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Research on Coordination Strategy of Dual Channel Supply Chain for Information and Service Sharing

Jianmin Yan

Shanghai University, Shanghai 200000, China

Abstract: E-commerce channels are favored by consumers with their low price strategy and cost advantages, while physical retail channels play games in the competition with efficient services. Each has its own advantages, which makes consumers flow between different channels, leading to conflicts between channels. This paper analyzes the dual-channel supply chain cooperation mode of information sharing and service sharing, explores the coordination model based on price compensation strategy, and discusses how the manufacturer's e-commerce channel and retailer's physical channel cooperate through the coordination incentive model based on price compensation strategy to achieve the total profit realized under centralized decision-making, and through service sharing to indirectly redistribute profits, achieving win-win cooperation between both parties.

Keywords: Dual channel, Information sharing, Supply chain coordination.

1. Introduction

With the rapid development of e-commerce in recent years, online shopping and home delivery have provided great convenience for people's shopping. Some people have changed the single way of buying physical goods in the past, and choose to browse and order physical goods on the e-commerce platform, which not only provides convenience for people's shopping experience, but also improves the quality of life of consumers. The rapid development of online sales channels has brought some impact on traditional retail channels.

At the same time, consumers' consumption level is constantly improving, and they pay more attention to the services related to products when making purchase decisions. High-quality service experience can improve customer satisfaction and drive the increase of demand. However, in actual operation, e-commerce channels often fail to provide consumers with satisfactory services or information related to services (such as after-sales service of electronic products or fitting information of clothing, shoes and hats). Although some e-commerce platforms propose schemes such as "seven days without reason for return or exchange" and "experience payment", consumers often choose offline retail channels for purchase due to delayed arrival and other reasons. Because retail physical channels are closer to the end consumer group, they generally have more and more real demand forecast information than manufacturers, and often gain greater advantages in the product service supply chain.

E-commerce channels are favored by consumers with their low price, while physical retail channels show efficient services in the competition. Each of them has its own advantages. The dual channel makes some consumers flow between them, which come out some conflicts when consumers make choices. Due to the different characteristics of e-commerce channels and traditional physical channels, the factors to be considered in the coordination process are also different, and the coordination of dual-channel supply chain has become a new trend.

2. Related Theories of the Supply Chain

(1) Supply chain information sharing incentive theory

Information sharing is seen as one of the key elements for successful management and coordination. It can not only reduce the risks caused by information asymmetry and incompleteness, reduce the total cost and increase the total profit, but also reduce the bullwhip effect prevalent in the supply chain. However, under actual circumstances, information sharing can only bring greater value added to manufacturers, while for retailers, after spending a certain amount of money to provide private information, the benefits are not large. Retailers are reluctant to participate in information sharing and supply chain coordination is difficult. Therefore, how to design an appropriate incentive mechanism to encourage retailers to participate in information sharing has become a hot topic of research in recent years.

Supply chain coordination includes information coordination and non-information coordination. This paper starts from information coordination to coordinate the supply chain, that is, the whole supply chain grasps the main information of each node to guide the supply relationship, especially how to improve the overall effect of the supply chain by encouraging the information sharing among members.

(2) Game theory

Game theory assumes that the players are rational, and the players in the game will take maximizing their own interests as the principle and goal, and act under certain constraints. Game theory holds that the actions of the players interact with each other and affect each other's decisions. Game theory is a common method to study the coordination of supply chain. It assumes the relevant situation of each member of the supply chain in the game process, establishes and deduces the formula of demand and profit, and calculates the optimal pricing of each member of the supply chain. The most commonly used competition model based on Nash equilibrium is the Stackelberg game model.

