order quantity of the logistics service platform provider under the centralized decision is far greater than it under Nash game decision. The results are verified by numerical examples.**

Keywords - Two-echelon logistics service supply chain; Nash game; Centralized decision

I. INTRODUCTION

As one of the most advanced management mode, supply chain management has become a hot research topic in the field of management. With the continuous development of the logistics service industry, scholars at home and abroad has concerned the logistics service supply chain. The logistics service supply chain, as an important branch in the field of service supply chain, has received more and more attention from scholars. The logistics service supply chain is a chain structure that is connected to the end customers from the initial logistics service provider during the process of the logistics service purchasing. Logistics service supply chain is essentially a kind of service supply chain based on the cooperation of logistics capability.

Many scholars both at home and abroad have studied the logistics service supply chain. MengLijun et al[1] analyzed the coordination problem of a two-echelon logistics service supply chain with one logistics service integrator and one functional logistics service providers, and developed Stackelberg game coordination with wholesale mechanism and coordination with revenue sharing mechanism. Liu Weihua et al[2] established a basic game theoretic model for quality supervision of cooperation in logistics service supply chain, considering a two-echelon supply chain structure including a logistic service integrator and a supplier, and first presented the mixed strategy Nash equilibrium. Yao Guanxin et al[3] studied the joint coordination of the three-echelon logistics service supply chain that was dominated by capacity subcontractors. Zhang Mi et al[4] established profit models of the integrator, supplier and overall logistics service supply chain and proposed a contracting approach. Jing Youguo et al[5] studied that the revenue sharing contract can achieve the supply chain coordination between the single logistics service integrator and the two functional logistics service providers the revenue sharing coefficient of the supplier satisfies a certain function. Zhu Weiping[6] proposed a coordination model with quantity cooperation alliance in which the random variable of demand is sensitive to price to resolve the coordination of a three-echelon logistics service supply chain that is composed of logistics service integrator. Huang Han[7] analyzed the structure of the logistics service supply chain, explained the cooperation of the supply chain capacity, and finally analyzed the measure to promote the cooperation and coordination of the supply chain capacity. He Chan et al[8] proposed a forecast-commitment contract, composed by a subcontractor with single function an integrator to coordinate the logistics service supply chain. Yuan Xumei et al[9] established the logistics service supply chain quality supervision model when the integrator will be punished and then considered the multi-echelon quality supervision model caused by the competitions between the subcontractors. Through the above documents can be found that existing researches mainly focus on the coordination mechanism of two echelon and three echelon of the logistics service supply chain, the measures to promote cooperation and coordination of the supply chain logistics service capability and the logistics service supply chain multi-level cooperation quality supervision mechanism and so on, rarely considering measures which the logistics service provider of the two echelon logistics service supply chain with capacity constraints takes.

On the basis of the existing literatures, the paper will first consider the existence of one logistics service provider and two logistics services platform providers, and the logistics service provider serves the logistics service platform provider. The logistics service provider can choose to investment production or subcontract to junior logistics service subcontractor when its capacity constraints. The optimal state of system revenue under the centralized decision and Nash game decision was discussed, respectively.

II. THE GAME OF TWO LOGISTICS SERVICE PLATFORM PROVIDERS AND ONE LOGISTICS SERVICE PROVIDER UNDER THE LOGISTICS SERVICE PROVIDER CAPACITY CONSTRAINTS

Considering that market exists one logistics service provider（F）and two logistics service providers（R_1，R_2）, the logistics service provider serves the logistics service platform provider. The logistics service provider can choose to investment production or subcontract to junior logistics service subcontractor when its capacity constraints. The income of interest subjects under different choices and the proportion of the logistics service supply chain revenue accounted for the optimal state are discussed below.

A. The logistics service provider with capacity constraints choose investment production

When the initial capacity of the logistics service provider constraints and less than the order quantity of the logistics service platform provider, the logistics service provider choose investment production.

1) Model hypothesis

Considering that the two-echelon logistics service supply chain was composed of two logistics service platform providers（R_1，R_2）and one logistics service provider（F）, the logistics service provider serves the logistics service platform provider. Because of the logistics service provider with capacity constraints, that is the initial capacity less than the order quantity of the logistics service platform provider, it needs to choose investment production to satisfy the order quantity of the logistics service platform provider. Customer demand is random, assuming that the distribution function is $F(x)$, the density function is $f(x)$, and mean value is μ.

