

# Adverse Selection and Moral Hazard in Logistics Transaction

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**Abstract** According to new institutional economics, Logistics transaction is a problem of Principal-agent that traditional organization transfers its internal logistics activities to the professional outsider which is borne the logistics agent's liability. The paper employs the theory of principal-agent, signaling game model and incentive model to analyze the forms and the problems about adverse selection and moral hazard in logistics transaction, to solve the fundamental issues caused by incomplete and asymmetrical information. The paper presents that information asymmetry, 'Short sighted', huge market and the limitation of signal dissemination system will result in adverse selection in logistics transaction. Adverse selection will result the excellent logistics supplier to be crowded out of the market gradually, result the condition of logistics supply insufficient and supply surplus existing in the same market, impede the improvement of logistics productivity, and moral hazard in logistics market will result insufficient effective demand. The paper implies that signal transferring and signal screening are the most common methods to resolve the above problem. The paper sets up a signaling game model and an incentive model, draws a conclusion that by designing appropriate signaling game model and incentive mechanism, we can change some asymmetrical and incomplete information into symmetrical and complete one to help improve the efficient of logistics transaction.

**Key words** adverse selection, moral hazard, logistics transaction, signaling game model, incentive modal

## 1 Introduction

Transaction is the basis of the modern economic society exiting, in the field of logistics, appearance of TPL is the sign of logistics specialization, and the foundation of logistics transaction's large-scale development, but there is very limited research on the logistics transaction from the economic perspective. According to new institutional economics, Logistics transaction is a problem of Principal-agent that traditional organization transfers its internal logistics activities to the professional outsider which is borne the logistics agent's liability. Fragmented type, business commissioned and strategic outsourcing are the most common types of logistics transaction. Except the first type, the other two has deeply embedded characteristics for the user's value-added chain. But because of the information asymmetry, incomplete information, bounded rationality and opportunism, there are so many uncertainties and risks both to the two transaction parties, which is harmful to the logistics transaction's healthy development. Adverse selection and moral hazard are the most important agency problems and have enormous impact.

## 2 What's the Adverse Selection and Moral Hazard in logistics Transaction

Incomplete and asymmetrical information are the generation roots of adverse selection and moral hazard. Incomplete information means that participants of logistics transaction can't get all the required information, and when some of them know some information which is unknown to the others, information asymmetry generates. We can classify the information asymmetry both from the latitude of time and content. From the angle of time, information asymmetry can be happened on the ex ante of contract signed or on the ex post. The former combined with bounded rationality and opportunism always results in the adverse selection problem. From the angle of content, information asymmetry can refer to somebody's action or knowledge and information, respectively called hidden action and hidden information.<sup>[1][2]</sup> Ex post hidden action always result in the moral hazard problem.

### 2.1 Adverse selection in logistics transaction

In the process of logistics transaction, adverse selection can be a problem that agent (TPL) make use of his private information to sign the contract benefit to himself but harmful to the principal. Before transaction, logistics agent knows his own information, knows his real service quality, working ability and cost, but principal doesn't know or just knows a little. In order to get the contract, the logistics suppliers would send some signal to meet the principal's outsourcing strategy or evaluation criteria even when they can't have the corresponding ability to provide these services in fact. For the principal,

because of information asymmetry, he can't recognize and judge those signal is true or false, then he can't identify the type of agents, this may arise adverse selection problem that the principal select the one whose ability and service quality is poor.

Although information asymmetry is the basic reason, there are still three major ones that will cause the adverse selection problem, they are

(1) In order to pursuit the profit maximization, 'Short sighted' arising from bounded rationality and opportunism will push logistics supplier to provide the information benefiting himself to logistics demand-side while hid the disadvantageous information to induce the demand-side make the wrong decision. Because the logistics outsourcing is a typical experience-attributes labor service, before the outsourcing happened, though the principal can understand some conditions about agent by agent's commitment, previous service record, market reputation and brand history, he can't make clear judgment about the agent's quality and effect for specific business.<sup>[3]</sup> So, in the market, logistics supplier always makes over-commitment to get competitive advantages not belonging to himself, for example, some supplier will make some commitment like 'zero delay', 'zero damage', '24-hour service', 'free for goods custody', ect.

(2) The market is so huge, even the principal takes so much time and energy to collect and select the information, it's impossible for one to get all that he'd like to know. Further more, it'll take cost to collect and select information, if the expense is so huge that is higher than the benefit derived from it, the principal has no initiative to do it. Under that condition, the principal will select some tendentious information according his individual preference, this may lead him to select inappropriate agent.