In the game model of dual-channel supply chain, the

decision-making modes of each main member of the supply chain are divided into two kinds: one is decentralized decision-making, that is, each member only considers the maximization of their own interests to make decisions; The other is centralized decision-making, that is, members seek win-win results through cooperation, and strive to maximize the collective interests of the whole supply chain. This paper only studies the pricing game between the retail entity channel and the manufacturer's e-commerce channel, which is a horizontal competition game. In decentralized decision-making, it is assumed that they follow the Stackelberg game led by the manufacturer's e-commerce channel. That is, the manufacturer's e-commerce outlets make pricing decisions first, and the physical retailers, as followers, act and make decisions according to the price and wholesale pricing of the manufacturer's e-commerce channel.

3. Analysis of Dual-channel Supply Chain Under Information and Service Sharing

Before information sharing, manufacturers can only predict market demand through retailers' order quantity and demand information of e-commerce channels, which often magnifies inaccurate information, resulting in reduced inventory risks and returns. After the information sharing, the manufacturer can obtain the retailer's private demand forecast information, so that the production can be more accurate. Secondly, because retailers are closer to consumers, they can provide high-quality services more accurately and effectively, which is easier than manufacturers to provide services directly or through e-commerce channels, and consumers have higher satisfaction. Therefore, information and service sharing is conducive to improving the overall benefit and customer experience of dual-channel supply chain. However, in the above information and service sharing, manufacturers gain more significant benefits while retailers do not. Meanwhile, they also have to spend fixed forecast and service costs. This conflict leads to increased difficulty in information and service sharing.

This paper considers a two-level supply chain with only one manufacturer (M) and one retailer (R), and assumes that only one manufacturer supplies products and sells direct sales through e-commerce channels, while only one offline retailer sells identical products. The Stackelberg game formed by the two is shown in Figure 3-1. In the model, retailers not only provide value-added services to customers, but also share services with manufacturers. Due to factors such as price sensitivity, appropriate acquisition cost, length of delay time and purchasing habits, consumers can not only purchase from physical retail channels but also choose to purchase directly from direct sales channels of e-commerce.

The model assumes the following:

Hypothesis 1. In real life, the dual-channel supply chain not only has internal competition, but also has competition among multiple parallel supply chains. This paper only considers the channel competition within the dual channel supply chain and ignores the other forms of competition.

Hypothesis 2. assumes that both manufacturer M and retailer R in the supply chain make completely rational decisions, with neutral risk preference and maximization of their own interests.

Hypothesis 3. only considers the forward flow of products in the supply chain, ignoring the reverse flow.

Hypothesis 4: It is assumed that the products sold by e-commerce channels and physical retail channels are of the same quality and similar, the production capacity of manufacturers is unlimited, and members at all levels have independent inventory without inventory pressure, without considering the loss of stock shortage.

Hypothesis 5. The retailer considers its inventory status and market demand forecast information comprehensively, submits order plan to the manufacturer, and shares private information about market demand forecast with the manufacturer.

Hypothesis 6. The cost of manufacturing for both the manufacturer and the retailer is 0.

Hypothesis 7. It is easy to calculate, this paper ignores the marginal cost of goods in each stage of the supply chain, and the wholesale volume of retailers and the direct sales profit of online channels directly affect the profit of manufacturers.

symbol	concept
p_1	Manufacturer's e-commerce channel direct sales price
p_2	Retailers' physical channel sales prices
d_1	Demand from Manufacturer
d_2	Demand from Retailer
w	Retailer purchases from manufacturer at wholesale price w
$c(v)$	The retailer's service cost
a	The basic market demand of this kind of product
θ	The competition coefficient of the two channels
λ	The sensitivity of service level to product sales volume
m	The market share of manufacturers' e-commerce channels
$\prod_1$	The manufacturer's profit
$\prod_2$	The retailer's profit
$\prod$	The whole supply channel's profit

