

Who Should Introduce an Offline Showroom? The Optimal Strategy for An E-Commerce Supply Chain Considering Service Cost Effectiveness

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Abstract: This paper explores how an e-commerce supply chain consisting of a brand manufacturer and an online retailer determines the optimal showroom strategy. By considering the difference of service cost-effectiveness between supply chain members and the impacts of showroom on customer purchasing behaviors, two showroom strategies are investigated, namely BS strategy where the manufacturer introduces a showroom and OS strategy where the retailer introduces a showroom. The results show that the manufacturer and the retailer adjust optimal decisions according to the relative size of cost-effectiveness coefficients. No matter how the optimal decisions vary, introducing showroom can always enhance the total demand. Besides, the BS strategy is optimal for supply chain members only when the manufacturer has an obvious cost advantage. For the OS strategy, even if the retailer has no cost advantage and bears a relatively high cost-effectiveness coefficient, it is still optimal for supply chain members than the BS strategy.

Keywords: E-commerce supply chain, showroom introduction, showroom strategy, experience service, service cost effectiveness.

1. Introduction

With the gradual maturity and the widespread popularity of Internet technology, e-commerce in China has achieved rapid development. According to the Chinese National Bureau of Statistics, the trade on the Internet reached 2,058 billion dollars and accounts for nearly 25% of the total retail sales in 2021. This indicates that e-commerce has become one of the main channels for residents to consume. As such, more and more single firms, such as WarbyParker.com and Bonobos.com, choose to enter a market by employing a pure online mode and selling products directly to customers without intermediary resellers for its well-documented benefits such as lower operation cost and broader market coverage.

Although the pure online mode has the aforementioned advantages, online firms are facing challenges. Through analyzing the reports of online retail market in the past several years, it can be found that although the trade on the Internet is increasing year by year, the growth rate is slowing down, which indicates that the development bottleneck of the pure online mode is gradually prominent. The reason for this is threefold. Firstly, the virtual pictures and texts provided by online firms cannot describe the non-digital attributes of products to customers. Secondly, with the upgrading of consumption, customers are pursuing experiential purchase. According to a report by McKinsey, 93% of the respondents need to visit a physical store to experience before purchasing electronic products. Besides, 57% of the respondents say that their need for experience is not satisfied well and hope that online firms can provide them with the opportunity of offline experience. Obviously, the pure online mode is unable to meet customers' growing need for experience. Lastly, due to the inconvenient factors such as waiting time, after-sale service, return process and potential risk of online payment [1], customers become hesitant to purchase online. Thus, offline

retailing still occupies a dominant position in the retail market [2].

To break through the development bottleneck, more and more online-first firms start to integrate online and offline channels by adopting an offline showroom strategy to satisfy customers' need for product experience [3]. For example, the online brand, WarbyParker.com, launches offline showrooms throughout the United States. Another example is Bonobos.com, who launches GuideShop without carrying inventories. Noticeably, these showrooms in practice are generally for providing customers with product experience and face-to-face chatting with professional salesperson only. When customers find the best-fit products in the showrooms, then they are induced to purchase online.

Recently, the showroom strategy has been proved to be an effective way for single online-first firms to satisfy customers' need for experience and increase operational efficiency [4]. However, compared with the single online-first firms, the game relationship and interest conflict between upstream and downstream firms will definitely make it much more complicated and challenging for an e-commerce supply chain to implement a showroom strategy. However, only a few scholars investigate whether the downstream firms in a supply chain should provide experience services for the upstream firms. In fact, there are (upstream) brands or (downstream) online retailers who launch showrooms in practice. Motivated by practical observation, we consider an e-commerce supply chain consisting of a brand manufacturer and an online retailer and investigate how the supply chain determines the optimal showroom strategy. Specifically, we consider two showroom strategies. One is BS strategy, which means that the brand manufacturer launches showroom, such as eyewear brand WarbyParker.com [4], menswear brand Bonobos.com [5]. The other is OS strategy, which means that the online retailers launch showrooms, such as online platform JD.com and Amazon.com [6].

To reflect the impact of showroom and the difference between the showroom strategies, we further consider the promoting effect and the reducing effect on the channel demands resulting from showroom as well as the difference between the two showroom strategies in experience and abilities of providing showroom services. Firstly, although the introduction of the showroom can attract potential customers to experience products, which may further be turned into demand in the showroom channel, it also makes divisional and reducing effects on the demand in the pre-existing online channel. Secondly, due to the difference in experience and abilities of providing service in the showroom, the service cost-effectiveness varies between the supply chain members. Under these circumstances, we investigate how the interaction of these factors affects the game relationship between the supply chain members and the optimal decisions and explore the optimal showroom strategy for the supply chain.

Thus, to address these problems, we consider an e-commerce supply chain consisting of one brand manufacturer and one online retailer, where the brand manufacturer distributes through the online retailer and the online retailer resells products to customers via the online channel. In order to satisfy customers' upgrading need for experiential purchase, we investigate how the e-commerce supply chain transforms into an omni-channel supply chain via introducing an offline showroom. Specifically, we are going to investigate the following issues:

(i) How do the two showroom strategies affect the supply chain members' optimal decisions and what is the difference of the impact between the two showroom strategies?

(ii) When the showroom is introduced, whether the promoting effect on the showroom demand can overwhelm the reducing effect on the demand in the pre-existing online channel and realize the increase of total demand? Moreover, which showroom strategy can improve the total demand to a greater degree?

(iii) How does the difference of service cost-effectiveness affect the choice of the showroom strategy from the perspective of the whole supply chain and which strategy can better improve the supply chain performance?

The rest of this paper is organized as follows. Section 2 reviews the related literature. Section 3 presents two analytical frameworks of a single-channel e-commerce supply chain and an omni-channel supply chain. Section 4 analyzes the impacts of two showroom strategies. Section 5 conducts numerical examples to intuitively reveal the impacts of showroom on market demand and optimal profits and analyze how to choose a showroom strategy. Section 6 concludes the paper.

2. Literature Review

There are two streams of literature primarily related to our research. One is offline service operation, and the other is channel integration. In the following, we review present research work of each stream.

2.1. Offline Service

Offline service, such as product experience, face-to-face chat with professional salesperson and so on, plays a crucial role in helping customers better understand the non-digital attributes of products and attracting potential market demand. Moreover, since such offline service cannot be available via online channels, it becomes an effective way for the

traditional retailer in a dual-channel supply chain to build competitive advantages and compete with the upstream manufacturer's online channel. Some scholars investigate the impact of offline service on the upstream manufacturer. For example, Dan et al. [7] investigate the strategic role of the competitive service provided by the retailer in a dual-channel supply chain. They find that the retailer service plays a significant role in the manufacturer's pricing decision. Li and Li [8] consider the scenario where the retailer provides competitive service. They find that a higher service level will drives the manufacturer to set a higher wholesale price to compete with the retailer. Although the offline service can bring competitive advantages for the retailer, it may not necessarily generate actual demand for the retailer's offline channel due to customer service free-riding behavior. Service free-riding behavior refers to that customers take advantage of the pre-sale service to trying out products in the offline channel and then purchase from the online channel operated by a competitor. Such behavior has been documented by industrial surveys and observations in the real world [9-12]. Some scholars investigate the impact of free riding. For example, Balakrishnan et al. [13] find that free riding can intensify price competition between the online and offline channels. Li et al. [14] investigate the impact of free riding on three service strategies and analyze the impacts of different service strategies on optimal decisions and profits. Bian et al. [15] investigate whether a manufacturer should introduce an online channel by himself or by a downstream retailer in the presence of customer free-riding behavior. Tian et al. [16] investigate how a manufacturer decides on the product strategy in the online and offline channels, namely homogeneous or differentiated products, when there exists free riding. Further, to alleviate the negative impact of free riding, Zhou et al. [17] verify the role of service cost-sharing contract in alleviating competition resulting from free riding. Liu et al. [18] put forward an agency selling agreement to alleviate negative impact of free riding and improve channel efficiency. Guo et al. [19] compare the role of cost-sharing contract in eliminating the negative impacts of free riding under Manufacturer-Stackelberg and Retailer-Stackelberg settings. In summary, scholars have paid much attention to the impact of offline service in the context of dual-channel supply chain, but they mainly concentrate on channel competition and channel conflict resulting from offline service.

