

# Service Cooperation Incentive Mechanism in a Dual-channel Supply Chain under Service Differentiation

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## Abstract

*An incentive mechanism about service effort provided by the manufacturer in a dual-channel supply chain is studied under asymmetric information. The principal-agent models are developed for asymmetric information and symmetric information, and then the optimal fixed payment and the optimal profit sharing ratio are obtained. In contrast to the case under symmetric information, the conclusion implies that the manufacturer's profit decreases under asymmetric information, the retailer's profit keep same even lower service level is provided. Thus, the system performance of the supply chain decreases.*

**Keywords:** supply chain, dual-channel, service differentiation, incentive mechanism

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## 1. Introduction

With the development of network and growth of customer's passion in network and increment of online shopping orders, channel reconstruction is a measure that more and more enterprises choose to apply [1]. In this case, dual channel supply chain with both the online channel and offline channel is generate, which may lead to serious channel conflicts. The previous researches had indicated that the buy-back strategy [2], price compensation strategy [3], price-discount strategy [4], two parts and promotion level compensation strategy [5] can effectively alleviate channel conflict and conducive for achieving supply chain coordination. But the important role of service level is neglected. In recent years, a certain number of electric business giant (e.g Jingdong Mall, Su-Ning electronics, and Taobao) use high-quality service rather than intense price war to gain competitive advantages, and floor, LED and other industries constantly increase capital investment to improve their service level. All of these have indicated that the competition between the enterprises gradually focuses on the service rather than the product. Enterprises that devote themselves to better logistic delivery service, return or replacement service, maintenance and experience service may win customers' trust. As the resulting problems, competition and cooperation with service in a dual channel supply chain have drawn attention within academic and business.

The introduction of online channel will be beneficial to enhance the manufacturers' bargaining power and reduce the double marginal benefit, which is the direct theory that supports the rapid development of electronic commerce [6]. Besides the convenience of online shopping, quality of service is another factor that might affect customers' purchasing behavior [7], and opening a direct channel might force the retailers to improve its service level [8]. Considering the significant influence of service on customer purchasing behavior, existing scholars mainly study from two dimensions: service competition and service cooperation. About the service competition, Xu et.al studied the problems of Stackelberg and Nash game decisions when suppliers compete with retailers for service [9]. Similarly, assuming the costs of service provided by traditional retailers are private informations, Mukhopadhyay respectively studied the optimal decision for service competition in a multi-channel supply chain under information sharing and information un-sharing [10]. Chen et al. formulated a model of channel selection of customer Based on service level have effect on demand [11]. Chen and Liu studied the optimal decisions for the competition of supply chain members when there are differentiated services. They found that the service competition makes the supply chain with dual-channel superior than the single channel [12]. Sun established a service competition model, where customers' channel preference is considered. The study found there are service discrimination in supply chain after

adding a direct channel, which maybe results in reduction of the customers' overall utility and the performance of supply chain system [13]. In addition, Luo et.al studied the influence on the service competition and the profit of supply chain when online channel provides value-added service [14]. Dan studied the retailers' optimal service and pricing strategy under noncooperation in dual-channel supply chain [15]. Various decision schemes under the service competition are conducive to improve the performance of supply chain, while the loss of the system efficiency is still large. Therefore, some scholars turn to study the optimal decision under the service cooperation in a dual-channel supply chain. For example, Xiao studied the pricing strategy in a dual-channel supply chain under service cooperation [16]. Luo et al. build a mechanism for coordinating supply chain, which based on suppliers and retailers to share the cost of services [17]. Kong et.al studied the impact of different service cost on the pricing strategy of manufacturers and retailers under service cooperation [18].

Viewing from the above literatures, most of the existing researches that related to service in dual-channel supply chain are from the perspective of service competition. Researches that related to service cooperation are gradually in-depth, and most of them are studied under information symmetry. In fact, there are no linear correlations between the increment of service cost and the improvement of service level. And the motivation to further increase the investment of service cost is very weak for the retailers, especially after that the service level reaches a certain level. However, consumers require a mostly perfect level of services, which makes the manufacturer to motivate the retailer to improve its service level when facing with fierce competition. Hence, considering the cooperation model of service that manufacturers entrust all the service of network channel to retailers to fulfill, we study the optimal incentive strategy of manufacturers to motivate retailers to provide high service level for customers of network channel and traditional retail channel.