The demand function of the manufacturer's e-commerce channel is:

$$d_1 = ma - p_1 + \theta p_2 + \lambda v$$

The demand function of retailer's physical channel is

$$d_2 = (1-m)a - p_2 + \theta p_1 + \lambda v$$

The profit function of the manufacturer's e-commerce channel is

$$\prod_1 = p_1 d_1 + w d_2$$

The profit function of retailer's physical channel is

$$\prod_2 = \frac{1}{2}\eta v^2 (p_2 - w) d_2$$

Proposition 1. In decentralized decision-making, both manufacturers and retailers have to maximize their own profits,

$$p_1^* = \frac{ma + \lambda v + (1-m)a\theta + \lambda v\theta}{2(1-\theta^2)}$$

$$p_2^* = \frac{ma\theta + \lambda v\theta}{2(1-\theta^2)} + \frac{[(1-m)a + \lambda v](3-\theta^2)}{4(1-\theta^2)}$$

$$w^* = \frac{ma\theta + \lambda v\theta + (1-m)a + \lambda v}{2(1-\theta^2)}$$

$$\pi_1^{d*} = \frac{\{[(1-m)a + \lambda v]\theta\}^2(1+\theta^2)}{8(1-\theta^2)} + \frac{(ma+\lambda v)^2(1+2\theta) + (ma-\lambda v)[(1-m)a+\lambda v]\theta(2+3\theta)}{4(1-\theta^2)(1+\theta)}$$

$$\pi_2^{d*} = \frac{[(1-m)a + \lambda v]^2}{16} - \frac{1}{2}\eta v^2$$

$$\pi^{d*} = \frac{[(1-m)a+\lambda v]^2(\theta^2+3))}{16(1-\theta^2)} + \frac{(ma+\lambda v)^2(1+2\theta)+(ma+\lambda v)[(1-m)a+\lambda v]\theta(2+3\theta)}{4(1-\theta^2)(1+\theta)} - \frac{1}{2}\eta v^2$$

Proposition 2. Under the decentralized decision-making

model, the optimal price of retailers and manufacturers, the quantity demanded and the wholesale price provided by manufacturers are all positively correlated with the service level. Meanwhile, the growth rate of manufacturers' prices is equal to that of wholesale prices, while the growth rate of retailers' prices is greater than that of wholesale prices.

With the improvement of service level, both manufacturers and retailers can raise product prices through quality service. The reason is that the improvement of service level means the increase of consumers' valuation, so consumers will be willing to pay a higher price for it. And through the optimal price decision, the demand of both sides increases with the increase of service level. For manufacturers, the improvement of service level can bring a direct increase in profits. As the price of the manufacturer increases, the demand of both retailers and manufacturers increases, so the profit of the manufacturer simply increases. For retailers, the improvement of service level can directly increase profits, because the growth rate of retailers' sales price is greater than that of the wholesale price provided by manufacturers, and the demand of retailers increases, so the profits of retailers will simply increase. In conclusion, in a service sharing environment, providing service levels can lead to increased profits for manufacturers and retailers.

Proposition 3. Under centralized decision-making, the total profits of the manufacturer and the retailer are both concave functions, and there is a unique optimal solution, and the optimal prices are as follows.

$$p_1^{c*} = \frac{(ma + \lambda v) + [(1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}]\theta}{2(1 - \theta^2)}$$

$$\mathrm{p}_2^{c*} = \frac{(\mathrm{ma} + \lambda \mathrm{v})\theta + (1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}}{2(1 - \theta^2)}$$

$$\pi^{c*} = \frac{(ma + \lambda v)^2 + [(1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}]^2 + 2(ma + \lambda v)[(1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}]\theta}{4(1 - \theta^2)} - \frac{1}{2}\eta \mathrm{v}^2$$

Proposition 4. $0 < v < \frac{a\lambda}{2(\eta - \eta\theta - \lambda^2)}$,the total profit of supply chain increased with the increase of service level. $v > \frac{a\lambda}{2(\eta - \eta\theta - \lambda^2)}$,the total profit of supply chain decreased with the increase of service level.