Π is the expected revenue of the logistics service supply chain under the centralized decision.

Π_1 is the expected revenue of the first logistics service platform provider under the Nash game decision.

Π_2 is the expected revenue of the second logistics service platform provider under the Nash game decision.

Π_F is the revenue of the logistics service provider under the Nash game decision.

Letter p is the price that the logistics service platform provider offers to the unit logistics service.

Letter g is the unit penalty cost of the logistics service platform provider when the demand of the logistics customer can't be satisfied.

Letter c_1 is the marginal cost of the logistics service platform provider R_1; letter c_2 is the marginal cost of the logistics service platform provider R_2; letter c_3 is the marginal cost of the logistics service provider F.

Letter w_1 is the wholesale price of the unit logistics capability that the logistics service provider offer to the logistics service platform provider R_1; letter w_2 is the wholesale price of the unit logistics capability that the logistics service provider offer to the logistics service platform provider R_2.

Letter r_1 is the unit subsidy price of F offering to spare capacity when R_1 excess capacity; letter r_2 is the unit subsidy price of F offering to spare capacity when R_2 excess capacity.

Letter Q_1 is the order quantity of the logistics service platform provider R_1; Q_{10} is the optimal order quantity of R_1 under the centralized decision; Q_{11} is the optimal order quantity of R_1 under the Nash game decision.

Letter Q_2 is the order quantity of the logistics service platform provider R_2; Q_{20} is the optimal order quantity of R_2 under the centralized decision; Q_{21} is the optimal order quantity of R_2 under the Nash game decision.

Letter e_1 is the service level that the logistics service provider F offers to the logistics service platform provider R_1; letter e_{10} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_1 under the centralized decision; letter e_{11} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_1 under the Nash game decision.

Letter e_2 is the service level that the logistics service provider F offers to the logistics service platform provider R_2; letter e_{20} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_2 under the centralized decision; letter e_{21} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_2 under the Nash game decision.

Letter B is the fixed cost that the logistics service provider invests in the production.

Letter A is the initial capacity of the logistics service provider.

Letter R is the coefficient of variation which cost follows production.

Assuming that the effort cost of the logistics service platform provider is $c(e)=\frac{1}{2}e^2$, when its service level is e.

2) The logistics service provider which choosing investment production under the centralized decision

Taking the two logistics service supply chain service platform and a logistics service provider as a whole, the system maximum revenue is analyzed so as to calculate the optimal order quantity and the service level of logistics capability. The expected revenue of the logistics service supply chain under the centralized decision model is:

$$\Pi = p\left[s_1(Q,e)+s_2(Q,e)\right]-c_1Q_1-c_2Q_2-c_3A$$
$$-\left[B+R(Q_1+Q_2-A)\right]-g\left[L_1(Q,e)+L_2(Q,e)\right]-c(e_1)-c(e_2)$$
$$=(p+g-c_1-R)Q_1+(p+g-c_2-R)Q_2-(p+g)e_1\int_0^{Q_1/e_1}F\left(x\right)dx$$
$$-(p+g)e_2\int_0^{Q_2/e_2}F\left(x\right)dx-(c_3-R)A-B-g\mu(e_1+e_2)-c(e_1)-c(e_2)$$

The second derivation of the $\prod$ about Q_1 is $\frac{\partial^2\Pi}{\partial Q_1^2}=-\frac{p+g}{e_1}f\left(\frac{Q_1}{e_1}\right)$.

For $f\left(\frac{Q_1}{e_1}\right)>o$, there is that the second-order derivative is less than zero. $\prod$ is convex function about Q_1, and using that the first order derivative is zero can evaluate the optimal value of Q_1, $Q_{10}=e_1F^{-1}(\frac{p+g-c_1-R}{p+g})$.