2.2. Channel Integration

With the continuous upgrading of customer purchase demand, firms come to realize that the relationship between online and offline channels should be complementary rather than competitive. Shearman [20] holds the view that the retail in the future sits at the integration of online and offline channels. Motivated by this trend, scholars begin to explore how to integrate channels under two modes. One is online to offline mode, and the other is offline to online mode. We focus on reviewing the latter since our research is related to the offline to online mode.

Regarding the offline to online mode, scholars mainly focus on the mode of "experience offline and purchase online", which is realized by launching offline showrooms for providing experience service and inducing customers to purchase online. Some scholars focus on whether an online-first firm should launch an offline showroom and investigate the impact of the showroom. For example, Li et al. [21] investigate whether an e-tailer selling differentiated products

launches a showroom and how to determine the product display strategy, and analyze the impact of showroom on optimal profit. Fan et al. [22] investigate the strategic choices between showroom and physical store for two e-tailers by considering channel preference. Konur [23] investigates whether two competitive e-tailers should launch a showroom individually or together. They find that a shared showroom can improve total profit. These studies focus on whether single firms launch a showroom. However, the game relationship between upstream and downstream members in a supply chain will definitely increase the complexity and difficulty of implementing showroom strategy. Several scholars investigate whether and how to choose a showroom strategy under a supply-chain situation. Liu et al. [24] investigate who, the manufacturer or the retailer, invests experience service into the offline channel owned by the retailer can bring more profit for the members and the whole supply chain. Dan et al. [25] investigate an online manufacturer should cooperative with a competing or noncompeting retailer to obtain experience service provision for online products. Guo et al. [26] investigate three showroom strategies in an e-commerce supply chain, namely manufacturer launching a showroom, retailer launching a showroom and a showroom launched by cooperation. They find that the choice of the showroom strategy needs to consider the impacts of production cost and product quality.

Present studies regarding launching offline showrooms concentrate on whether single firms or the downstream member in a supply chain should launch a showroom and provide experience service. By assuming the same service cost-effectiveness coefficient between supply chain members, Liu et al. [24] and Guo et al. [26] compare and analyze the effects when the upstream member and the downstream member launch a showroom respectively. However, due to the difference of service experience and abilities, the service cost-effectiveness coefficient between members often varies. Besides, different from previous studies, we consider the interaction of promoting and reducing effects on channel demand resulting from the introduction of the showroom and explore whether the former can overwhelm the latter to

demonstrate the value of the showroom in enhancing market demand. Based on the difference in service cost-effectiveness coefficient and the interaction of the two effects, we further investigate whether and who to launch the showroom can enhance market demand, improve members' profits and the whole supply chain performance better.

3. Model Framework

We consider an e-commerce supply chain consisting of a brand manufacturer (she, hereinafter referred as to manufacturer) and an online retailer (he, hereinafter referred as to retailer), as shown in Figure 1 (a). The manufacturer distributes the product to the retailer at wholesale price w_m , and then the retailer resells the product through his online channel at price p_r . To meet customers' need on product experience, this e-commerce supply chain intends to transfer to an omni-channel supply chain through introducing a showroom. The showroom provides consumers with experience service, which may include product trial, functional experience and assistant help, etc., and induces them to purchase in the online channel. We use s to denote the service level. Similar to [27], we assume that the service cost is $C(s) = \frac{1}{2}ks^2$, in which $k(k > 0)$ denotes the service

cost-effectiveness coefficient (hereinafter referred as to cost coefficient). Specifically, we consider two kinds of showroom strategies. One is BS strategy where the manufacturer introduces a showroom (as shown in Figure 1 (b)), and the other is OS strategy where the retailer introduces a showroom (as shown in Figure 1 (c)).

First of all, we investigate the benchmark case in which the e-commerce supply chain does not introduce a showroom. Then, we investigate the two kinds of showroom strategies. In the following, we use the superscript N, B and O to denote the benchmark case, the BS strategy and the OS strategy, and use subscript m and r to denote the manufacturer and the retailer, respectively. To avoid trivial cases, we assume that $p_r > w_m$.

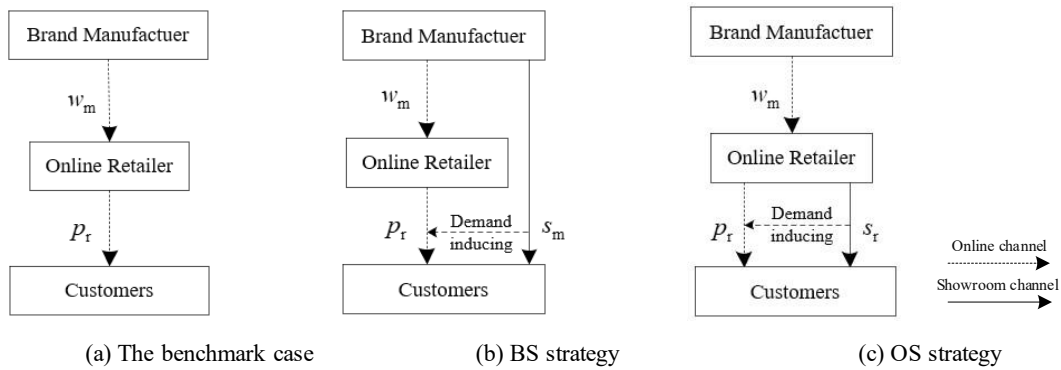


Figure 1. supply chain structures under different cases

3.1. Benchmark Case: The Absence of Showroom

To investigate the value of showroom, we first analyze the optimal decisions under the benchmark case in the absence of showroom (denoted by superscript N). Under this case, customers can only buy the product through the retailer's online channel directly. Thus, the channel demand is determined by the base demand and the online price. Without loss of generality, we assume that the market base of the

online channel is 1. In addition, similar to many studies related to online and offline channels, such as [28-29], we adopt linear form to build demand functions. Then, the demand in the online channel is described as follows:

$$d_r^N = 1 - p_r^N \quad (1)$$

Based on equation (1), we can further establish the manufacturer's and the retailer's profit functions as follows:

$$\pi_m^N(w_m^N) = w_m^N d_r^N \quad (2)$$

$$\pi_r^N(p_r^N) = (p_r^N - w_m^N) d_r^N \quad (3)$$

The manufacturer and the retailer maximize their own profits in a Stackelberg game. The sequence of the game is as follows. The manufacturer acts as a leader to set the wholesale price w_m^N first, and then the retailer acts as a follower to set price p_r^N after observing w_m^N . By using the backward induction method, the optimal decision, demand and profit under the benchmark case are $w_m^{N*} = \frac{1}{2}$, $p_r^{N*} = \frac{3}{4}$, $d_r^{N*} = \frac{1}{4}$, $\pi_m^{N*} = \frac{1}{8}$ and $\pi_r^{N*} = \frac{1}{16}$.

3.2. Omni-channel Supply Chain

In the omni-channel supply chain, customers have two choices when they decide to purchase. One is that they can purchase through the online channel directly, and the other is that they can first visit the offline showroom and then switch to the online channel to purchase (hereinafter referred to as showroom channel). Thus, compared with the benchmark case, the introduction of showroom will divide the base market into two parts, namely the base market of the online channel and the base market of showroom channel. Besides, since the experience service in the showroom can help customers to gain more knowledge and perception for the product, it effectively promotes the product demand in showroom channel. However, such experience service may

attract customers who originally intend to purchase online directly, which then makes certain negative effect on the demand in the online channel. Thus, the demand in the online channel and the demand in the showroom channel are

$$d_{r1} = a - p_r - \lambda s_i \quad (4)$$

$$d_{r2} = 1 - a - p_r + s_i \quad (5)$$

Where $i = m, r$. s_m and s_r denote the experience service level provided by the manufacturer and by the retailer, respectively. a ($0 < a < 1$) denotes base market size of the online channel, and $1 - a$ denotes the base market size of the showroom channel. λ ($0 < \lambda < 1$) denotes the reducing effect of experience service on the demand in the online channel. In the following, we are going to analyze the BS strategy where the manufacturer introduces a showroom and the OS strategy where the retailer introduces a showroom, respectively.