Proposition 5. Under centralized decision making, the manufacturer's optimal price is equal to that in decentralized decision making, while the retailer's optimal price is lower than that in decentralized decision making. In addition, the total profit of supply chain in centralized decision-making is always greater than that in decentralized decision-making, and the difference is:

$$\pi^{c*} - \pi^{d*} = \frac{(ma + \lambda v)^2}{16} > 0$$

Aiming at the coordination strategy adjustment of supply chain under decentralized decision-making and the incentive mechanism of retailers, this paper proposes a price compensation model of dual-channel supply chain to coordinate the supply chain, so that both manufacturers and retailers can participate in the coordination process, so as to achieve the maximum profit.

4. Research on Coordination Incentive Mechanism of Dual-channel Supply Chain Under the Condition of Information and Service Sharing

In the dual-channel supply chain under the e-commerce environment, the manufacturer can only grasp the market demand information through the direct marketing channel of e-commerce, while the retailer's information acquisition channel is more extensive and accurate, but belongs to private information. The manufacturer adopts the price compensation strategy to encourage the retailer to provide the real demand information to the manufacturer by reducing the wholesale price. At the same time, retailers share their services with manufacturers' e-commerce outlets, thus achieving price-based coordination.

This price compensation strategy provides a good idea to solve the problem of cooperation between the two parties. On the one hand, lower wholesale price can improve the enthusiasm and authenticity of information sharing of retailers, so as to achieve the optimal total profit of the two parties in the centralized decision-making. On the other hand, it can also share services to avoid retailers from crowding out outlet stores of e-commerce channels with low prices. Therefore, the advantage of this incentive mechanism is that it can realize the maximization of supply chain profits and redistribute profits through direct or indirect means such as reducing wholesale prices or providing services, so as to ensure that both sides of the supply chain can obtain more profits at the same time than in the decentralized decision-making process, so as to achieve a win-win effect.

Therefore, the manufacturer first considers the retailer's decision-making process, makes its own price equal to the optimal price in the centralized decision-making, and provides a reasonable wholesale price. p_2 makes decisions with its own profit maximization as the goal, and makes its price reach the optimal price p_2 in the centralized decision-making. Service sharing is regarded as indirect profit distribution, which is used to coordinate the profits of both parties. Enable both sides to achieve a win-win situation.

Proposition 6. To maximize the profits of both sides, the manufacturer sets its own price and provides the wholesale price as:

$$p'^*_1 = \frac{ma + \lambda \mathrm{v} + (1 - \mathrm{m})\mathrm{a}\theta + \lambda \mathrm{v}\theta}{2(1 - \theta^2)}$$

$$w'^* = \frac{(ma + \lambda v)\theta + [(1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}]\theta^2}{2(1 - \theta^2)}$$

$$p'^*_2 = \frac{(ma + \lambda v)\theta + (1 - \mathrm{m})\mathrm{a} + \lambda \mathrm{v}}{2(1 - \theta^2)}$$

$$\pi'^*_1 = \frac{\{(ma + \lambda \mathrm{v}) + [(1 - m)\mathrm{a} + \lambda \mathrm{v}]\theta\}^2}{4(1 - \theta^2)}$$

$$\pi'^*_2 = \frac{[(1 - m)\mathrm{a} + \lambda \mathrm{v}]^2}{4} - \frac{1}{2}\eta \mathrm{v}^2$$

Proposition 7. Under the price compensation strategy, the wholesale price provided by the manufacturer to the retailer is lower, and the sales price of the manufacturer's e-commerce direct sales channel and the retailer's physical channel are respectively equal to the optimal under the centralized decision. Meanwhile, the demand of the manufacturer's e-commerce direct sales store decreases, while that of the retailer's physical channel increases.

Proposition 8. Before service sharing, that is, before the retailer apportion related services (such as after-sales service) to the manufacturer, the retailer's improved profit is greater than the optimal profit in the decentralized decision, while the manufacturer's profit is smaller than the optimal profit in the decentralized decision, but the total profit of both parties is greater than the total profit in the decentralized decision.