## 2. Model Description

We consider a dual-channel supply chain composed of one manufacturer and one retailer, and the manufacturer is the leader. The manufacturer sales its products to end customers directly at price  $p_d$ . The retailer buys the products from the manufacturer at wholesale price  $w$  and then sales them to customers at retail price  $p_r$ , where  $w < p_r$ . Since the retailer has the location advantage that it can face the customers directly, in order to improve online channel efficiency and customer satisfaction and effectively integrate supply chain resources, the manufacture entrusts electronic channel service (e.g. return and replacement service, advertising, mail notification) to the retailer to fulfill. That is, the retailer not only provides service  $s_r$  to customers of traditional retail channel, but also provides service  $s_d$  to customers in online channel. The cost for proving the service is  $C(s) = (\eta/2)s^2$ . The parameter  $\eta$  represents the cost coefficient of the services. The smaller the value of  $\eta$ , the greater the utility of unit service level. Assuming the service level  $s \in [0,1]$ , the value of 0 represents the retailer does not provide services and 1 represents the retailer provides perfect service. The manufacturer forms a principal-agent relationship with the retailer, in which the manufacturer is the principal and the retailer is the agent. The specific process is shown as figure.1. Despite it is difficult for the manufacturer to observe service level of the retailer, the sales volume  $Q$  generated by the retailer providing service can be known exactly, where  $Q = f(s) + \varepsilon$ . The production function of service level  $s$  is given as  $f(s)$ , and there are  $f'(s) > 0$  and  $f''(s) < 0$ , which indicated that improvement of service level will increase output of service and the increase is decreasing. For analytic simplicity, we assume  $f(s) = ks$ , where  $k$  represents the service output coefficient. Since the retailer provides service for both online channel and traditional channel, there is  $k_d = k_r = k$ . Therefore, the sales volume of manufacturer and retailer are respectively given by  $Q_d = ks_d + \varepsilon_d$ ,  $Q_r = ks_r + \varepsilon_r$ . The parameter  $\varepsilon$  represents exogenous and uncertain stochastic variable, such as changes of consumer preference or market environment. Referencing literature [19] and [20], there is  $\varepsilon \square N(0, \sigma^2)$ . Depending on

the sales volume the manufacturer will pay service reward  $t(Q_d, Q_r)$  to the retailer in an effort to maximize its profits. Weitman [21] put forward the rationality for using linear contract. Holmstro and Milrgrom [22] also proved that linear contract can optimize the supply chain system. They assumed the incentive function as  $t(Q_d, Q_r) = \alpha + \beta(p_d Q_d + w Q_r)$ , where  $\alpha$  is the fixed payments that the manufacturer pays to the retailer and  $\beta (0 \leq \beta \leq 1)$  is the ratio of profit sharing provided by the manufacturer for motivating retailer to improve its service level. Similar to the literature [21], we assume that manufacturer is a risk neutral and the retailer is a risk aversion. It means that retailer can eliminate the risk or the risk condition by changing the plan to protect its interests from damage. We also assume there is no cross-buying between customers.



Figure 1. Service cooperation diagram in a dual-channel supply chain

According to the above assumes, the manufacturer’s expected profits is given by:

$$\begin{aligned}
 E \pi_d &= E [p_d Q_d + w Q_r - t(Q_d, Q_r)] \\
 &= E [p_d Q_d + w Q_r - \alpha - \beta p_d Q_d - \beta w Q_r] \\
 &= -\alpha + (1 - \beta) p_d S_d + (1 - \beta) w S_r
 \end{aligned}
 \tag{1}$$

