Game Analysis on Return Costs of Dual Channel Supply Chain Considering Service

Tao SHI, Qian CHEN and Rong-rong PU
Chongwen Road, Nan'an District in Chongqing, China

Keywords: Service supply chain, Returns, Stackelberg game.

Abstract. In order to solve the problem of return cost, this paper studies the retailer-led supply chain based on Stackelberg game theory, in which retailers and manufacturers are set up to maximize their profits as a goal considering service and the return cost. Discussing the problem of return cost when the retailer or the manufacturer exists in service. The study found when retailers exist services and the manufacturer bear the cost, the manufacturer reduce the cost of return to bear the loss of profits by increasing the wholesale price, the cost of return commitment will not affect the retailer's sales price and service levels, so the total profit of the supply chain no matter who is responsible for the return of the cost is equal. When the manufacturers has the service, the total profit of the supply chain when the retailer takes the return cost is greater than the total supply chain profit when the manufacturer assumes the return cost.

Introduction

The rise of ecommerce platforms such as taobao and jingdong, smart logistics and other technologies development have changed the way people used in shopping[1]. However, online shopping has brought us convenience, but also brought a high return rate. According to the U.S. Retail Federation: the return value of the U.S. retail trade is about 286 billion U.S. dollars, accounting for 8.89% of the total U.S. sales [2]. In order to reverse this situation, traditional retailers such as the apparel industry and the home improvement industry have been transitioning to new retail model which combining the online and offline sales channels with the offline services to reduce the return loss. For example, Dyson vacuum cleaner for online shopping consumers establish offline service team, directly providing suction carpet and teaching curtain demonstration in the customer's home, that online and offline combination of network channel will reduce return rate from 30% to 10 % [3]. Return: As an unavoidable problem in the supply chain, the return policy is usually provided by the retailer to bear the return cost. In fact, there is no law requiring the retailer to bear the cost of return. If the retailer takes too much cost, the retailer will suffer high inventory pressure and a substantial decline in profitability, retailers may consider shifting the cost of returns to the manufacturer. However, for manufacturers of perishable goods, the retailer returns the unsold product to the manufacturer and the resulting return cost is borne by the manufacturer, which is under pressure from the manufacturer to incur significant production costs and return costs, if retailers can bear some the cost from manufacturer, whether it can reduce the supply chain losses.

Literature Review

At present, many scholars focus on the dual-channel decision-making with service impact, including the impact of service delivery, service overflow and hitchhiking effects on the decision-making of dual channels. Kurata and Nam consider the product after-sales service situation, establish Nash and Stackelberg model to analysis the supply chain and concluded that pareto optimal supply chain service levels below the level of service to meet customer utility[4]. Zhang Xumei and others think that under the influence of pre-sales service, the optimal service level and the price for centralized decision-making are lower than the decentralized decision-making, the final proposed a supply chain—pareto to improve service cost covenant[5]. Zhang Pan studies the influence of the increase of online channels on the sales price, service level
and profit of retailers, and discusses the game model of information free riding behavior[6]. The above study explores the influence of retailers' service presence on dual-channel decision making, and does not discuss the game of price if the manufacturer has service. Zhou Yiting and others research directly marketing channels of personalized service can improve consumer preferences and supply chain profits, that the two pricing contracts can achieve supply chain coordination[7]. Chen used delivery lead time as a measure of manufacturer service level and used product accessibility as a measure of channel service level to study service competition between online and offline channels[8]. Luo Meiling believes that the free riding of online direct sales channels has restrained the enthusiasm of the retailers, but it can coordinate the supply chain through the service cost sharing strategy[9].

The above research focuses on service and supply chain coordination competition merely, but did not consider the impact of service and return rates on the supply chain. In Chen and Grewal's model of supply chain considering customer returns, the authors assume horizontal and vertical competition between manufacturers and retailers, with one retailer at both retailers providing a full refund in the market, and new retailers entering the market under another Retailer's decision to choose to provide a full refund policy or partial refund policy[10]. McWilliams set up a dual-monopoly model for retailers with quality differences, arguing that a full refund policy would benefit low-quality retailers but hurting the profits of high-quality retailers[11]. Ofek points out that the level of assistant service of retailers can effectively reduce the return rate, improve the pricing and profit level of retailers, and also increase the pricing of online direct selling channels[12]. Considering the retail service and consumer returns, Liu Yongmei thinks that retail service can help to increase retailers' channel power. However, when the level of retail service is greater than a certain threshold, retail service can reduce the return rate and realize the pareto Optimal[13].

Although the above studies explored the impact of service and return on supply chain decision-making, the supply chain structure focused on the partial concentration of dual channels and did not discuss the impact of service and return on the dual channels in the retailer-led dual-channel supply chain structure. At present, there are few researches on the decision-making of return and service supply chain. However, in real life, retailers also have both online and offline channels.

Model

Considering a supply chain and a retailer-led supply chain model, retailers or manufacturers to provide services under the circumstances, the use of the Stackelberg model to explore the return on cost commitment. The manufacturer makes a product and sells it to the retailer at a wholesale price, retailers build their own online and offline channels, and sell the product online and offline. Known returns are directly proportional to sales, and the cost of returns is related to sales, so the cost of returns is directly proportional to sales.