3.2.1. BS Strategy: The Brand Manufacturer Introduces a Showroom

In the BS strategy (denoted by superscript B), the manufacturer introduces a showroom and provides experience service. The service level is s_m , and the service cost is $C(s_m) = \frac{1}{2} k_m s_m^2$. The sequence of events in the BS strategy is as follows. The manufacturer first sets the wholesale price w_m^B and the experience service level s_m^B , then the retailer sets the product price p_r^B , that is:

$$\max \pi_m^B(w_m^B, s_m^B) = w_m^B (d_{r1}^B(p_r^{B*}(w_m^B, s_m^B), s_m^B) + d_{r2}^B(p_r^{B*}(w_m^B, s_m^B), s_m^B)) - C(s_m^B) \quad (6)$$

Where

$$\begin{cases} p_r^{B*}(w_m^B, s_m^B) = \arg\max_{p_r^B > w_m^B} \pi_r^B \\ \pi_r^B(p_r^B) = (p_r^B - w_m^B) (d_{r1}^B(p_r^B, s_m^B) + d_{r2}^B(p_r^B, s_m^B)) \end{cases} \quad (7)$$

After solving equations (6) and (7), we obtain the optimal decisions in the BS strategy.

Theorem 1. In the BS strategy, the manufacturer's and the retailer's optimal decisions are $w_m^{B*} = \frac{2k_m}{8k_m - (1-\lambda)^2}$,

$$s_m^{B*} = \frac{1-\lambda}{8k_m - (1-\lambda)^2}, \quad p_r^{B*} = \frac{3k_m}{8k_m - (1-\lambda)^2}.$$

Proof of Theorem 1. By using the backward induction method, we could obtain the retailer's best response function of price with regard to w_m^B and s_m^B as $p_r^{B*}(w_m^B, s_m^B)$ from Equation (7). It is easily to know that π_r^B is concave in p_r^B . Then, we derive $p_r^{B*}(w_m^B, s_m^B) = \frac{1}{4}(1 + 2w_m^B + s_m^B - \lambda s_m^B)$ by letting $\partial \pi_r^B(p_r^B) / \partial p_r^B = 0$. After substituting $p_r^{B*}(w_m^B, s_m^B)$ into Equation (6), we obtain the Hessian Matrix of π_m^B on

$$w_m^B \text{ and } s_m^B \text{ as } H = \begin{bmatrix} -2 & \frac{1}{2}(1-\lambda) \\ \frac{1}{2}(1-\lambda) & -k_m \end{bmatrix}. \text{ Thus, } \pi_m^B \text{ is}$$

jointly concave in w_m^B and s_m^B when $k_m > \frac{(1-\lambda)^2}{8}$. After

solving $\partial \pi_m^B / \partial w_m^B = 0$ and $\partial \pi_m^B / \partial s_m^B = 0$, we obtain w_m^{B*} and s_m^{B*} . By substituting w_m^{B*} and s_m^{B*} into $p_r^{B*}(w_m^B, s_m^B)$, we can have p_r^{B*} .

According to Theorem 1, we find that the increase of the cost coefficient will pose pressure on the manufacturer and lead to a decrease of service level. Besides, the enhancement of the reducing effect of experience service also forces the manufacturer to decrease service level to control the channel competition between the online channel and the showroom channel. Then, the manufacturer would decrease the wholesale price to allow the retailer to set the retail price flexibly. Although the decreased service level mitigates the reducing effect on the demand in online channel, it also reduces the promoting effect on the demand in showroom channel. After balancing these effects, the retailer decreases the retail price to attract more potential customers to combat the adverse effect.

By substituting the optimal decisions into equations (4), (5), (6) and (7), we obtain the optimal total demand and the

$$\text{optimal profits as } d_r^{B*} = \frac{2k_m}{8k_m - (1-\lambda)^2},$$

$$\pi_m^{B*} = \frac{1}{2} \frac{k_m}{8k_m - (1-\lambda)^2}, \quad \pi_r^{B*} = \frac{2k_m^2}{(8k_m - (1-\lambda)^2)^2}.$$

3.2.2. OS Strategy: The Online Retailer Introduces a Showroom

In the OS strategy (denoted by superscript O), the retailer introduces a showroom and provides experience service. The service level is s_r , and the service cost is $C(s_r) = \frac{1}{2}k_r s_r^2$.

$$\max \pi_m^O(w_m^O) = w_m^O \left(d_{r1}^O(p_r^{O*}(w_m^O), s_r^{O*}(w_m^O)) + d_{r2}^O(p_r^{O*}(w_m^O), s_r^{O*}(w_m^O)) \right) \quad (8)$$

Where

$$\begin{cases} (p_r^{O*}(w_m^O), s_r^{O*}(w_m^O)) = \operatorname{argmax}_{p_r^O > w_m^O} \pi_r^O \\ \pi_r^O(p_r^O, s_r^O) = (p_r^O - w_m^O) \left(d_{r1}^O(p_r^O, s_r^O) + d_{r2}^O(p_r^O, s_r^O) \right) - C(s_r^O) \end{cases} \quad (9)$$

After solving equations (8) and (9), we obtain the optimal decisions in the OS strategy.

Theorem 2. In the OS strategy, the manufacturer's and the retailer's optimal decisions are $w_m^{O*} = \frac{1}{4}$,

$$s_r^{O*} = \frac{1}{2} \frac{1-\lambda}{4k_r - (1-\lambda)^2}, \quad p_r^{O*} = \frac{1}{4} \frac{6k_r - (1-\lambda)^2}{4k_r - (1-\lambda)^2}.$$

Proof of Theorem 2. Firstly, we obtain the Hessian Matrix of π_r^O on p_r^O and s_r^O , and derive that $H = \begin{bmatrix} -4 & 1-\lambda \\ 1-\lambda & -k_r \end{bmatrix}$. Thus, π_r^O is jointly concave in p_r^O and s_r^O when $k_r > \frac{(1-\lambda)^2}{4}$. By letting $\partial \pi_r^O / \partial p_r^O = 0$ and $\partial \pi_r^O / \partial s_r^O = 0$, we obtain $p_r^{O*}(w_m^O)$ and $s_r^{O*}(w_m^O)$. After substituting $p_r^{O*}(w_m^O)$ and $s_r^{O*}(w_m^O)$ into π_m^O , we find that π_m^O is strictly concave in w_m^O . By solving $\partial \pi_m^O / \partial w_m^O = 0$, we obtain w_m^{O*} . By substituting w_m^{O*} into $p_r^{O*}(w_m^O)$ and $s_r^{O*}(w_m^O)$, we can have p_r^{O*} .

According to Theorem 2, the manufacturer's wholesale price remains constant in the OS strategy regardless of the cost coefficient and the reducing effect. For the retailer, the increase of both the cost coefficient and the reducing effect would force the retailer to decrease the service level to control service cost and reduce the negative impact of the reducing effect. Meanwhile, the retailer decreases his retail price in order to stimulate the demand.

Substituting the optimal decisions into equations (4), (5), (8) and (9), we obtain the optimal total demand and the

$$\text{optimal profits as } d_r^{O*} = \frac{k_r}{4k_r - (1-\lambda)^2},$$

$$\pi_m^{O*} = \frac{1}{4} \frac{k_r}{4k_r - (1-\lambda)^2}, \quad \pi_r^{O*} = \frac{1}{8} \frac{k_r}{4k_r - (1-\lambda)^2}.$$

4. Analyses on the Impacts of Showroom

To analyze how the difference of the cost coefficients between the supply chain members affects the showroom value, we assume $k_r = \theta k_m$, in which $\theta (\theta > 0)$ denotes the

The sequence of events in the OS strategy is as follows. The manufacturer first sets the wholesale price w_m^O , then the retailer sets the product price p_r^O and the experience service level s_r^O , that is

difference between the supply chain members' cost coefficients (hereinafter referred to as the ratio of cost coefficient). If $\theta = 1$, it means that the manufacturer and the retailer incur the same service cost when providing the same service level. If $\theta < 1$, it means that the manufacturer incurs a higher service cost than the retailer when providing the same service level. If $\theta > 1$, it means that the manufacturer incurs a lower service cost than the retailer when providing the same service level. After substituting $k_r = \theta k_m$ into the optimal decisions and profits in Section 3, we would show the impacts of showroom.

