ISSN: 2688-8653

Optimization of Incentive Contracts in Logistics Service Supply Chain

Yue Zhang

School of Economics and Management, Chongqing University of Posts and Telecommunications, Chongqing, China

Abstract

In the process of logistics service supply chain contract design, due to the existence of information asymmetry, it is difficult for integrator to optimize the incentive of provider based on their own observations, and ultimately affect the overall benefits of the logistics service supply chain. This paper constructs a principal-agent model between integrator and provider. By comparing the relationship between the output values of the contract before and after the customer information feedback, this paper studies the contract optimization problem in the logistics service supply chain, and uses Matlab for numerical simulation analysis. Discuss how to set relevant parameters to achieve the optimal incentive effect of the contract. Research shows that considering customer information feedback into contract optimization can help solve the problem that integrator in the logistics service supply chain cannot truly judge the degree of supplier effort due to information asymmetry, and improve the level of efforts of provider and reduce the total agent cost of the integrator. Improve the incentive effect of the contract, and thus improve the overall income of the supply chain.

Keywords

Logistics Service Supply Chain; Contract Optimization.

1. Introduction

With the rapid development of e-commerce in recent years, the logistics service industry has gradually attracted attention. As an important model of product distribution, the logistics service supply chain has become an indispensable part of social life[1]. The current competition among enterprises has gradually transformed into competition between the supply chain and the supply chain, and the development of the logistics service supply chain is crucial. In April 2018, the National Development and Reform Commission issued the "Notice on Doing a Good Job in Cost Reduction in 2018", which pointed out that it will accelerate the reduction of logistics costs and carry out a comprehensive reform of logistics cost reduction and efficiency improvement. However, due to the late development of the logistics service supply chain model in my country, facing the problem of information asymmetry between logistics service integrators and logistics service providers, integrators lack effective incentives for providers, making integrators unable to do well. The integration of logistics services and the lack of cooperation awareness among providers have caused problems such as high operating costs, low output efficiency, and slow development of the logistics service supply chain. Integrators promote the development of the logistics service supply chain by increasing capital and equipment investment and other resource allocation, which requires relatively high costs and cannot fundamentally solve the problem. Compared with this, the integrator optimizes the logistics service supply chain from the aspect of incentive contract not only helps to solve the fundamental problem, but also requires lower costs. Therefore, how to realize the optimal incentive of the contract and improve the overall output of the logistics service supply chain has begun to attract attention.

ISSN: 2688-8653

Many scholars have conducted corresponding research on the contract coordination problem of the logistics service supply chain, such as Zhang Jianjun, Zhao Qilan and others based on the multiple cooperation modes of the product supply chain and the service supply chain in the supply chain system for optimal decision-making and benefit distribution. Research[2]. Li Xiaoping used the method of game theory to study the quality monitoring game behavior between logistics service providers and integrators[3]. Based on the perspective of fairness preference, Zhang Cuihua et al. established a revenue model of quality supervision and collaboration considering the quality supervision of integrators and the cooperation of providers[4]. Scholars such as Shi Yuan used the system dynamics methodology to construct the benchmark model and information sharing model of the service supply chain. Through comparative analysis, it is concluded that the information sharing mechanism can improve the stability and revenue of the supply chain[5]. Liu Yanqiu and others use the principal-agent theory to establish the relationship between reliability and cost, combine supplier reliability with supply chain option contracts, and build a logistics service supply chain option contract model that considers reliability[6]. Through the solution and comparative analysis of the model, some countries have concluded that the revenue sharing contract can achieve supply chain coordination[7]. Wang Zhihong and others found that the introduction of an option mechanism to study the optimization decision-making of the logistics service supply chain in an uncertain market environment can improve the flexibility of the logistics service supply chain and reduce the risks caused by market uncertainty[8]. Liu Zhengchi and others added knowledge collaboration into the model to build an income model that combines performance and property rights[9]. Scholars such as Meng Lijun established a centralized control model, a master-slave coordination model, and a revenue-sharing coordination model. Through the comparison of the models, they found that the revenue-sharing contract can maximize the overall benefits of the logistics service supply chain[10].