Available retailer demand function:
\[ Q_{ret} = a - bp + ns \]  
(1)

Manufacturer Demand Function:
\[ Q_{ret} = Q_{ret} \]  
(2)

Manufacturer Profit Function:
\[ \pi_{man} = wQ_{man} \]  
(3)

Retailer profit function:
\[ \pi_{ret} = (p - w - \lambda)Q_{ret} \]  
(4)

Return costs function:
\[ R = \lambda Q_{ret} \]  
(5)

Service cost function:
\[ c_{s} = 0.5hs^2 \]  
(6)
Among them, $h$ is the service-sensitive coefficient of the market, $b$ is the price sensitivity coefficient of the product, $a$ is the total market capacity, $t$ is the price spillover intensity, $n$ is the service cost coefficient, and $\lambda$ is the correlation coefficient between the return cost and the total sales volume. For the sake of discussion, we will not discuss the impact of unit product cost here.

**Only Retailers Provide Service**

When retailers have service, retailers provide consumers with service. After consumers purchase goods, they can enjoy the unreasonable return policy provided by retailers, and the return cost will be borne by retailers. When the retailer offers the service, the cost of return will be borne by the retailer or the manufacturer, which can reduce the return on supply chain profit losses.

**Conversation One: Retailers Bear the Cost of Return**

Use the Stackelberg model, at first retailers decide on sales prices and service levels first, and manufacturers determine the wholesale price according to the retailer's behavior. The final result is

$$m_i = \frac{2ab - \lambda n^2 + 2bnh}{4bh - a}, \quad s_i = \frac{h(a - bh)}{4bh - a}, \quad p_i = \frac{3ab - \lambda n^2 + 3bh}{4bh - a}$$

**Conversation Two: Manufacturer Bear the Cost of Return**

In this case when retailers provide services, the product is returned directly to the manufacturer, and the return cost is borne by the manufacturer. According to the reverse induction, at first the manufacturer determines the wholesale price, then the retailer determines the sales price and the service level. The final result is

$$s_i = \frac{n(a - 2b)}{4bh - a}, \quad w_i = \frac{ab - \lambda n^2 + 3bh}{4bh - a}, \quad p_i = \frac{3ab - \lambda n^2 + 3bh}{4bh - a}$$

Proposition 1: When the retailer has service only, the marginal profit of the goods is greater than the marginal profit of the goods when the retailers bear the return cost. The marginal profit of the goods is inversely proportional to the return cost coefficient. The wholesale price of the product at the time the retailer assumes the return cost is lower than the wholesale price at which the manufacturer assumed the return cost. Whether the return cost is borne by the manufacturer or retailer, the service and the selling price of the goods are equal.

Proposition 2: When the retailer provides services, the total profit of the supply chain when the retailer undertakes the return cost is equal to the total profit of the supply chain that the manufacturer bears the cost of return. There is no difference in the total profit of the supply chain.

**Only Manufacturers Provide Service**

In many electronic products, consumers enjoy manufacturers' after-sales service. For example, after consumers buy an Apple mobile phone at a retailer, they enjoy services provided by Apple Inc. Such as AppStore software download updates and Siri voice services. Then In this case, the return cost incurred by the retailer or manufacturer. How reduce the losses caused by the return and achieve optimal Pareto supply chain when the return cost incurred by the retailer.

**Conversation Three: Retailers Bear the Cost of Return**

In this case, when the manufacturer provides services, the retailer is responsible for selling the product. First, retailers determine the profit margins independently, the manufacturer determine the wholesale price and service levels. The final result is

$$w_i = \frac{h(a - bh)}{4bh - 2a}, \quad s_i = \frac{n(a - bh)}{4bh - 2a}, \quad p_i = \frac{(3a + bh)ab - (a + bh)b}{b(4bh - 2a)}$$
Conversation Four: Manufacturer Bear the Cost of Return

In this case, when the manufacturer provides services, the product is returned directly to the manufacturer, and the return cost is borne by the manufacturer. First retailers determine the marginal profit autonomously, and the manufacturer re-determines the wholesale price and service level. The final result is

\[
\begin{align*}
W_i &= \frac{b(\alpha - b\mu + b\lambda) - \alpha}{2b\mu - \lambda} \\
S_i &= \frac{n(\alpha - b\mu + b\lambda)}{2b\mu - \lambda} \\
P_i &= \frac{b(\alpha + b\lambda) + (b\lambda - \alpha)\lambda}{b(2b\mu - \lambda)}
\end{align*}
\]

(10)

Proposition 3: At the manufacturer's service, the marginal profit at the retailer's return cost is greater than the marginal profit at which the manufacturer assumes the return cost. When the retailer undertakes the return cost, the marginal profit of the goods is proportional to the return cost. When the manufacturer assumes the return cost, the marginal profit of the goods is inversely proportional to the return cost. The wholesale price and the selling price at which the retailer undertakes the return cost are less than the wholesale price and the selling price at the time the manufacturer assumes the return cost.

Proposition 4: Under the service provided by the manufacturer, the total profit of the supply chain that retailers bear the return cost is greater than the total supply chain profit of the manufacturer who bear the return cost.

Summary

This paper studies the game analysis of retailers and manufacturers about the cost of return when the supply chain has service impact. Detailed discussion of different service providers, the cost of the problem of commitment. The study found no difference in the total supply-chain profit between retailers bear the cost of returns and manufacturers bear the cost of returns when only the retailers have services. When the manufacturers have services, the total supply chain profit at retailer undertakes return cost is greater than the total supply chain profit at the manufacturer undertakes return cost.

References