The retailer’s profits is given by:

$$\pi_r = p_r Q_r - w Q_r + t(Q_d, Q_r) - C(s_d, s_r)
 \tag{2}$$

When the retailer is a risk averse, according to literature [21], we use absolute risk aversion to describe the degree of risk aversion of retailer and give the retailer’s utility function as classical constant absolute risk aversion function  $\mu(\pi_r) = -e^{-\rho \pi_r}$ . The parameter  $\rho$  is risk aversion measurement. It represents that the retailer is risk appetite type when  $\rho < 0$  and is risk neutral when  $\rho = 0$  and is risk aversion when  $\rho > 0$ . We assume the real returns obey normal distribution and the expectation is  $m$  and the variance is  $n$ , namely  $\pi_r \sim N(m, n)$ . Therefore, the retailer’s expected utility is given by:

$$\begin{aligned}
 E \mu(\pi_r) &= \int_{-\infty}^{+\infty} -e^{-\rho \pi_r} f(x) d_x \\
 &= \int_{-\infty}^{+\infty} -e^{-\rho \pi_r} \frac{1}{\sqrt{2\pi n}} e^{-\frac{(x-m)^2}{2n}} d_x \\
 &= -e^{-\rho(m - \frac{\rho}{2}n)}
 \end{aligned}
 \tag{3}$$

Where,

$$\begin{aligned}
 m &= E \pi_r = E [p_r Q_r - w Q_r + t(Q_d, Q_r) - C(s_d, s_r)] \\
 &= E \left[ (P_r - w) Q_r + \alpha + \beta p_d Q_d + \beta w Q_r - \frac{\eta}{2} (s_d^2 + s_r^2) \right], \\
 &= \alpha + k \beta p_d s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2)
 \end{aligned}
 \tag{4}$$

$$n = V(\pi_r) = (p_r - w + \beta w)^2 \sigma_r^2 + \beta^2 p_d^2 \sigma_d^2 \quad (5)$$

The retailer maximizes the expected utility function is equivalent to maximize its certainty equivalent earnings [19]:

$$\begin{aligned} \bar{\pi}_r &= m - \frac{\rho}{2} n \\ &= \alpha + k\beta p_d s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \end{aligned} \quad (6)$$

According to retained earnings, the retailer judge whether accept the contract or not. If the certainty equivalent gains  $\bar{\pi}_r$  are less than the retained earnings  $v_0$ , namely  $\bar{\pi}_r < v_0$ , the retailer will not accept the contract. The retailer's participations constraints is:

$$(IR) \quad \alpha + k\beta p_d s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \geq v_0$$

Faced with any incentive conditions, the retailer will always choose appropriate service level  $s_d$  and  $s_r$  to maximize its profits. The retailer's incentive compatibility constraint is given by:

$$(IC) \quad \max_{(s_d, s_r)} \alpha + \beta p_d k s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2$$

### 3. Service Cooperation Incentives under Information Symmetry

In a dual-channel supply chain, information symmetry means the manufacturer, who controls the online channel, knows the information that is related to customers. The information is held by retailers, which includes consumer preference, service cost and service level. In order to maximize its own profits, by controlling the fixed payment and profit sharing ratio the manufacturer will make the retailer to provide a higher service level for the two channels and simultaneously ensure the retailer can get at least the retained earnings. On the contrary, if there is no information superiority, the retailer will certainly ensure the service quality to improve customer service satisfaction in order to avoid damaging its retained earnings. Service cooperation under information symmetry makes supply chain members to achieve a win-win.

Under information symmetry, the retailer's service level  $s_d$  can be observed by manufacturers. At this point, the incentive compatibility constraint doesn't work, and any level of service  $s$  can be achieved by meeting compulsory contract of the participation constraints  $IR$ . The manufacturer chooses appropriate service level  $s_d$  and  $s_r$ , fixed payments  $\alpha$  and profit sharing ratio  $\beta$  to maximize its own profit. The decision-making model is given by:

$$\begin{aligned} \max_{\alpha, \beta, s_d, s_r} E\pi_d &= -\alpha + (1 - \beta) p_d k s_d + (1 - \beta) w k s_r \\ \text{s.t. } (IR) \quad &\alpha + \beta p_d k s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \geq v_0 \end{aligned} \quad (7)$$

According to the decision-making model, if we maximize the manufacturer's profits, equal sign of the participation constraints must be taken. Therefore,

$$\alpha + \beta p_d k s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 = v_0,$$