4.1. The Impact of Showroom on Optimal Pricing Decisions

After comparing the supply chain members' optimal prices among the benchmark, BS strategy and OS strategy, we obtain Proposition 1.

Proposition 1 The difference of impact on the optimal price decisions between the two showroom strategies is shown as follows.

- (i) When $(\theta, k_m) \in R_1, R_1 = \left\{ \theta \leq 1, k_m > \frac{A}{4\theta} \right\}$, we have i)
- $$w_m^{N*} > w_m^{B*} > w_m^{O*}; \quad \text{ii) if } \frac{A}{4\theta} < k_m < \frac{A}{3\theta}, \text{ then}$$
- $$p_r^{O*} > p_r^{N*} > p_r^{B*}; \quad \text{if } \frac{A}{3\theta} < k_m < \frac{A}{2(3\theta-2)}, \text{ then}$$
- $$p_r^{N*} > p_r^{O*} > p_r^{B*}; \text{ if } k_m > \frac{A}{2(3\theta-2)}, \text{ then } p_r^{N*} > p_r^{B*} > p_r^{O*};$$
- (ii) When $(\theta, k_m) \in R_2, R_2 = \left\{ \theta > 1, \max\left(\frac{A}{4\theta}, \frac{A}{8}\right) < k_m \leq \frac{A}{4} \right\}$, we have
- i) $w_m^{B*} > w_m^{N*} > w_m^{O*}$; ii) if $\frac{A}{4\theta} < k_m < \min\left(\frac{A}{4}, \frac{A}{2(3\theta-2)}\right)$,
- $$\text{then } p_r^{O*} > p_r^{B*} > p_r^{N*}; \text{ if } \max\left(\frac{A}{8}, \frac{A}{2(3\theta-2)}\right) < k_m < \frac{A}{3\theta},$$
- $$\text{then } p_r^{B*} > p_r^{O*} > p_r^{N*}; \text{ if } \max\left(\frac{A}{8}, \frac{A}{3\theta}\right) < k_m < \frac{A}{4}, \text{ then}$$
- $$p_r^{B*} > p_r^{N*} > p_r^{O*};$$

- (iii) When $(\theta, k_m) \in R_3, R_3 = \left\{ \theta > 1, k_m > \frac{A}{4} \right\}$, we have i)
- $$w_m^{N*} > w_m^{B*} > w_m^{O*}; \quad \text{ii) if } \frac{A}{4} < k_m < \frac{A}{3\theta}, \text{ then}$$
- $$p_r^{O*} > p_r^{N*} > p_r^{B*}; \quad \text{if } \frac{A}{3\theta} < k_m < \frac{A}{2(3\theta-2)}, \text{ then}$$
- $$p_r^{N*} > p_r^{O*} > p_r^{B*}; \quad \text{if } k_m > \max\left(\frac{A}{2(3\theta-2)}, \frac{A}{4}\right), \text{ then}$$

$p_r^{N^*} > p_r^{B^*} > p_r^{O^*}$; in which $A=(1-\lambda)^2$.

Proof of Proposition 1. As we mentioned before, k_m need to satisfy the condition $k_m > \max\left\{\frac{A}{4\theta}, \frac{A}{8}\right\}$, and we have that

$k_m > \frac{A}{4\theta}$ if $\theta \leq 2$ and $k_m > \frac{A}{8}$ otherwise. We first prove

the relationships between wholesale prices under different strategies. It is easily to find that $w_m^{N^*} > w_m^{O^*}$. Then, we would compare $w_m^{N^*}$ with $w_m^{B^*}$. After setting $\Delta w_m^{B^*} = w_m^{N^*} - w_m^{B^*}$,

we derive that $\Delta w_m^{B^*} = \frac{1}{2} \frac{\lambda^2 - 2\lambda - 4k_m + 1}{\lambda^2 - 2\lambda - 8k_m + 1}$. Let

$f_1 = \lambda^2 - 2\lambda - 4k_m + 1$ and $f_2 = \lambda^2 - 2\lambda - 8k_m + 1$, and we

can see that f_1 and f_2 monotonically decrease in k_m .

When $0 < \theta \leq 1$, we find that $f_1\left(\frac{A}{4\theta}\right) < 0$ and

$f_2\left(\frac{A}{4\theta}\right) < 0$. Thus, we have $f_1 < 0$ and $f_2 < 0$, and hence

$w_m^{N^*} > w_m^{B^*}$. Then, we further compare $w_m^{B^*}$ with $w_m^{O^*}$. After setting $\Delta w_m^{OB^*} = w_m^{O^*} - w_m^{B^*}$, we derive

$\Delta w_m^{OB^*} = \frac{1}{4} \frac{(\lambda - 1)^2}{\lambda^2 - 2\lambda - 8k_m + 1} < 0$. Thus, when $0 < \theta \leq 1$, we

have $w_m^{N^*} > w_m^{B^*} > w_m^{O^*}$. The proof under the condition $\theta > 1$ is similarly. The proof of the comparison of retail prices under different strategies is similar to that of wholesale prices.

To show Proposition 1 intuitively, we draw Figure 2 and Figure 3 by setting $\lambda = 0.1$, where $A = 0.81$.

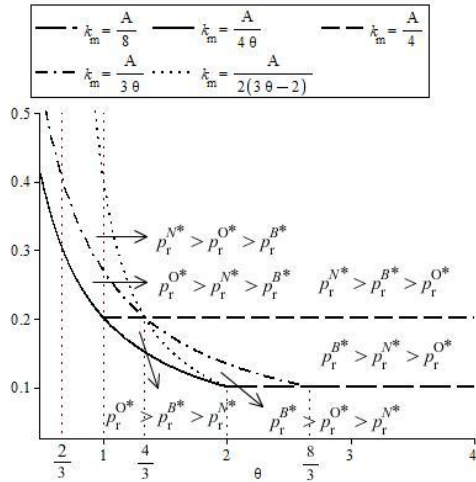


Figure 2. The impact of the two showroom strategies on the retail prices

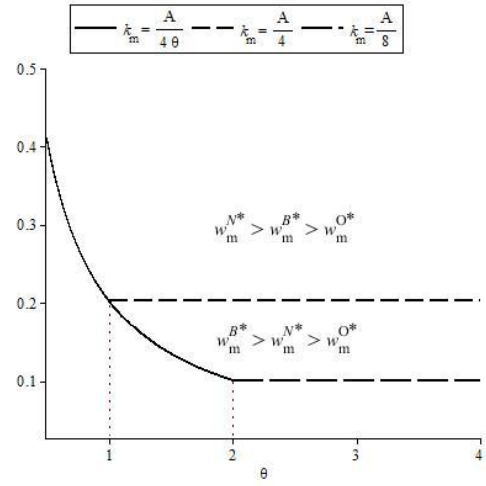


Figure 3. The impact of the two showroom strategies on the wholesale prices

Based on Figure 2 and Figure 3, we find that the difference of impact on the optimal pricing decisions between the two showroom strategies is related to the ratio of cost coefficient (θ) and the cost coefficient (k_m).

Firstly, we analyze the impact under the condition of $\theta \leq 1$. Under this condition, the manufacturer always decreases the wholesale price no matter who introduces the showroom. However, the manufacturer decreases the wholesale price to a greater degree in the OS strategy than that in the BS strategy. As for the retailer, he would decrease the retail price in the BS strategy, while his pricing strategy in OS strategy is further related to the ratio of cost coefficient and the cost coefficient.