When discussing contract incentives in the logistics service supply chain in the above literature, most scholars choose to study from various aspects such as supervision, rewards and punishments, and model comparison[11] to study how integrators formulate contracts to achieve optimal incentives for providers. The essence of the incentive is to rely on the integrator to collect the judgment basis and design the incentive contract to carry out the research on the distribution of benefits between the integrator and the provider. However, the current research still has some shortcomings. When designing incentive contracts, the information factors in the logistics service supply chain are not considered comprehensively. Adding insufficient information as incentives to contract incentives will affect the effectiveness of contract incentive design. Sex, not achieving the optimal incentive effect. The logistics service supply chain is the cooperation between integrators and providers to provide customers with logistics services. Therefore, the quality and efficiency of the service are mainly determined by customer evaluation. Adding the information factors that customers have to the incentive contract design can improve the information factors . Customer information feedback is the service information feedback provided by the customer to the integrator based on the service provided by the provider, and the corresponding evaluation is given based on the service quality and efficiency of the provider. Integrators combine their observed provider output with customer information feedback in order to better understand the logistics services provided by the provider and establish an effective incentive mechanism.

Some scholars have also conducted related discussions on the issue of customer information feedback. For example, R. Glenn Richey et al. analyzed how to introduce various feedback information through empirical analysis methods to improve the entire supply chain through the coordination of individual members of the supply chain. The efficiency of the chain[12]. Scholars such as Qin Xinghong added factors such as customer expectations and quality cost to optimize the contract when constructing the competition and cooperation model between

ISSN: 2688-8653

integrators and providers[13]. However, most scholars use qualitative methods to study, and quantitative research methods have not studied the impact of customer information feedback on the effect of incentive contracts. Therefore, based on the classic Homestrom principal-agent model, this paper introduces customer information feedback factors, comprehensively considers multi-agent and two-way moral hazard factors, and establishes an incentive contract model to improve the effect of incentive contracts in the logistics service supply chain. By analyzing the effort level of logistics service integrators and providers, incentive sharing and payment, and integrator's general agent cost equivalent function, the significant effect of customer information feedback mechanism in the optimization of logistics service supply chain incentive contracts is studied, and numerical simulations are carried out. The analysis further clarifies the relationship between the supply chain output and the relevant influencing parameters, and verifies the theoretical effect of customer information feedback on the improvement of the incentive contract of the logistics service supply chain.

2. Model Assumptions and Parameter Settings

Hypothesis 1: The logistics service integrator is the principal, the service provider is the agent, and the integrator's risk preference type is risk-neutral, and the service provider is risk-averse [14]. In the process of providing logistics services, integrators integrate the capabilities of logistics service providers, and then provide logistics services to customers. The logistics service output of this process requires the joint efforts of integrators and service providers to complete, but integrators and service providers It is difficult to observe the effort level of the integrator. Assuming that the effort level of the integrator is a one-dimensional variable, the effort level of the service provider is also a one-dimensional variable.

Hypothesis 2: This article comprehensively considers the multi-agent problem, so here the number of service providers is set to two, and it is a competitive relationship. The output function of the integrator is in the form of, and the output function of the service provider is, where and are the output coefficients of the effort of the integrator and the service provider respectively, and the coefficient is the competition coefficient between the provider and the provider. The output of an agent is affected by both its own effort and the effort of another agent. The output of the agent will increase with the increase of its own effort, but it will decrease with the increase of the effort of the agent. Represents the exogenous uncertain factors and obeys the distribution. The effort level of the agent determines the mean value of the output, but does not affect the variance of the output.