Namely,

$$\alpha = v_0 - \beta p_d k s_d - (p_r - w + \beta w) k s_r + \frac{\eta}{2} (s_d^2 + s_r^2) + \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 + \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \quad (8)$$

Substituting (8) into (7), we obtain:

$$\max E\pi_d = -v_0 + p_d k s_d + p_r k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \quad (9)$$

Taking the first order partial derivatives of (9) with respect to  $s_d$ ,  $s_r$  and  $\beta$  respectively, and letting them equal to zero. The optimal service levels under the online channel and the retail channel are  $s_d^* = k p_d / \eta$  and  $s_r^* = k p_r / \eta$  respectively. The manufacturer's profit sharing ratio is  $\beta^* = (w^2 - w p_r) \sigma_r^2 / (p_d^2 \sigma_d^2 + w^2 \sigma_r^2)$ . Since  $w < p_r$ , then  $\beta^* < 0$ . And the manufacturer's profits will decrease because of  $\partial_{E\pi_d} / \partial \beta = -\rho p_d^2 \sigma_d^2 \beta - \rho \sigma_r^2 (p_r - w + \beta w) w < 0$ , where  $0 \leq \beta \leq 1$ , then  $\beta^* = 0$ .

When the manufacturers can observe the retailer's service level, in each channel the service level is inversely proportional to the service costs and proportional to the sale pricing of products and has nothing to do with the profit sharing ratio. In this case, the retailer just obtains the part of the fixed payment in the incentive compensation and does not share the profits of online channel.

Substituting  $s_d^*$ ,  $s_r^*$  and  $\beta^*$  into (8) and (9), we can obtain the optimal fixed payments  $\alpha^*$  paid by the manufacturer and the optimal expected profits of manufacturer. They are given by:

$$\begin{aligned} E\pi_d^* &= -v_0 + \frac{k^2 p_r (p_r - w)}{\eta} - \frac{k^2 (p_d^2 + p_r^2)}{2\eta} - \frac{\rho \sigma_r^2 (p_r - w)^2}{2} + \frac{k^2 p_d^2}{\eta} + \frac{k^2 w p_r}{\eta} \\ &= -v_0 + \frac{k^2}{2\eta} (p_d^2 + p_r^2) + \frac{\rho \sigma_r^2}{2} (p_r - w)^2 \end{aligned} \quad (10)$$

Since the manufacturer can observe the retailer's service level, if  $s_d < k p_d / \eta$  and  $s_r < k p_r / \eta$ , the manufacturer can forcibly make the retailer's profit less than its retained earnings by reducing fixed payments as a punishment.

#### 4. Cooperation Incentive Services under Asymmetric Information

The dual-channel supply chain is a value chain composed of different stakeholders, in which the distribution of information is often asymmetrical. Since it is difficult for the manufacturers to observe the retailer's service level, the retailer has more information than the manufacturer. In order to obtain more profits, the retailer often conceals or misrepresents some important and related information from the manufacturer, such as the service requirements and service preferences of consumers and the service costs. The manufacturer can't obtain the service information accurately, which result in compulsory measures losing its efficacy. At this time, the manufacturer will design a corresponding incentive measure to motivate the retailer to improve its service level. Both the participation constraint and incentive compatibility constraint play a role. The decision-making model is reformulated as:

$$\max_{\beta} E\pi_d = -\alpha + (1 - \beta) p_d k s_d + (1 - \beta) w k s_r \quad (11)$$

$$s.t. (IR) \quad \alpha + \beta p_d k s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \geq v_0$$

$$(IC) \max_{(s_d, s_r)} \alpha + \beta p_d k s_d + (p_r - w + \beta w) k s_r - \frac{\eta}{2} (s_d^2 + s_r^2) - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2$$

The retailer seeks the optimal service level  $s_d$  and  $s_r$  to achieve maximum profits, according to the first-order conditions of the incentive compatibility, we obtain:

$$\frac{\partial \bar{v}}{\partial s_d} = \beta k p_d - \eta s_d = 0, \quad \frac{\partial \bar{v}}{\partial s_r} = (p_r - w + \beta w) k - \eta s_r = 0.$$

By solving the above two equation, we can obtain the optimal service levels provided by the retailer for network channel and traditional channel under information asymmetry, which respectively given as  $\bar{s}_d^* = \bar{\beta}^* k p_d / \eta$  and  $\bar{s}_r^* = (p_r - w + \bar{\beta}^* w) k / \eta$ .