Specifically, when $\theta \leq \frac{2}{3}$, the increase of k_m forces the

retailer to change his pricing strategy from price increase to price decrease, while the decrement is smaller than that in the BS strategy. When $\frac{2}{3} < \theta \leq 1$, the retailer still adopts the

same pricing strategy with the increase of k_m . However, when k_m is relatively large, the retailer would decrease his retail price to a greater degree than that in the BS strategy.

Then, we analyze the impact under the condition of $\theta > 1$. Under this condition, the impact of the showroom on the manufacturer's wholesale price depends on the cost coefficient k_m . That is, i) when k_m is small, namely

$\max\left(\frac{A}{4\theta}, \frac{A}{8}\right) < k_m \leq \frac{A}{4}$, the manufacturer would increase

wholesale price in the BS strategy while decrease it in the OS strategy. As for the retailer, he would also increase the retail price in the BS strategy while adjust pricing strategy according to the ratio of cost coefficient θ in the OS strategy.

When $1 < \theta \leq \frac{4}{3}$, the retailer also increases the retail price,

and the price increment in the OS strategy is larger than that in the BS strategy. When $\frac{4}{3} \leq \theta \leq \frac{8}{3}$, the retailer's pricing

strategy changes from price increase to price decrease. When $\theta > \frac{8}{3}$, the retailer would always decrease the retail price. ii)

when k_m increases, namely $k_m > \frac{A}{4}$, the manufacturer

implements the same strategy as that under $\theta \leq 1$. As for the retailer, he decreases his retail price in the BS strategy. However, in the OS strategy, the retailer's pricing strategy changes from price increase to price decrease with the increase of k_m when $1 < \theta \leq \frac{4}{3}$. when $\theta > \frac{4}{3}$, the retailer

always decreases his retail price, and the price decrement is larger than that in the BS strategy.

The above analyses indicate that after the showroom is introduced, the manufacturer and the retailer would adjust the optimal pricing strategy according to the ratio of cost coefficient, namely whether the member has a cost advantage, and the cost coefficient. For the manufacturer, she always decreases wholesale price in the OS strategy to provide the retailer with a lower procurement cost regardless of whether she has a cost advantage. For the retailer, he always follows the manufacturer's pricing strategy in the BS strategy to ensure a relatively stable margin profit.

In the following, we would compare and analyze the experience service levels in the BS and OS strategies.

4.2. The Comparison of Service Level

After comparing s_m^{B*} and s_r^{O*} , we obtain Proposition 2.

Proposition 2. (i) when $0 < \theta \leq 1$, if $k_m > \frac{A}{4\theta}$, then

$s_m^{B*} < s_r^{O*}$; (ii) when $1 < \theta \leq 2$, if $\frac{A}{4\theta} < k_m < \frac{A}{8(\theta-1)}$, then

$s_m^{B*} < s_r^{O*}$; if $k_m > \frac{A}{8(\theta-1)}$, then $s_m^{B*} > s_r^{O*}$; (iii) when

$\theta > 2$, if $k_m > \frac{A}{8}$, then $s_m^{B*} > s_r^{O*}$.

Proof of Proposition 2. The difference between s_m^{B*} and s_r^{O*} is $s_m^{B*} - s_r^{O*} = \frac{1}{2} \frac{(\lambda-1)(\lambda^2-8\theta k_m-2\lambda+8k_m+1)}{(\lambda^2-2\lambda-8k_m+1)(\lambda^2-4\theta k_m-2\lambda+1)}$.

After setting $f_3 = \lambda^2 - 8\theta k_m - 2\lambda + 8k_m + 1$, we find that f_3 increases in k_m and $f_3\left(\frac{A}{4\theta}\right) > 0$ when $0 < \theta \leq 1$. Thus, $f_3 > 0$. Similarly, we can obtain that $\lambda^2 - 2\lambda - 8k_m + 1 < 0$ and $\lambda^2 - 4\theta k_m - 2\lambda + 1 < 0$. Thus, we have $s_m^{B*} < s_r^{O*}$ under $0 < \theta \leq 1$. Similar to the proof when $0 < \theta \leq 1$, we can obtain the results of the difference between s_m^{B*} and s_r^{O*} under $1 < \theta \leq 2$ and $\theta > 2$.

Proposition 2 shows the difference between the service levels in the BS and the OS strategies. We can see that such difference is primarily related to the ratio of cost coefficient. When $\theta \leq 1$, the service level in the OS strategy is higher than that in the BS strategy. With the increase of the ratio of cost coefficient, namely $1 < \theta \leq 2$, the difference is further affected by the cost coefficient. Specifically, if the cost coefficient is small, the service level in the OS strategy is higher than that in the BS strategy. As the cost coefficient increases, the service level in the OS strategy becomes lower than that in the BS strategy due to the increase of service cost. When $\theta > 2$, the service level in the BS strategy is higher than the OS strategy.

4.3. The Impact of Showroom on Total Demand

After comparing the total market demand among the benchmark, BS strategy and OS strategy, we obtain Proposition 3.

Proposition 3 (i) When $\theta \leq 2$, we have $d_r^{N*} < d_r^{B*} < d_r^{O*}$; (ii) When $\theta > 2$, we have $d_r^{N*} < d_r^{O*} < d_r^{B*}$.

Where $d_r^{j*} = d_{r1}^{j*} + d_{r2}^{j*}$, $j = N, B, O$.

Proof of Proposition 3. The proof is similar to that of Proposition 2 and hence is omitted.

Proposition 3 reveals that the impact of different showroom strategies on total market demand is related to the ratio of cost coefficient. Firstly, compared with the benchmark case, we find that the introduction of showroom can increase the total market demand by attracting extra customers and satisfying customers' needs for experience. However, the demand increment varies between the two showroom strategies, which is further related to the ratio of cost coefficient. That is, when $\theta \leq 2$, the increment in the OS strategy is larger than that in the BS strategy. Otherwise, the increment in the BS strategy is larger than that in the OS strategy. Combined with Proposition 2, we find that the level of experience service in the showroom plays a crucial role in promoting market demand.

4.4. The Impact of Showroom on Profits

After comparing the supply chain members' optimal profits among the benchmark, BS strategy and OS strategy, we obtain Proposition 4.

Proposition 4 The impact of showroom on supply chain members' optimal profits is as follows.

(i) The impact on the optimal profits in the BS strategy is

i) When $0 < \theta < 2 - \sqrt{2}$, if $k_m > \frac{A}{4\theta}$, we have $\pi_m^{N*} > \pi_m^{B*}$,

$\pi_r^{N*} > \pi_r^{B*}$;

ii) When $2 - \sqrt{2} < \theta \leq 1$, a. if $k_m > \frac{A}{4\theta}$, $\pi_m^{N*} > \pi_m^{B*}$; b. If

$\frac{A}{4\theta} < k_m < \frac{(2+\sqrt{2})A}{8}$, then $\pi_r^{N*} < \pi_r^{B*}$; If $k_m > \frac{(2+\sqrt{2})A}{8}$,

then $\pi_r^{N*} > \pi_r^{B*}$;

iii) When $\theta > 1$, a. If $\max\left\{\frac{A}{4\theta}, \frac{A}{8}\right\} < k_m < \frac{A}{4}$, then

$\pi_m^{N*} < \pi_m^{B*}$, $\pi_r^{N*} < \pi_r^{B*}$; b. If $\frac{A}{4} < k_m < \frac{(2+\sqrt{2})A}{8}$, then

$\pi_m^{N*} > \pi_m^{B*}$, $\pi_r^{N*} < \pi_r^{B*}$; c. If $k_m > \frac{(2+\sqrt{2})A}{8}$, then

$\pi_m^{N*} > \pi_m^{B*}$, $\pi_r^{N*} > \pi_r^{B*}$

(ii) The impact on the optimal profit in the OS strategy is

i) When $0 < \theta < 4$, a. If $\max\left\{\frac{A}{4\theta}, \frac{A}{8}\right\} < k_m < \frac{A}{2\theta}$, then

$\pi_m^{N*} < \pi_m^{O*}$, $\pi_r^{N*} < \pi_r^{O*}$; b. If $k_m > \frac{A}{2\theta}$, then $\pi_m^{N*} > \pi_m^{O*}$,