The second derivation of the $\prod$ about e_1 is $\frac{\partial^2\Pi}{\partial e_1^2}=-\frac{Q_1^2(p+g)}{e_1^3}f\left(\frac{Q_1}{e_1}\right)-c''(e_1)$, so the second-order derivative is less than zero, and using that the first order derivative is zero can evaluate that the optimal value of e_1 satisfies:

$$c'(e_1)=\frac{Q_1(p+g)}{e_1}F\left(\frac{Q_1}{e_1}\right)-(p+g)\int_0^{Q_1/e_1}F\left(x\right)dx-g\mu=e_{10}$$

The same can be obtained respectively below:

The optimal order quantity of the logistics service platform provider R_2 is $Q_{20}=e_2F^{-1}(\frac{p+g-c_2-R}{p+g})$; and the best service level that the logistics service provider offers to the logistics service platform provider satisfies:

$$c'(e_2)=\frac{Q_2(p+g)}{e_2}F\left(\frac{Q_2}{e_2}\right)-(p+g)\int_0^{Q_2/e_2}F\left(x\right)dx-g\mu=e_{20}$$

Making decision based on the principle of maximizing the benefit of the logistics service supply chain under the centralized decision situation, the order quantity of the logistics service platform provider respectively are Q_{10} and Q_{20}, obtaining that the revenue of the logistics service supply chain reaches to a best state when the service level of the logistics service platform provider are e_{10} and e_{20}.

3) The logistics service provider which choosing investment production under Nash game decision

The expected revenue of the logistics service platform provider R_1 is:

$$\Pi_1=ps_1(Q,e)-c_1Q_1-w_1Q_1-gL_1(Q,e)+r_1I_1(Q,e)$$
$$=(p+g-c_1-w_1)Q_1-(p+g-r_1)e_1\int_0^{Q_1/e_1}F\left(x\right)dx-ge_1\mu$$

The second derivation of the $\prod_1$ about Q_1 is $\frac{\partial^2\Pi_1}{\partial Q_1^2}=-\frac{p+g-r_1}{e_1}f\left(\frac{Q_1}{e_1}\right)$. For $r_1<p$, the second-order derivative is less than zero, and basing that the first order derivative is zero can evaluate that the best order quantity is $Q_{11}=e_1F^{-1}(\frac{p+g-c_1-w_1}{p+g-r_1})$.

The expected revenue of the logistics service platform provider R_2 is:

$$\Pi_2=ps_2(Q,e)-c_2Q_2-w_2Q_2-gL_2(Q,e)+r_2I_2(Q,e)$$
$$=(p+g-c_2-w_2)Q_2-(p+g-r_2)e_2\int_0^{Q_2/e_2}F\left(x\right)dx-ge_2\mu$$

The same can be obtained that the best order quantity is:

$$Q_{21}=e_2F^{-1}(\frac{p+g-c_2-w_2}{p+g-r_2})$$

The expected revenue of the logistics service provider when choosing investment production is:

$$\Pi_F=w_1Q_1+w_2Q_2-c_3A-[B+R(Q_1+Q_2-A)]$$
$$-r_1I_1(Q,e)-r_2I_2(Q,e)-c(e_1)-c(e_2)$$
$$=(w_1-R)Q_1+(w_1-R)Q_2-(c_3-R)A-B$$
$$-r_1e_1\int_0^{Q_1/e_1}F(x)dx-r_2e_2\int_0^{Q_2/e_2}F(x)dx--c(e_1)-c(e_2)$$

The second derivation of the $\prod_F$ about e_1 is $\frac{\partial^2\Pi_F}{\partial e_1^2}=-\frac{Q_1^2r_1}{e_1^3}f\left(\frac{Q_1}{e_1}\right)-c''(e_1)$, so the second-order derivative is less than zero. Obviously, $\prod_F$ is convex function about e_1, so there exists the best value. Basing that the first order derivative is zero can evaluate that the best service level that the logistics service provider offers to the logistics service platform provider satisfies:

$$c'(e_2)=\frac{Q_2r_2}{e_2}F\left(\frac{Q_2}{e_2}\right)-r_2\int_0^{Q_2/e_2}F\left(x\right)dx=e_{21}$$

4) Example analysis

Assuming that the demand of the logistics service obeys [0,100] uniform distribution, and $p=20$, $g=1$, $c_1=2$, $c_2=3$, $c_3=6$, $w_1=13$, $w_2=12$, $r_1=3$, $r_2=2$, $B=3000$, $R=9$, $A=600$.

Under the centralized decision, inputting parameters can be obtained: $\mu=50$. The optimal logistics capability order quantity of the logistics service platform provider R_1 is $Q_{10}=8948.8$, and the optimal service lever is

$e_{10}=188$; while the optimal logistics capability order quantity of the logistics service platform provider R_2 is $Q_{20}=6143.3$, and the optimal service lever is $e_{20}=143.2$. So the optimal revenue of the system is $\prod=26691.1$.