(3) In logistics market, the limitation of signal dissemination system also hinders the participants to get all true information. There are multiple-latitude standards to judge the logistics supplier, for example business operating ability, background, credit, service quality, economic conditions, financial conditions and operating performance, ect. We can make use of quantitative indicators to assess some of them, for example, the percentage of zero goods damage, the percentage of goods delivery on time, the percentage of meeting ordering accurately, all them can be used to assess the service level. But it's difficult to set up objective indicators to be used as evaluation scale for some other standards, and even it's set up there are not always exiting an independent and fair organization to calculate and announce it regularly.

## **2.2 Moral hazard in logistics transaction**

After the logistics contract is signed, the principal just can observe the results but difficult to supervise the whole service process, so logistics supplier may take action which is disadvantage to the principal and damages his interests, that's moral hazard. In logistics transaction, moral hazard problem includes

( 1 ) Simplifying the logistics procedures. In order to pursuit the profit maximization, when selecting agent, some principal puts too much emphasis on the low price, it increases the occurrence probability of moral hazard. Because those agent also pursuit high profit, they always omit some important procedure (for example to simplifying the processing procedure, deal with goods arbitrarily) to reduce the cost, then result in lower service quality.

( 2 ) Revealing the business secrets of customers. The deeply embedded characteristics of business commissioned and strategic outsourcing make it possible for the logistics supplier to master his customers' operation information and even the business secrets. The logistics supplier has the responsibility to keep the secret, but in fact, because of loose management and interests driving, some of them reveal the business secret of customers to the competitors and make huge loss.

( 3 ) Collecting payment on behalf of customers, but absconding with the money because of poor management. Theoretically, once the logistics company receives the payment, he should hand it over to his customers, but in practice, there're always 3 days or more to be as buffering period, this create the opportunity to dip into payment for logistics company, when those misused money accumulate to much too pay up, the logistics company will abscond with the money. In recent years, the provinces of Henan, Sichuan, and Sanxi, the aforementioned incidents frequently happen, even bring out the local logistics industry's credit crisis.

## **3 The Influence of Adverse Selection and Moral Hazard on Logistics Transaction**

### **3.1 The influence of adverse selection on logistics transaction**

Adverse selection will result the excellent logistics supplier to be crowded out of the market gradually. On the market lack of effective information transmission mechanism, the principal knows that he is on the information inferiority position, so when purchasing the logistics service, he will assume all

the service quality is bad and tend to select the supplier whose charges are low, this will cause the good logistics supplier with high cost being crowded out of the market by bad logistics supplier with low cost, forming "Lemon market". This situation indicates that information asymmetry will cause the disequilibrium of market, if lack of necessary interest mechanism, many logistics company will take action to lower the service quality, at last vicious competition emerges and market slides into disorder.

Adverse selection will cause the condition of logistics supply insufficient and supply surplus exist in the same market. Providing high value-added service is connected with high cost, for example, to provide the real-time and dynamic information retrieval service or goods tracing service, it need to invest in expensive equipment such as GPS, this will increase the cost of logistics supplier, but adverse selection will drive the supplier focus on the low-level basic logistics business, so the high-level logistics service's supply is short but low-level logistics service's supply is surplus.

Adverse selection will impede the improvement of logistics productivity. On the information inferiority market, logistics demand-side tends to refuse to buy or decrease the amount of logistics service, this will limit the market expansion of good logistics supplier, so this will weaken the supplier's initiative to improve productivity.

### **3.2 The influence of moral hazard on logistics transaction**

The most important effect of moral hazard in logistics market is the problem of insufficient effective demand. Just as mentioned above, in order to maximize his interest or minimize the loss, the principal will tend to refuse to buy or decrease the amount of logistics service when unable to distinguish the difference of agents. According to the research of 'China modern logistics development report (2006)'<sup>[4]</sup>, in the mid of manufacturing companies which didn't make use of TPL's service, logistics supplier's credit problem and business secret being revealing or logistics business is out of control caused by credit problem are the most important reasons for them to give up logistics outsourcing, poor service quality and high service charges come follow. Demand limitation put a curb on the healthy and fast development of logistics industry.

## **4 Signaling Game Model of logistics Transaction**

### **4.1 Selection of signal by logistics supplier**

When there's information asymmetry, competitive equilibrium may not be standard Pareto optimality but may be Pareto optimality with some restraint. So, in order to make correct decision, the participants may have motives to change the asymmetrical and incomplete information into symmetrical and complete information. Signal transferring and signal screening are the most common methods to resolve the above problem. Signal transferring means that agent selects some signals to distinguish himself from others, when principal observes these signals he can identify the type of agent and decide to sign the contract or not. Signal screening means that the principal provides various contracts, agent selects the most appropriate one according to his own condition, and then the principal can identify the type of agent by agent's selection. In this article, signal transferring model is discussed.