Similar to the case that the information is symmetry, the retailer will take the equations of the participation constraint, so substituting (7),  $\bar{s}_d^*$  and  $\bar{s}_r^*$  into (11), we can obtain:

$$\begin{aligned} \max_{\beta} E\pi_d = & -v_0 + \frac{\beta k^2 p_d^2}{\eta} + \frac{k^2 p_r (p_r - w + \beta w)}{\eta} - \frac{k^2}{2} \left[ \frac{\beta^2 p_d^2}{\eta} + \frac{(p_r - w + \beta w)^2}{\eta} \right] \\ & - \frac{\rho}{2} (p_r - w + \beta w)^2 \sigma_r^2 - \frac{\rho}{2} \beta^2 p_d^2 \sigma_d^2 \end{aligned} \quad (12)$$

Taking the first order partial derivatives of (12) with respect to  $\beta$  and letting it equal to zero, the optimal profit sharing ratio under asymmetric information is given by:

$$\bar{\beta}^* = \frac{k^2 (p_d^2 + w^2) - \eta \rho \sigma_r^2 (w p_r - w^2)}{k^2 (p_d^2 + w^2) + \eta \rho (p_d^2 \sigma_d^2 + w^2 \sigma_r^2)} \quad (13)$$

Viewing from the Equation (13), when manufacturers can't observe the retailer's service level, the service level that the retailer provide to the customer of online channel is proportional with the profit sharing ratio and inversely proportional with service costs. When the profits sharing ratio is improved, there must be a corresponding increase in the service level provided to online channel. The service level of retail channel is related to the retail price and wholesale price. In the retail channel, the customers will enjoy a higher service level when the difference between the wholesale price and the retail price is large, and the retail channel also will provide higher service level when the profit sharing ratio is improved. Meanwhile, the retailers' risk preferences  $\rho$  have influence on the profit sharing ratio of the retailer. The more conservative the retailer, the lower the profit-sharing ratio shared from manufacturers will be.

Substituting  $\bar{s}_d^*$ ,  $\bar{s}_r^*$  and  $\bar{\beta}^*$  into (11) or (12), the optimal fixed payment that the retailer gain from the manufacturer and the optimal profits of the manufacturer under information asymmetry respectively are:

$$\begin{aligned} \bar{\alpha}^* = & v_0 + \left( \frac{\rho \sigma_d^2}{2} - \frac{k^2}{2\eta} \right) (\bar{\beta}^*)^2 P_d^2 - \left( \frac{k^2}{2\eta} - \frac{\rho \sigma_r^2}{2} \right) (P_r - w + \bar{\beta}^* w)^2 \\ = & v_0 + \left( \frac{\rho \sigma_d^2}{2} - \frac{k^2}{2\eta} \right) P_d^2 \left[ \frac{k^2 (p_d^2 + w^2) - \eta \rho \sigma_r^2 (w p_r - w^2)}{k^2 (p_d^2 + w^2) + \eta \rho (p_d^2 \sigma_d^2 + w^2 \sigma_r^2)} \right]^2 \\ & - \left( \frac{k^2}{2\eta} - \frac{\rho \sigma_r^2}{2} \right) \left[ P_r - w + \frac{k^2 (p_d^2 + w^2) - \eta \rho \sigma_r^2 (w p_r - w^2)}{k^2 (p_d^2 + w^2) + \eta \rho (p_d^2 \sigma_d^2 + w^2 \sigma_r^2)} w \right]^2 \end{aligned} \quad (14)$$

$$\begin{aligned} \bar{E}\pi_d^* = & -v_0 + \left( \frac{k^2\bar{\beta}^*}{\eta} - \frac{\rho\sigma_d^2(\bar{\beta}^*)^2}{2} - \frac{k^2(\bar{\beta}^*)^2}{2\eta} \right) p_d^2 \\ & + \left( \frac{k^2}{2\eta} - \frac{\rho\sigma_r^2}{2} \right) (P_r - \omega + \bar{\beta}^*\omega)^2 + \frac{k^2w(1-\bar{\beta}^*)}{\eta} (P_r - \omega + \bar{\beta}^*\omega) \end{aligned} \quad (15)$$