Under the Nash game decision, the optimal logistics capability order quantity of the logistics service platform provider R_1 is $Q_{11}=555.6$, and the expected revenue is $\prod_1=826.6$; while the optimal logistics capability order quantity of the logistics service platform provider R_2 is $Q_{21}=315.8$, and the expected revenue is $\prod_2=446.2$; the optimal logistics service value which the logistics service provider offers to R_1 is $e_{11}=16.7$, and its offering to R_2 is $e_{21}=10$, $\prod_F=1402.1$.

By comparison, it can be found that the system revenue under the Nash game decision has not reached the optimal state of the system revenue under the centralized decision, that is $\prod_1+\prod_2+\prod_F<\prod$. Further calculation shows that the system revenue under Nash game decision accounts for 10 per cent of the biggest system revenue under the centralized decision. So the system revenue under the Nash game decision has not reached the best state when the logistics service provider chooses to invest in production.

But the data above also can be seen that the logistics service capacity order quantity of the logistics service platform provider under centralized decision is far more than its under the Nash game decision. Decision-making subject under the centralized decision only pursuits the maximization of system revenue, without considering that the maximum system revenue may bring the waste of resources.

B. The logistics service provider with capacity constraints choose to subcontract the insufficient part

When the initial capacity of the logistics service provider constraints and less than the order quantity of the logistics service platform provider, the logistics service provider choose to subcontract the insufficient part to junior subcontractor.

1) Model hypothesis

Considering that the three-echelon logistics service supply chain was composed of two logistics service platform providers (R_1 , R_2) , one logistics service provider (F) and one logistics service subcontractor S . Because of the logistics service provider with capacity constraints, that is the initial capacity less than the order quantity of the logistics service platform provider, it needs to choose to subcontract the insufficient part to junior subcontractor to satisfy the order quantity of the logistics service platform provider. Customer demand is random, assuming that the distribution function is $F(x)$, the density function is $f(x)$, and mean value is μ .

Letter c_1 is the marginal cost of the logistics service platform provider R_1 ; letter c_2 is the marginal cost of the logistics service platform provider R_2 ; letter c_3 is the marginal cost of the logistics service provider F ; letter c_4 is the marginal cost of the logistics service subcontractor.

Letter w_1 is the wholesale price of the unit logistics capability that the logistics service provider offers to the logistics service platform provider R_1 ; letter w_2 is the wholesale price of the unit logistics capability that the logistics service provider offers to the logistics service platform provider R_2 .

Formula $w=\mathrm{w}_3+Ke_3$ is the wholesale price of the unit logistics capability that the logistics service subcontractor S offers to the logistics service provider, and coefficient K is a constant.

Letter e_1 is the service level that the logistics service provider F offers to the logistics service platform provider R_1 ; letter e_{10} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_1 under the centralized decision; letter e_{11} is the best value of service level that the logistics service provider F offers to the logistics service platform provider R_1 under the Nash game decision.

Letter e_3 is the service level that the logistics service subcontractor S offers to the logistics service provider F .

2) The logistics service provider which choosing to subcontractor under the centralized decision

Taking the two logistics service supply chain service platform and a logistics service provider and a logistics service subcontractor as a whole, the system maximum revenue is analyzed. The expected revenue of the logistics service supply chain under the centralized decision model is:

$$\begin{aligned}\prod=&p[s_1(Q,e)+s_2(Q,e)]-c_1Q_1-c_2Q_2-c_3A-c_4(Q_1+Q_2-A)\\&-g[L_1(Q,e)+L_1(Q,e)]-c(e_1)-c(e_2)-c(e_3)\\&=(p+g-c_1-c_4)Q_1+(p+g-c_2-c_4)Q_2-(p+g)e_1\int_0^{Q_1/e_1}F(x)dx\\&-(p+g)e_2\int_0^{Q_2/e_2}F(x)dx-(c_3-c_4)A-g\mu(e_1+e_2)-c(e_1)-c(e_2)-c(e_3)\end{aligned}$$

The second derivation of the $\prod$ about Q_1 is

$$\frac{\partial^2\prod}{\partial Q_1{}^2}=-\frac{p+g}{e_1}f\left(\frac{Q_1}{e_1}\right).$$

There is that the second-order derivative is less than zero. $\prod$ is convex function about Q_1 , and using that the first order derivative is zero can evaluate the optimal value of Q_1 , $Q_{10}=e_1F^{-1}(\frac{p+g-c_1-c_4}{p+g})$.