There are all kinds of signals in the market, it's a problem for good logistics supplier that what kind of signal should be send to distinguish himself from others. The basic principle is the signal sent by good logistics supplier should not be imitated by bad ones, or the cost of signal sending is much lower. As mentioned above, all the agents can make commitment like 'zero delay', 'zero damage', '24-hour service' or 'free for goods custody', but if the good supplier can give some warranty to principal, for example he guarantee if he breaks the contract and can't realize 'zero delay', he will pay some compensation to the principal, the situation will be different. Because the operating ability is good, so the probability of breaking contracts is lower than poor suppliers', the compensation cost is also much lower, so the poor suppliers can't imitate this kind of signal sent by good suppliers.

### **4.2 Signaling game model and its equilibrium<sup>[5]</sup>**

Spence, M won a Nobel Price for economics for his pioneering contribution in this field, we'll discuss the Signaling game model in logistics transaction following Spence's theory.

Here, we use service quality as the indicator to represent the information about the degree of risk, the probability of success, development potential, ect, in logistics transaction. Those are the private information of logistics supplier, that's to say, the principal doesn't know the real quality, but only knows the average quality and its distribution.

Suppose there two types of logistics supplier in the market, their service quality is  $\theta_H$  and  $\theta_L$ ,  $\theta_H > \theta_L > 0$ . The probability of providing high-level service is  $\text{Prob}(\theta = \theta_H) = (0,1)$ . Suppose  $\theta_H$  providing remedy warranty for breach of contract, the warranty is observable, the cost of breach is the

function of remedy warranty represented by  $e$  and  $\theta$ . Suppose  $c(e, \theta)$  can take quadratic derivative,  $c(0, \theta) = 0$ ,  $c_e(e, \theta) > 0$ ,  $c_\theta(e, \theta) < 0$ ,  $c_{ee}(e, \theta) > 0$  and  $c_{e\theta}(e, \theta) < 0$ . Price of logistics service is  $\omega$ , so the utility whose type is  $\theta$  and remedy warranty is  $e$  is  $u(\omega, e | \theta) = \omega - c(e, \theta)$ .

Game is developed step by step. In the natural state, the type of logistics supplier is decided, each supplier select the level of remedy warranty, after observing the remedy warranty, principal gives his quotation on logistics service, and then agent decides to serve the principal or not. Here, the concept of equilibrium is Perfect Bayesian Equilibrium, PBE.

If belief function  $\mu(e)$  can be used as the common probability judgment of supplier belonging to high-level group,  $\mu(e) \in [0, 1]$ , then, under the following conditions, logistics supplier's strategy, principal's strategy and this belief function can form a perfect Bayesian equilibrium.

(1) Given the principal's strategy, logistics supplier's strategy is optimum

(2) Principal's belief is deduced from logistics supplier's strategy according to Bayesian principle

(3) Principal's quotation forms Nash equilibrium, the probability of supplier belonging to high-level group is the principal's belief function  $\mu(e)$ .

When remedy warranty is  $e$ , principal think the probability of supplier belonging to high-level group is  $\mu(e)$ , then, principal's pure strategy is to set the price on the level equal to service quality, that's  $\omega^* = \mu(e)\theta_H + (1 - \mu(e))\theta_L$ , so the principal's PBE is between  $\theta_H$  and  $\theta_L$ , but what's the supplier's strategy? Supplier has preference between  $\omega$  and  $e$ , attention that  $\omega$  and  $e$  is positive correlation, so the two indifference curves of  $\theta_H$  suppliers and  $\theta_L$  suppliers intersect only once, and on the intersection point, the slope of  $\theta_H$  is lower. The reason is that given  $(\omega, e)$ , the marginal rate of substitution of supplier's price and remedy warranty is equal to the marginal cost of breach of contract, that's  $(d\omega/de)_\mu = c_e(e, \theta)$ , while  $c_e(e, \theta)$  is degressive function of  $\theta$ .

There are following conclusions about separate equilibrium that's different type's supplier select different remedy warranty.

Each type's supplier gets the price equal to his service quality. In any separate PBE, principal's belief is decided by supplier's strategy, so when the principal sees the remedy warranty level is  $e^*(\theta_H)$ , he thinks the probability of high service quality supplied by that supplier is 1, so he'll pay a price equal to high service quality. That's the same to  $\theta_L$ , so  $\omega^*(e^*(\theta_H)) = \theta_H$ ,  $\omega^*(e^*(\theta_L)) = \theta_L$ .

In any separate PBE, the supplier whose service quality is low wouldn't provide and remedy warranty. According to last paragraph's analysis, if the supplier is  $\theta_L$ , he can get the price of  $\omega^*(e^*(\theta_L))$ , even his remedy warranty is zero, so the supplier has no incentive to provide remedy warranty.