Proposition 7 and Proposition 8 indicate that before service sharing, in order to maximize the total profit of the supply

chain, the manufacturer will first reduce the wholesale price so that the retailer will set the price and achieve the optimal price in the centralized decision-making. In such a state, the retailer's demand will increase, and thus the retailer's profit will increase. For the manufacturer, if the retailer's product price p_2 decreases while its own price p_1 remains unchanged, the demand for e-commerce direct sales channels will inevitably decrease and the manufacturer's own sales revenue will decrease. But for the supply chain as a whole, the increase in the retailer's profit from lower prices is greater than the decrease in the manufacturer's profit, so the total profit of both increases. This paper argues that retailers' physical channels can provide some services to manufacturers' e-commerce direct sales channels for OEM, indirectly to make up for manufacturers' income losses.

5. Conclusion

This paper analyzes and studies the dual-channel cooperation mode of information sharing and service sharing, explores the coordination model based on price compensation strategy, analyzes and compares the optimal selling price and wholesale price of both parties under decentralized decision making and centralized decision making, and finds that centralized decision making can always achieve higher profits, but decentralized decision making only pursues the maximum profit. As a result, profit coordination cannot be realized under the dual channels. This paper focuses on how the manufacturer's e-commerce channel and retailer's physical channel cooperate through the coordination model based on price compensation strategy to achieve the total profit under centralized decision-making, and realize the profit redistribution indirectly through service sharing, so as to further win-win cooperation between both parties. It is found that the coordination model of dual-channel supply chain based on price compensation strategy can better solve the problem of information and service cooperation in dual-channel supply chain.

The study found that when retail entities share private information with manufacturers, the manufacturers can reduce the wholesale price to their satisfaction. In addition, by requiring their service sharing, the manufacturers can achieve the profit coordination through dual channels. For example, in the home appliance industry, online outlets sell through e-commerce channels and can cooperate and coordinate with physical retail stores in the place of sale. While enjoying the profits generated by its private information and service OEM, appropriately reduce the wholesale price. On the one hand, it can solve the after-sales problems of e-commerce channels in remote areas, reduce the purchase cost for offline retailers, improve the profits of both parties and the total profits of the supply chain, and achieve a win-win situation. The research in this paper provides a good solution to the problems such as the inaccurate after-sales service of e-commerce enterprises and manufacturers' demand information under the current rapid development trend of e-commerce. At the same time, it improves the income of e-commerce channel manufacturers and retailers' physical channels, which has strong theoretical and practical guiding significance. At the same time, different from the revenue sharing coordination model, this paper focuses on the optimization and cooperation on the wholesale price or after-sales service related to the cost, so as to provide a new perspective for the coordination of dual-channel supply chain conflicts.

References

[1] Modak N M, Panda S, Sana S S, et al. Corporate social responsibility, coordination and profit distribution in a dual-channel supply chain[J]. Pacific Science Review, 2014, 16(4): 235-249.

[2] Yan R. Profit sharing and firm performance in the manufacturer-retailer dual-channel supply chain[J]. Electronic Commerce Research, 2008, 8(3): 155-172.

[3] Xu G, Dan B, Zhang X, et al. Coordinating a dual-channel supply chain with risk-averse under a two-way revenue sharing contract[J]. International Journal of Production Economics, 2014, 147: 171-179.

[4] Xia Z, Liu Y, Zhang Q. A dual supply chain revenue sharing contract considering online reviews and rebate[J]. Journal of Revenue and Pricing Management, 2022, 21(3): 321-331.

[5] Dabaghian N, Tavakkoli-Moghaddam R, Taleizadeh A A, et al. Channel coordination and profit distribution in a three-echelon supply chain considering social responsibility and product returns[J]. Environment, Development and Sustainability, 2022, 24(3): 3165-3197.