$\pi_r^{N*} > \pi_r^{O*}$

ii) When $\theta \geq 4$, if $k_m > \frac{A}{8}$, we have $\pi_m^{N*} > \pi_m^{O*}$,

$$\pi_r^{N^*} > \pi_r^{O^*}.$$

Proof of Proposition 4. (i) We first prove the impact of showroom on the optimal profit in the BS strategy. Through comparing $\pi_m^{N^*}$ and $\pi_m^{B^*}$, we obtain

$$\pi_m^{B^*} - \pi_m^{N^*} = -\frac{1}{8} \frac{\lambda^2 - 2\lambda - 4k_m + 1}{\lambda^2 - 2\lambda - 8k_m + 1}. \quad \text{By setting}$$

$f_4 = \lambda^2 - 2\lambda - 4k_m + 1$, we find that f_4 decreases in k_m and $f_4\left(\frac{A}{4\theta}\right) < 0$ when $0 < \theta \leq 1$. Then, we have $f_4 < 0$. In

addition, it is obvious to see that $\lambda^2 - 2\lambda - 8k_m + 1 < 0$. Thus, we have $\pi_m^{N^*} > \pi_m^{B^*}$ when $0 < \theta \leq 1$. Through comparing $\pi_r^{N^*}$ and $\pi_r^{B^*}$, we obtain

$$\pi_r^{B^*} - \pi_r^{N^*} = -\frac{1}{16} \frac{32k_m^2 - 16(1-\lambda)^2 k_m + (1-\lambda)^4}{(\lambda^2 - 2\lambda - 8k_m + 1)^2}. \quad \text{By setting}$$

$f_5 = 32k_m^2 - 16(1-\lambda)^2 k_m + (1-\lambda)^4$, we find that f_5 is concave in k_m . By substituting $k_m = \frac{A}{4\theta}$ into f_5 , we find

that $f_5\left(\frac{A}{4\theta}\right) > 0$ when $0 < \theta < 2 - \sqrt{2}$. Then, we need to

further compare $\frac{A}{4\theta}$ with the roots of $f_5 = 0$. By setting

$f_5 = 0$, we derive the roots of $f_5 = 0$ as $\frac{(2-\sqrt{2})A}{8}$ and

$\frac{(2+\sqrt{2})A}{8}$. Obviously, $\frac{A}{4\theta} > \frac{(2-\sqrt{2})A}{8}$. Then, we have

$f_5 > 0$ and hence $\pi_r^{N^*} > \pi_r^{B^*}$ when $0 < \theta \leq 2 - \sqrt{2}$.

Similarly, we obtain the impacts under $\theta > 2 - \sqrt{2}$. Then, the impact of showroom on the manufacturer's optimal profit is proved.

(ii) the impact of showroom on the retailer's optimal profit is similar to (i) and hence is omitted.

Proposition 4 shows the impacts of showroom introduction on the supply chain members' profits in different showroom strategies. When the ratio of cost coefficient is small, namely $\theta \leq 1$, the manufacturer suffers from the BS strategy while both members benefit from the OS strategy. When the ratio of cost coefficient is moderate, namely $1 < \theta \leq 4$, if the cost

coefficient is relatively small, both members can benefit from showroom introduction regardless of who introduces it. As the ratio of cost coefficient increases, namely $\theta > 4$, both members can benefit from the BS strategy but suffer from the OS strategy if the cost coefficient is relatively small.

Based on Proposition 4, we further compare the supply chain members' optimal profits in the BS strategy and the OS strategy, and then we obtain the Corollary 1.

Corollary 1 (i) When $0 < \theta \leq 1$, we have $\pi_m^{B^*} < \pi_m^{O^*}$, $\pi_r^{B^*} < \pi_r^{O^*}$;

(ii) When $1 < \theta < 2$, i) $\pi_m^{B^*} < \pi_m^{O^*}$. ii) If $\frac{A}{4\theta} < k_m < \frac{\theta A}{16(\theta-1)}$, then $\pi_r^{B^*} < \pi_r^{O^*}$. If $k_m > \frac{\theta A}{16(\theta-1)}$, then $\pi_r^{B^*} > \pi_r^{O^*}$;

(iii) When $\theta \geq 2$, we have $\pi_m^{B^*} > \pi_m^{O^*}$, $\pi_r^{B^*} > \pi_r^{O^*}$.

Proof of Corollary 1. The proof is similar to the proof of proposition 4 and hence is omitted. $\square$

We can see that when the retailer has a cost advantage, both members can obtain more profits in the OS strategy than those in the BS strategy. With the increase of the ratio of cost coefficient, the OS strategy can still bring more profit for the manufacturer even if the retailer does not have a cost advantage. As the ratio of cost coefficient further increases, the manufacturer's cost advantage is becoming obvious. Then, the BS strategy can bring more profits for the supply chain members than the OS strategy.

5. Numerical Analyses

In this section, we conduct numerical analyses to compare the benchmark case with the two showroom strategies and show the impacts of different showroom strategies on market demand and the optimal profits more intuitively and comprehensively.

5.1. Impact of Showroom on Market Demand

In this subsection, we are going to analyze how the promoting and reducing effects resulting from the introduction of showroom affect market demand. By setting $\theta=1$ and $k_m=0.3$, we obtain the impacts of showroom on channel demand in the BS and OS strategies and the results are summarized in Figure 4 and Figure 5, where $\Delta d_{r1}^{B^*} = d_{r1}^{B^*} - d_{r1}^{N^*}$ and $\Delta d_{r1}^{O^*} = d_{r1}^{O^*} - d_{r1}^{N^*}$.

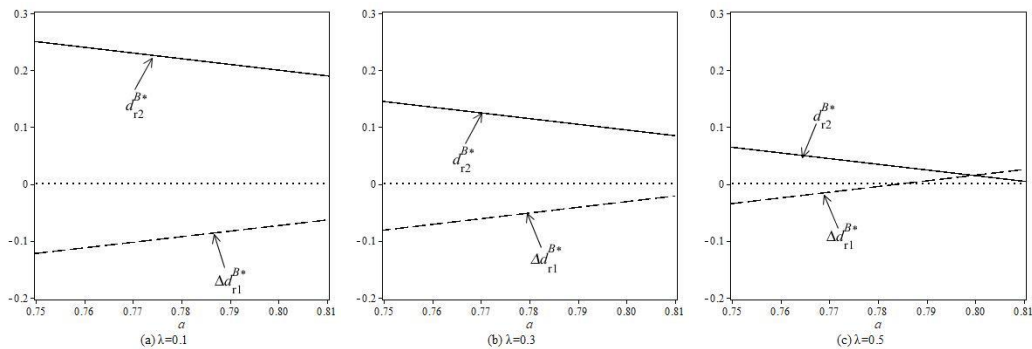


Figure 4. The impact of showroom on the market demand in the BS strategy

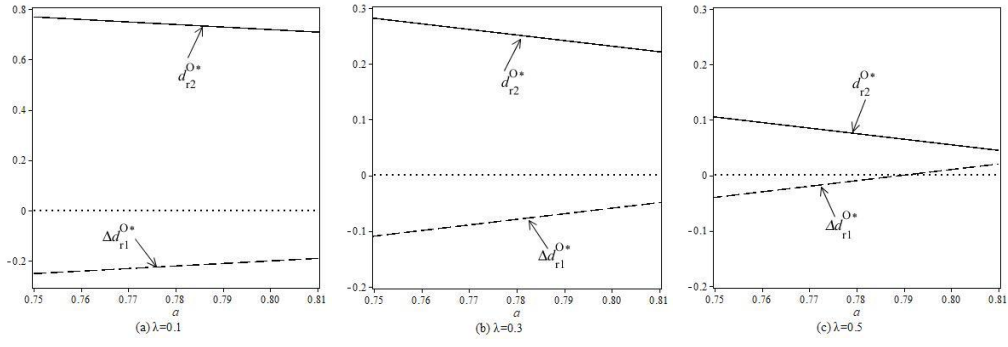


Figure 5. The impact of showroom on the market demand in the OS strategy

Figure 4 and Figure 5 show that showroom introduction takes away some customers who originally purchase in the online channel directly to the showroom channel and result in the demand reduction for the online channel. This suggests that introducing a showroom will cannibalize the demand in the online channel. Further, the intensity of cannibalization is related to the reducing effect of experience service on the demand in the online channel. Through horizontally comparing Figures. 4 (a), 4 (b) and 4 (c), as well as Figures. 5 (a), 5 (b) and 5 (c), we find that the intensity of cannibalization decreases as the reducing effect increases. This is because the enhancement of the reducing effect forces the party who introduces the showroom to reduce service level in order to control the negative impact on the demand in the online channel. However, the demand in the showroom channel also accordingly decreases as the experience service level decreases. Even so, the promoting effect overwhelms the reduction effect, thus resulting in the increase of the total market demand.