Hypothesis 3: The efforts of integrators and service providers need to invest in costs. Assume that the effort cost function of the integrator is, and the effort cost function of the service provider is, which is the cost coefficient of the effort of the integrator and the service provider, and the assumptions are the same.

Hypothesis 4: The customer's service feedback based on the provider's logistics service is, which is a continuous variable. Due to the influence of the customer's subjective emotions and other factors, the customer information feedback is set to, and. Among them, represents the exogenous uncertainty factor, and obeys a normal distribution with a mean value of 0 and a variance of. It is the subjective information feedback of the customer to the service provided by the service provider. The larger the value, the higher the customer satisfaction, which is related to the effort of the service provider.

Hypothesis 5: The principal-agent contract is based on the agent's output and customer feedback, and is a linear contract, that is:, which represents the agent's total income, is the agent's fixed income, and has nothing to do with it, is the agent The output share based on one's own output. It means that the agent does not bear any risk, that the agent bears all risks, and it is the customer information feedback coefficient.

ISSN: 2688-8653

Hypothesis 6: The total output will increase as the efforts of the agents and integrators increase.

3. Model Solving

The integrator directly divides according to the respective output of the provider. The expected income of the integrator is the total output of the entire logistics service supply chain minus its own effort cost and payment to the service provider:

$$EU_x = V(x, y_i, y_j) - S_i - S_j - C(x)$$

The logistics service provider acts as an agent, and the integrator will make a payment for it. The payment consists of two parts, one is a fixed payment, and the other is a performance payment. The benefit of the service provider is the payment of the integrator minus the cost of its own efforts:

$$U_i = \alpha_i + \beta_i[ky_i + b(y_i - y_j) + \eta M_i] - \frac{1}{2}cy_i^2$$

$$U_j = \alpha_j + \beta_j[ky_j + b(y_j - y_i) + \eta M_j] - \frac{1}{2}cy_j^2$$

The deterministic equivalent income of the expected income of the available provider is:

$$EU_i = \alpha_i + \beta_i[ky_i + b(y_i - y_j) + \eta M_i] - \frac{1}{2}cy_i^2 - \frac{1}{2}\rho\beta_i^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)]$$

$$EU_j = \alpha_j + \beta_j[ky_j + b(y_j - y_i) + \eta M_j] - \frac{1}{2}cy_j^2 - \frac{1}{2}\rho\beta_j^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)]$$

Therefore, the optimal incentive contract design model 1 of the logistics service supply chain considering the customer information feedback is as follows:

$$\max EU_x = (1-\beta_i)[ky_i + b(y_i - y_j)] + (1-\beta_j)[ky_j + b(y_j - y_i)] + \lambda x - \alpha_i - \alpha_j - \frac{1}{2}cx^2 - \eta(\beta_i M_i + \beta_j M_j) \quad (1)$$

$$x \in \arg\max EU_x \quad (2)$$

$$y_i \in \arg\max EU_i = \alpha_i + \beta_i[ky_i + b(y_i - y_j) + \eta M_i] - \frac{1}{2}cy_i^2 - \frac{1}{2}\rho\beta_i^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)] \quad (3)$$

$$\alpha_i + \beta_i[ky_i + b(y_i - y_j) + \eta M_i] - \frac{1}{2}cy_i^2 - \frac{1}{2}\rho\beta_i^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)] \geq \overline{U} \quad (4)$$

$$y_j \in \arg\max EU_j = \alpha_j + \beta_j[ky_j + b(y_j - y_i) + \eta M_j] - \frac{1}{2}cy_j^2 - \frac{1}{2}\rho\beta_j^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)] \quad (5)$$

$$\alpha_j + \beta_j[ky_j + b(y_j - y_i) + \eta M_j] - \frac{1}{2}cy_j^2 - \frac{1}{2}\rho\beta_j^2[\delta^2 + \eta^2\delta_m^2 + 2\eta Cov(\pi, M)] \geq \overline{U} \quad (6)$$

ISSN: 2688-8653

4. Model Analysis

By solving the model, it can be seen that the relevant parameters of the model have changed to a certain extent in the two models that consider and do not consider customer information feedback. Here we have selected several important indicators to compare the incentive effects of the two models.