### 5. Analysis About the Impact of Different Services on Cooperative Mechanisms

The distinction between online channel and traditional channel gives rise to the difference of customer service experience in each channel. The online channel brings customers more product information, and the work hours more convenient and unlimited, while the traditional channel provides customers with the lower risk, perceived experience in store and without distribution. Different service experience in the two channels will alter the customer purchasing behavior and lead to the change of demand structure of the market.

On the premise of service cooperation, the optimal service level provided to the two channels by the retailer respectively are  $s_d^* = kp_d/\eta$  and  $s_r^* = kp_r/\eta$  when information symmetry and respectively are  $\bar{s}_d^* = \bar{\beta}^*kp_d/\eta$  and  $\bar{s}_r^* = (p_r - w + \bar{\beta}^*w)k/\eta$  when information asymmetry. According to these, under the conditions of service cooperation, whether the information is symmetric or not, the manufacture and the retailer can profit more when the retailer provides differentiated services ( $s_d \neq s_r$ ) for the two channels.

The following, we will further analyze whether the information symmetry has impact on profits of manufacturer, retailer and supply chain system when the manufacturer cooperates with the retailer who will provide differentiated services. The difference between manufacturer's profits under information symmetry and information asymmetry is:

$$\begin{aligned} \Delta E\pi_d = & E\pi_d^* - \bar{E}\pi_d^* \\ = & \frac{k^2(1-\bar{\beta}^*)^2}{2\eta} (p_d^2 - w^2) + \frac{\rho}{2} (\bar{\beta}^*)^2 \sigma_d^2 p_d^2 + \frac{(1-\beta)^2}{\eta} w^2 + \frac{\rho}{2} \sigma_r^2 \bar{\beta}^* w (2p_r - 2w + \bar{\beta}^*w) \end{aligned} \quad (16)$$

According to the limits that  $0 < \beta < 1$ ,  $w < p_r$ ,  $w < p_d$ , we know  $\Delta E\pi_d$  is constantly positive. Therefore, because of information asymmetry the manufacturer suffers losses. Using the advantage of facing customer directly the retailer delivers incomplete information to the manufacturer, which making it difficult for manufacturer to predict market demand accurately, thereby it is difficult to make scientific and rational decisions of production and transportation.

Different with manufacturer, the retailer's profits remain unchanged whether information is symmetric or not. The reason is that the retailer's certainty equivalent gains unchanged. However, the retailer can still profit. Under information asymmetry service level of the two channels both are lower than that under information symmetry, which allows the retailer to obtain unchanged profits by providing a lower service level. In other words, actually, the retailer's profits disguisedly increase under the existing service level. Because of the reduction of the manufacturer's profits, the supply chain system's profits also reduce.

The retailer's service costs directly influence the manufacturer's profits under the condition of cooperation. Whether the information is symmetric or not the manufacturer's profits will decrease with the increase of service cost coefficient  $\eta$ . But when information is asymmetric, the reduction of service costs enable the retailer to obtain a greater profits sharing ratio ( $\partial\beta/\partial\eta < 0$ ). Because of information asymmetry, the manufacturer loses more profits ( $\partial\Delta E/\partial\eta < 0$ ). Accordingly, the manufacturers will set up efforts to collect more information that the market demands.

### 6. Numerical Analysis

This section will verify the impact of service costs on manufacturers' profits in the cases of information symmetry and asymmetry using numerical examples. Assuming that a kind of

product is sold through dual channel, and  $p_d = 0.5$ ,  $p_r = 0.6$ ,  $w = 0.3$ ,  $v = 0.1$ ,  $\sigma_d^2 = 2$ ,  $\sigma_r^2 = 1.5$ ,  $\rho = 0.5$ ,  $k = 0.5$ . Using Matlab7.0 for simulation calculations, we can get changes of the manufacturer's profits with different service level under the conditions of information symmetry and asymmetry, and these are shown as Figure 2-5.