Besides, through vertically comparing Figure 4 and Figure 5, we find that the retailer is willing to provide a higher service level than the manufacturer when they have the same

cost coefficient. The higher service level can bring about a stronger promoting effect on the demand in the showroom channel. However, it also generates a stronger reducing effect on the demand in the online channel. Combining these two effects, we find that the promoting effect can overwhelm the reducing effect. Therefore, when the manufacturer and the retailer have the same cost coefficient, the OS strategy where the retailer introduces a showroom can bring more market demand to the supply chain.

5.2. Impact of Showroom on the Optimal Profits

In this subsection, we would analyze the impacts of different showroom strategies on the supply chain members' optimal profits. Firstly, we analyze the impacts of the BS strategy and the OS strategy on the optimal profits in subsection 5.2.1 and subsection 5.2.2, respectively. Then, we further compare and analyze the impacts of the BS strategy and the OS strategy on optimal profits in subsection 5.2.3.

5.2.1. Impact of the BS Strategy on the Optimal Profit

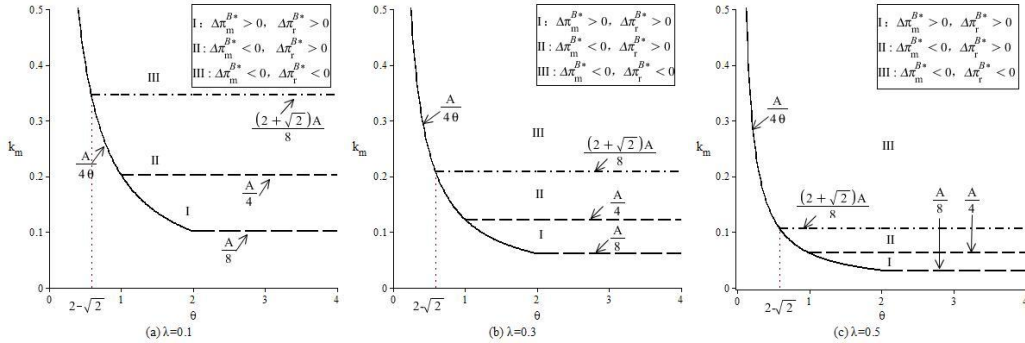


Figure 6. The impact of showroom on the optimal profit in the BS strategy

Figure 6 shows that the impact of the BS strategy on the supply chain members' optimal profits, where $A=0.81$ in Figure 6 (a), $A=0.49$ in Figure 6 (b), $A=0.25$ in Figure 6 (c), $\Delta\pi_m^{B*} = \pi_m^{B*} - \pi_m^{N*}$ and $\Delta\pi_r^{B*} = \pi_r^{B*} - \pi_r^{N*}$. We can see that the impact is related to the ratio of cost coefficient (θ) and the cost coefficient (k_m). When the ratio of cost coefficient is less than $2 - \sqrt{2}$, both the members suffer from the BS strategy. As the ratio of the cost coefficient increases ($2 - \sqrt{2} < \theta \leq 1$), the BS strategy can benefit the retailer if the cost coefficient is relatively small. For the manufacturer, she will still suffer a profit loss because the increased demand brought by the showroom cannot offset the service cost. As the ratio of the cost coefficient further increases ($\theta > 1$), both members can benefit from the BS strategy when the cost

coefficient is relatively small (Region I). Given the ratio of the cost coefficient, the profit increment in the win-win region would decrease as the cost coefficient increases.

By comparing Figures. 6 (a), 6 (b) and 6 (c), we can see that given the ratio of cost coefficient, the reducing effect will decrease the upper and lower boundaries of the win-win region and further shorten the range of the region. Besides, given the ratio of cost coefficient and cost coefficient, the enhancement of the reducing effect will lead to the reduction of profit increment.

5.2.2. Impact of the OS Strategy on the Optimal Profit

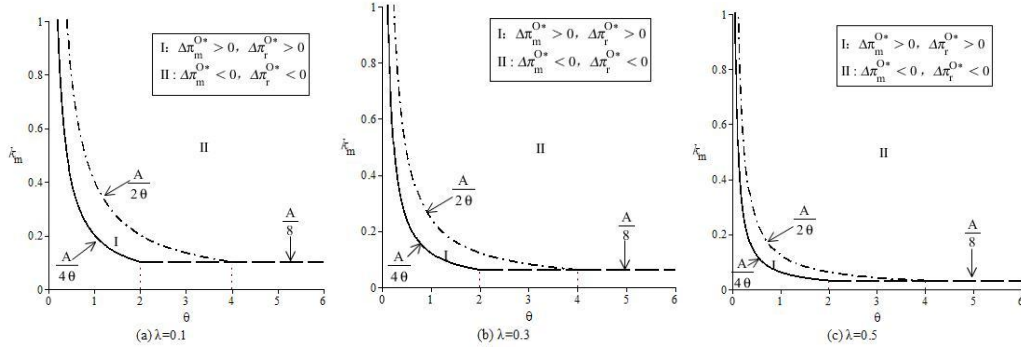


Figure 7. The impact of showroom on the optimal profit in the OS strategy

Figure 7 shows that the impact of OS strategy on the supply chain members' optimal profits, where $A=0.81$ in Figure 7 (a), $A=0.49$ in Figure 7 (b), $A=0.25$ in Figure 7 (c), $\Delta\pi_m^{OS} = \pi_m^{OS} - \pi_m^{N*}$ and $\Delta\pi_r^{OS} = \pi_r^{OS} - \pi_r^{N*}$. The impact is related to the ratio of cost coefficient (θ) and the cost coefficient (k_m). We can see that both members can achieve win-win situation in the OS strategy when $\theta \leq 4$ and $\max\left\{\frac{A}{4\theta}, \frac{A}{8}\right\} < k_m < \frac{A}{2\theta}$. Furthermore, it can be found that with the increase of the ratio of cost coefficient, the value of the upper and lower boundaries of the interval decreases, and the range of the win-win interval is shortened. Meanwhile, given the ratio of cost coefficient, the increase of the cost coefficient will lead to the decrease of profit increment. When $\theta > 4$, both members suffer from the OS strategy, and the profit decrement will be aggravated with the increase of the cost coefficient.

By comparing Figures 7 (a), 7 (b) and 7 (c), we can see that given the ratio of cost coefficient, the reducing effect will decrease the upper and lower boundaries of the win-win region and further shorten the range.

The observations on Figure 6 and Figure 7 indicate that the impact of different showroom strategies depends on whether the supply chain members have a cost advantage, the cost coefficient and the reducing effect of experience service provided in the showroom on the demand in the online channel. Firstly, compared with the benchmark, the BS strategy benefits the supply chain members only when the manufacturer has a cost advantage and bears a relatively small cost coefficient. As for the OS strategy, it can benefit both members regardless of whether the retailer has a cost advantage or not ($0 < \theta \leq 1$ or $1 < \theta < 4$). However, as the retailer's cost advantage weakens, the profit increment in the win-win region decreases. Secondly, given the ratio of the cost coefficient, the increase of cost coefficient will weaken the promoting effect of showroom on the members' profits. Lastly, the enhancement of the reducing effect requires the party introducing the showroom to pay more attention to cost control. This is because the enhancement of the reducing effect will discourage the party from providing high level of experience service, which then leads to a negative impact on the total market demand. At this point, a smaller cost coefficient is needed to further reduce the service cost and ensure the profit increase.