The second derivation of the $\prod$ about e_1 is $\frac{\partial^2 \prod}{\partial e_1^2} = -\frac{Q_1^2(p+g)}{e_1^3} f\left(\frac{Q_1}{e_1}\right) - c''(e_1)$, so the second-order derivative is less than zero, and using that the first order derivative is zero can evaluate that the optimal value of e_1 satisfies:

$$c'(e_1) = e_{10} = \frac{Q_1(p+g)}{e_1} F\left(\frac{Q_1}{e_1}\right) - (p+g)\int_0^{Q_1/e_1} F(x)dx - g\mu$$

The same can be obtained respectively below:

The optimal order quantity of the logistics service platform provider R_2 is $Q_{20} = e_2 F^{-1}(\frac{p+g-c_2-c_4}{p+g})$; and the best service level that the logistics service provider offers to the logistics service platform provider satisfies:

$$c'(e_2) = e_{20} = \frac{Q_2(p+g)}{e_2} F\left(\frac{Q_2}{e_2}\right) - (p+g)\int_0^{Q_2/e_2} F(x)dx - g\mu$$

Making decision only based on the principle of maximizing the benefit of the logistics service supply chain under the centralized decision situation, without considering the revenue of each decision-making in the supply chain.

3) The logistics service provider which choosing to subcontractor under Nash game decision

The logistics service platform is much more concerned about the service level of the third subcontractor when the logistics service provider chooses to subcontractor. Because the service level of subcontractor is relevant to customer satisfaction, it directly affects customer demand for the logistics service, leading to affect the revenue of the logistics service platform provider finally. So the logistics service platform provider supervises that the logistics service provider strictly requests the service level of the logistics service subcontractor.

The expected revenue of the logistics service platform provider R_1 is:

$$\begin{aligned}\prod_1 &= ps_1(\mathrm{Q},\mathrm{e}) - c_1Q_1 - w_1Q_1 - gL_1(\mathrm{Q},\mathrm{e}) + r_1I_1(\mathrm{Q},\mathrm{e}) \\ &= (p+g-c_1-w_1)Q_1 - (p+g-r_1)e_1\int_0^{Q_1/e_1} F(x)dx - ge_1\mu\end{aligned}$$

The second derivation of the $\prod_1$ about Q_1 is $\frac{\partial^2 \prod_1}{\partial Q_1^2} = -\frac{p+g-r_1}{e_1} f\left(\frac{Q_1}{e_1}\right)$. For $r_1 < p$, the second-order derivative is less than zero, and basing that the first order derivative is zero can evaluate that the best order quantity is $Q_{11} = e_1 F^{-1}(\frac{p+g-c_1-w_1}{p+g-r_1})$.

The expected revenue of the logistics service platform provider R_2 is:

$$\begin{aligned}\prod_2 &= ps_2(\mathrm{Q},\mathrm{e}) - c_2Q_2 - w_2Q_2 - gL_2(\mathrm{Q},\mathrm{e}) + r_2I_2(\mathrm{Q},\mathrm{e}) \\ &= (p+g-c_2-w_2)Q_2 - (p+g-r_2)e_2\int_0^{Q_2/e_2} F(x)dx - ge_2\mu\end{aligned}$$

The same can be obtained that the best order quantity is:

$$Q_{21} = e_2 F^{-1}(\frac{p+g-c_2-w_2}{p+g-r_2})$$

The expected revenue of the logistics service provider when choosing to subcontract is:

$$\begin{aligned}\prod_F &= w_1Q_1 + w_2Q_2 - c_3A - r_1I_1(Q,e) - r_2I_2(Q,e) \\ &-(w_3 + Ke_3)(Q_1 + Q_2 - A) - c(e_1) - c(e_2) \\ &= (w_1 - w_3 - Ke_3)Q_1 + (w_2 - w_3 - Ke_3)Q_2 - (c_3 - w_3 - Ke_3)A \\ &-r_1e_1\int_0^{Q_1/e_1} F(x)dx - r_2e_2\int_0^{Q_2/e_2} F(x)dx - c(e_1) - c(e_2)\end{aligned}$$