In hybrid equilibrium, different suppliers will select the same remedy warranty ( $e^*$ ), so the principal will pay for the same price  $\omega^*(e^*) = \lambda\theta_H + (1 - \lambda)\theta_L = E(\theta)$  to all of them, the problem is how the supplier select the level of remedy warranty, all the level between 0 and  $\bar{e}$  can be accepted. Good supplier will not promote his quality over the level of  $\bar{e}$ , because poor supplier also can get expected price  $E(\theta)$  even without any remedy warranty, at that time, the utility of poor supplier is much higher. So in hybrid equilibrium, the situation that all the suppliers don't provide warranty is better than the situation that some of them provide warranty. But in practice, good supplier worries about that if he doesn't provide any warranty, the impression will be damaged, so he will still provide some.

## 5 Incentive Modal in Logistics Transaction<sup>[6]</sup>

Under the condition of moral hazard, the stochastic output incarnates the agent's real effort and some good luck, but the problem is that the principal can't distinguish these two factors. The method to solve this problem is that the principal design a contract to induce agent to make great effort. Apparently, only the agent gets his action utility maximization, the principal can get his own utility maximization. In order to realize the above objective, the principal must provide some incentive mechanism, and the incentive mechanism should meet the following conditions

(1) Agent's action following the principle of action utility maximization, that's condition of incentive compatibility.

(2) Under the condition of "natural" interference, agent's receipt shouldn't be lower than scheduled receipt, that's condition of participation.

(3) After the contract is performed, principal's revenue should be maximized, and this can't be reached under any other contracts, that's condition of revenue maximization.

Under this contract, principal hopes to induce agent make great effort with the lowest cost. The solution of this problem defines the suboptimum cost performing this effort. Generally speaking, suboptimum cost is always more than optimum cost when action is observable, the reason is when considering the problem ‘induce agent make great effort at lowest cost’, incentive compatibility is always only restrictive.

Suppose principal can't observe the agent's action  $\alpha$  and natural condition  $\theta$ , he can only observe the output  $\pi$ . Suppose there are two action selection H and L, H represents ‘work hard’ and L represents ‘lazy’.  $\underline{\pi}$  and  $\bar{\pi}$  is the minimum and maximum possible value. If the agent works hard ( $\alpha=H$ ),  $F_H(\pi)$  and  $f_H(\pi)$  is his output's distribution function and distribution density function, and If the agent is lazy ( $\alpha=L$ ),  $F_L(\pi)$  and  $f_L(\pi)$  is his output's distribution function and distribution density function. Suppose output will increase if the agent take effort to work, that's  $\pi(\alpha, \theta)$  is the increasing function of  $\alpha$ . If  $\pi$  is stochastic, distribution function will meet the condition of first-order stochastic, that's to all  $\pi \in [\underline{\pi}, \bar{\pi}]$ ,  $F_H(\pi) \leq F_L(\pi)$ , the rigorous inequality will be correct to some  $\pi$ . The physical meaning of above analysis is the probability of winning high profit with hard work is higher than lazy.

Suppose the cost of hard work is higher than the cost of lazy,  $c(H) > c(L)$ , if agent selects  $\alpha=H$ , the condition of incentive compatibility means  $\frac{\partial S}{\partial \pi} \neq 0$  (if  $\frac{\partial S}{\partial \pi} = 0$ , that's the optimum is irrelevant with  $s^*$  and  $\pi$ ). In order to provider enough incentive to agent work hard, principal must give up the Pareto optimum risk share contract. The problem for principal is to select incentive contract to resolve the next optimum problem

$$\begin{aligned} & \max_{s(\pi)} \int V(\pi - S(\pi))g_H(\pi)d\pi \\ \text{s.t. (IR)} & \int U(S(\pi))g_H(\pi)d\pi - C(H) \geq \bar{U} \\ \text{(IC)} & \int U(S(\pi))g_H(\pi)d\pi - C(H) \geq \int U(S(\pi))g_L(\pi)d\pi - C(L) \end{aligned}$$

IR is the condition of participation, IC is condition of incentive compatibility that's given  $s(\pi)$ , the expected utility got from work hard is higher than the one got from lazy.

## 6 Conclusion

Information asymmetry, incomplete information, bounded rationality and opportunism will result in adverse selection and moral hazard problem in logistics transaction. Both adverse selection and moral hazard will increase the transaction costs and even result in market failure. But by designing appropriate signaling game model and incentive mechanism, we can change some asymmetrical and incomplete information into symmetrical and complete one to help improve the efficient of logistics transaction.

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