5.2.3. Analysis of the Showroom Strategy

To make a comparative analysis on which showroom strategy can better improve the supply chain members' profits, we conduct a comparison of the optimal profit among the

benchmark case, the BS strategy and the OS strategy by setting $\lambda=0.3$. From Corollary 1. (i), we can see that when the ratio of cost coefficient is small ($\theta \leq 1$), only the OS strategy can benefit both the supply chain members and the whole supply chain. Thus, in the following, we focus on analyzing the showroom strategy when $\theta > 1$. The result is summarized in Figure 8.

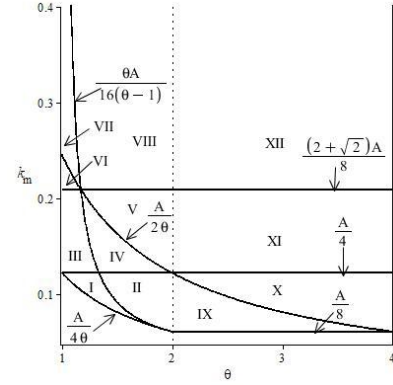


Figure 8. The profit comparisons among the three cases

Figure 8 shows the result of the profit comparisons among the benchmark case, the BS strategy and the OS strategy, where $A=0.49$. The result is related to the ratio of cost coefficient and the cost coefficient:

i) When the ratio of cost coefficient locates between 1 and 2 ($1 < \theta \leq 2$), compared with the benchmark case, both the two showroom strategies can benefit the supply chain members when $\frac{A}{4\theta} < k_m \leq \frac{A}{4}$. However, the profit increment

varies and depends on k_m . If k_m is relatively small (Region I), the OS strategy can bring more profit increment for both members than the BS strategy. If k_m is relatively large (Region II), the manufacturer prefers the OS strategy while the retailer prefers the BS strategy. When $\frac{A}{4} < k_m \leq \frac{(2+\sqrt{2})A}{8}$, the retailer can still benefit from the

BS strategy while the manufacturer suffers from it. As for the OS strategy, whether it can bring profit increase depends on k_m . In detail, if k_m is relative small (Region III), then the OS strategy can benefit both members. Besides, the retailer benefits more from the OS strategy than the BS strategy. If k_m is moderate (Region IV), the OS strategy can still benefit both members even if the retailer bears an increased cost coefficient, while the retailer's profit increment is less in the

OS strategy than that in the BS strategy. If k_m is relatively large (Region V), the OS strategy can no longer benefit the members due to the cost disadvantage and large cost coefficient faced by the retailer. When $k_m > \frac{(2+\sqrt{2})A}{8}$, both

members suffer from the the BS strategy (Regions VI~VIII). As for the OS strategy, it can benefit both members only if k_m is small (Region VI).

ii) As the ratio of cost coefficient further increases ($2 < \theta \leq 4$), when $\frac{A}{8} < k_m \leq \frac{A}{4}$, the BS strategy can benefit

both members. As for the OS strategy, whether it can bring profit increase depends on k_m . If k_m is relatively small (Region IX), it can also bring profit increase for the members. However, the profit increment is less than that in the BS strategy. If k_m is relatively large (Region X), the supply chain members suffer from the OS strategy. When $\frac{A}{4} < k_m \leq \frac{(2+\sqrt{2})A}{8}$, the BS strategy benefits the retailer

only while the OS strategy benefits neither of the members (Region XI). When $k_m > \frac{(2+\sqrt{2})A}{8}$, neither strategy can

benefit the supply chain members (Region XII).

The above analyses indicate that when the retailer has an absolute cost advantage ($\theta < 1$), the OS strategy can benefit both the supply chain members. As the retailer's cost advantage weakens and the manufacturer gradually has a cost advantage, who introduces the showroom can bring more profit increase depends on the cost coefficient. For the manufacturer, even if she has a relatively obvious cost advantage, the promoting effect of showroom on supply chain members' profits in the BS strategy is still less than that in the OS strategy. When the manufacturer has a prominent cost advantage and a relatively small cost coefficient, the BS strategy can bring more profit increment for the supply chain members than the OS strategy. For the retailer, even if he does not have a cost advantage and faces a large cost coefficient, the OS strategy can still bring more profit increment for both the members than the BS strategy under certain conditions.

6. Conclusions

6.1. Summary

Considering the difference of service cost-effectiveness coefficients between supply chain members as well as the promoting and reducing effects resulting from showroom introduction on channel demand, we explore who introduces a showroom can better improve the performance for an e-commerce supply chain. Through analyzing the impacts of two showroom strategies on the optimal pricing, the optimal service level, the total market demand and the optimal profit, we obtain the following results.

Firstly, how the two showroom strategies affect the supply chain members' optimal pricing strategies depends on whether the party introducing the showroom has a cost advantage and the cost coefficient. For the manufacturer: 1) she always decreases the wholesale price in the OS strategy to provide the retailer with a lower procurement cost; 2) In the BS strategy, when the manufacturer has a cost advantage, her

optimal pricing strategy changes from price increase to price decrease with the increase of the cost coefficient. When the manufacturer does not have a cost advantage, she always decreases the wholesale price to create a greater potential margin profit for the retailer and drive the retailer to set a lower retail price to attract customers. For the retailer: 1) No matter how the manufacturer's pricing strategy changes, he always follows the manufacturer's wholesale price strategy to ensure a relatively stable margin profit in the BS strategy. 2) In the OS strategy, when the retailer has a cost advantage, he will be prompted to increase his retail price to earn more margin profit if the cost coefficient is relatively small. As the cost advantage weakens and the cost coefficient increases, the retailer will always take the strategy of price decrease to promote market demand through low price.

Then, no matter who introduces the showroom, the demand promoting effect can overwhelm the negative impact of the reducing effect, thus realizing the increase of total market demand. However, the increment of the total market demand varies under the BS and the OS strategies, which depends on who has a cost advantage. In addition, whether the two showroom strategies can realize profit growth depends on whether the party introducing the showroom has a cost advantage and its cost coefficient. As for the BS strategy, only when the manufacturer has a prominent cost advantage and a small cost coefficient can it benefit the supply chain members. As for the OS strategy, no matter whether the retailer has a cost advantage or not, it can benefit both the manufacturer and the retailer under certain conditions. However, as the retailer's cost advantage weakens, both the members' profit increments will decrease. Given the ratio of cost coefficient, the increase of the cost coefficient and the enhancement of reducing effect will weaken the promotion effect of showroom on supply chain members' profits.

Finally, we would conclude the showroom strategy. When the retailer has a cost advantage ($\theta \leq 1$), only the OS strategy can improve the supply chain profit. When the retailer does not have a cost advantage ($1 < \theta \leq 2$), the OS strategy is still the optimal strategy for the supply chain and the members. When the manufacturer has a prominent cost advantage ($2 < \theta \leq 4$), although both the two showroom strategies can improve the supply chain profit under certain conditions, the BS strategy outperforms the OS strategy. When the brand manufacturer has an absolute cost advantage ($\theta > 4$), only the BS strategy can improve the supply chain profit.

6.2. Managerial Insights

The above results imply that a traditional e-commerce supply chain should focus on the following two points when transforming to an omni-channel supply chain. First, from the perspective of improving the overall benefit, the upstream and downstream firms in the supply chain should have a good understanding of each other's service cost effectiveness by communicating the strategies and experience of providing services. Second, after introducing a showroom channel, it is necessary to control the reducing effect of this channel on the demand in the pre-existing online channel. This is because the enhancement of the reducing effect will weaken the promoting effect of the showroom on profits. Then, the party introducing the showroom has to offset the negative reducing effect with a lower cost coefficient. Therefore, managers should first estimate and control the intensity of the reducing effect through market survey, and then improve service efficiency and reduce service cost by training staffs in the

showroom to strengthen the professional knowledge and effective communication skills.

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