The second derivation of the $\prod_F$ about e_1 is $\frac{\partial^2 \prod_F}{\partial e_1^2} = -\frac{Q_1^2 r_1}{e_1^3} f\left(\frac{Q_1}{e_1}\right) - c''(e_1)$. So the second-order derivative is less than zero. Basing that the first order derivative is zero can evaluate that the best service level that the logistics service provider offers to the logistics service platform provider R_1 is:

$$e_{11} = c'(e_1) = \frac{Q_1 r_1}{e_1} F\left(\frac{Q_1}{e_1}\right) - r_1\int_0^{Q_1/e_1} F(x)dx$$

The second derivation of the $\prod_F$ about e_2 is less than zero. Basing that the first order derivative is zero can evaluate that the best service level that the logistics service provider offers to the logistics service platform provider R_1 is:

$$e_{21} = c'(e_2) = \frac{Q_2 r_2}{e_2} F\left(\frac{Q_2}{e_2}\right) - r_2\int_0^{Q_2/e_2} F(x)dx$$

The second derivation of the $\prod_S$ about e_3 is $\frac{\partial^2 \prod_S}{\partial e_3^2} = -c''(e_3)$. So the second-order derivative is less than zero. Basing that the best value of e_3 satisfies: $c'(e_3) = K(Q_1 + Q_2 - A)$.

4) Example analysis

Assuming that the demand of the logistics service obeys [0,100] uniform distribution, and $p = 20$, $g = 1$, $c_1 = 2$, $c_2 = 3$, $c_3 = 6$, $c_4 = 5$, $w_1 = 13$, $\mathrm{w}_2 = 12$, $\mathrm{w}_3 = 11$, $r_1 = 3$, $r_2 = 2$, $A = 600$.

Under the centralized decision, inputting parameters can be obtained: $\mu = 50$. The optimal logistics capability order quantity of the logistics service platform provider R_1 is $Q_{10} = 27820.6$, and the optimal service lever is $e_{10} = 417.1$; while the optimal logistics capability order quantity of the logistics service platform provider R_2 is $Q_{20} = 21807.4$, and the optimal service lever is

$e_{20} = 352.3$. So the optimal revenue of the system is $\prod = 61306.2$.

Under the Nash game decision, the optimal logistics capability order quantity of the logistics service platform provider R_1 is $Q_{11} = 555.6$, and the expected revenue is $\prod_1 = 826.6$; while the optimal logistics capability order quantity of the logistics service platform provider R_2 is $Q_{21} = 315.8$, and the expected revenue is $\prod_2 = 446.2$; the optimal logistics service value which the logistics service provider offers to R_1 is $e_{11} = 16.7$, and its offering to R_2 is $e_{21} = 10$. According to $e_3 = \max(e_{11}, e_{21})$, we can obtain $K = 0.06$, and the expected revenue is $\prod_F = 3587.9$; while the service level which subcontractor S offering is $e_3 = e_{11} = 16.7$ and the expected revenue is $\prod_S = 1760.4$.

By comparison, it can be found that the system revenue under the Nash game decision has not reached the optimal state of the system revenue under the centralized decision, that is $\prod_1 + \prod_2 + \prod_F + \prod_S < \prod$. Further calculation shows that the system revenue under Nash game decision accounts for 10.8 per cent of the biggest system revenue under the centralized decision. So the system revenue under the Nash game decision has not reached the best state when the logistics service provider chooses to invest in production.

III. Conclusion

In this paper, we mainly consider that market exists one logistics service provider and two logistics service providers, and the logistics service provider offers the logistics service to two logistics service platform providers. Considering the supply chain decision game with logistics capacity constraints and adopting Nash game method, not only the optimum state of the system revenue under the centralized decision and Nash game decision but also logistics capacity constraints choosing to investment production or subcontract to junior logistics service subcontractor are discussed respectively. The study indicates that the order quantity of the logistics service platform provider under the centralized decision is far greater than it under Nash game decision. This paper only considered the single market circumstance of one logistics service provider, but it has not considered the condition of multiple logistics service providers competing. Multi-stage supply chain decision is also worthy of further discussion.

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