(1) Integrator effort level

Conclusion 1 For logistics service integrators, their optimal effort level is often related to their own output conversion coefficient and effort cost coefficient. The optimal effort level increases with the increase of their own conversion coefficient and increases with the effort cost coefficient. Become smaller. In general, integrators want to improve their optimal effort level by reducing their own effort cost. It is very difficult to reduce effort cost. Integrators can consider increasing their effort level by increasing the output conversion coefficient. For example, technological innovation, updating resource allocation, etc., can effectively increase the value and increase the effort of the integrator. In this paper, after introducing customer information feedback, the integrator's optimal level of effort remains unchanged. As the designer of the contract, the integrator aims at maximizing his own revenue. Therefore, the integrator does not want to increase his level of effort, but hopes to improve the provider's Effort level to increase your income.

(2) Service provider effort level

The provider's optimal effort level is related to its own output conversion coefficient, the competition coefficient between providers, and its own effort cost coefficient. Among them, the optimal effort level has a positive correlation with the provider's output conversion coefficient and the degree of competition, and has a negative correlation with the effort cost coefficient and the risk aversion cost. The greater the degree of competition among providers, the higher their level of effort. Therefore, when incentivizing providers to provide better logistics services, they can achieve the goal at a lower cost by coordinating the level of competitiveness between providers.

(3) Fixed payment

Without considering the customer information feedback model, fixed payment is related to the provider's output conversion coefficient, effort cost coefficient, and risk aversion cost, which can be achieved by changing the agent's effort to output conversion coefficient and the logistics service provider's cost coefficient To adjust the provider's optimal effort level. Considering the customer information feedback model, fixed payment is related to the provider's output conversion coefficient, effort cost coefficient, competition coefficient between providers, risk aversion cost, and customer feedback parameters.

The number of related influence parameters of fixed payment under the mode of customer information feedback is less than that of fixed payment under the mode of considering customer information feedback. This is because the introduction of customer information feedback has a greater impact on the entire contract configuration environment and affects the service. The optimal effort level of the provider has an impact, which changes the total output of the entire logistics service supply chain, thereby affecting the output share of the service provider.

Therefore, integrators can adopt different incentive methods according to different competition levels between providers, and adjust parameters through the level of competition among providers, and the cost is relatively low. The integrator can choose the provider to cooperate with according to the provider's competitiveness level, and can also take some measures to improve the level of competition among service logistics providers. While

ISSN: 2688-8653

designing effective incentives for the provider, it also adjusts its own Fixed payment to ensure the quality of logistics services.

5. Conclusion

From the perspective of contract optimization, this paper constructs an incentive contract model of "considering customer information feedback" and "not considering customer information feedback", and finds that considering the customer's information feedback in the optimal configuration of the contract can increase the information that the integrator can obtain The greater the degree of control over the logistics services provided by the providers, the better incentives for the providers to provide logistics services. In addition, after considering customer information feedback, the contract configuration methods are richer, and the cost is lower compared with traditional improved equipment. For example, the lower cost of competition can be used to effectively incentivize providers.

The results of the two contract models are compared and analyzed. Compared with the incentive contract model that does not consider customer information feedback, the incentive effect of the model after consideration has been improved in terms of the degree of effort of the provider, and the total agency cost of the integrator the reduction also has a certain impact on the fixed payment and share ratio. Regarding the optimal effort level of the provider, the general agent cost of the integrator, etc., taking into account the subjective information feedback of the customer, a better incentive effect can be achieved, and the incentive channels have become richer and the effect is better. The conclusions of this paper are helpful for logistics service integrators to better formulate incentive contracts to achieve the improvement of logistics service output.

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