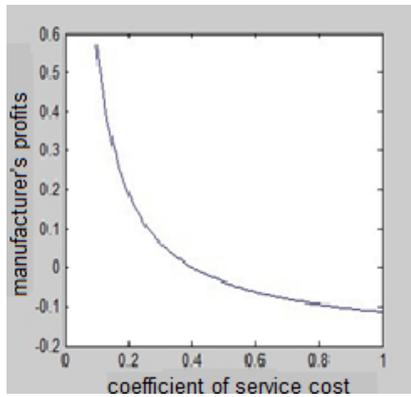


Figure 2. Manufacture's profits under information symmetry

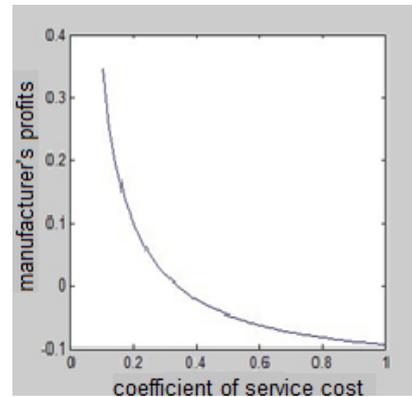


Figure 3. Manufacture's profits under information asymmetry

In Figure 2 and Figure 3, whether information is symmetric or not, the manufacturer's profits always decrease with the increase of the retailer's service costs, but under information asymmetry the decrease is only slightly higher than that under information symmetry. This confirms the assertion that there is no seriously influence on manufacturer's profits when the retailer conceals service information.

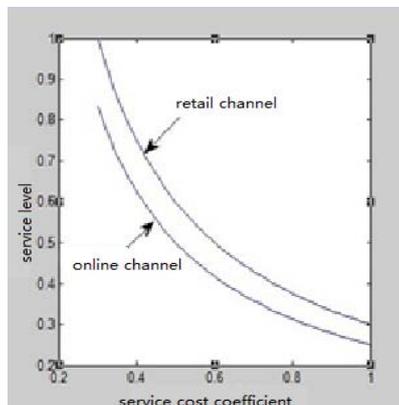


Figure 4. Service level under information symmetry

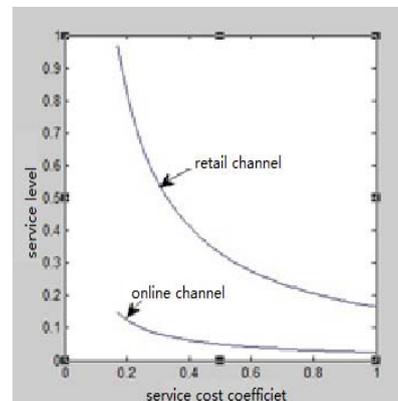


Figure 5. Service level under information asymmetry

Viewing from Figure 4 and Figure 5, the service level provided by retailers to the traditional channel is always higher than that to the direct online channel, and with the increase of service costs, differentiation of service level will become increasingly obvious, especially in the case of information asymmetry.

## 7. Conclusion

With the continuous improvement of market, customer service has become an important factor that strongly influences the interests of supply chain members. Assuming there are no cross-buying in dual-channel supply chain composed of one manufacturer and one retailer, the incentives mechanism when the manufacturer entrusts online channel service to the retailer is studied. We establish a principal-agent model to solve it and the optimal fixed payment and optimal sharing ratio are given. The authors also compared and analyze the relationship between service levels of online channel and retail channel and the impact of service costs and uncertain factors of market on manufacturer profits. The results show that the decrease of the retailer's service cost and the increase of uncertain factors in market will reduce the manufacturer's profits. It is worth noted that some assumptions in this text are very strict, for example that cross-buying behavior does not exist, which is different from the actual market situation. Thus, further and perfect researches are needed.

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