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# OPTIMAL PRICING STRATEGY OF RETAILERS CONSIDERING SPECULATIVE CUSTOMERS' ADD-ON ITEMS RETURN BEHAVIOR WITH CROSS-STORE FULL-REDUCTION PROMOTION

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**Abstract.** This purpose of the paper is to explore the optimal price strategy for the retailers under the cross-store full-reduction promotion mode, where speculative consumers will deliberately purchase add-on items to qualify for discounts when the purchase amount is less than the "full-reduction" threshold and then return the add-on items after successful payment. With respect to the optimal decision problem consisting of two online complementary retailers and an e-commerce platform in the face of speculative consumers' add-on items return behavior, we construct the single-cycle sales decision models based on the revenue sharing contract. Furthermore, through the derivative function analysis method, we examine the effect of the proportion of speculative consumers, the proportion of product sharing discount amount and revenue sharing coefficient on the platform's sale strategy and the retailers' the optimal price strategy. The results show that whether platform implements cross-store full-reduction promotion strategy or not, the product price increases with the increase of revenue sharing coefficient. In addition, under the non-promotion sales mode, the optimal price is not affected by the speculative consumers' behavior. Under the cross-store full-reduction promotion sales mode, the optimal price changes with the proportion of product sharing discount amount and the proportion of speculative consumers. And the price of only purchasing single product in this case is always higher than the price under the non-promotion sales mode. Finally, we compare the profits under the two scenarios, it is found that the profits under the cross-store full-reduction promotion sales mode are not always higher than that under non-promotion sales mode and the boundary conditions for the platform to adopt different modes are further given.

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## 1. Introduction

In recent years, the emergence of internet information technology has greatly promoted the development of online retail. According to the data of the National Bureau of Statistics of New China, the online retail sales reached 11.76 trillion yuan in 2020, realizing an increase of 10.9% over 2019[1]. To achieve this goal, platform

*Keywords.* Revenue sharing contract, Cross-store full-reduction promotion, Add-on items return behavior, Price strategy.

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[1]http://www.mofcom.gov.cn/article/i/jyjl/j/202101/20210103033716.shtml.

discount promotion has become the marketing normality, and a new model of cross-store full-reduction promotion has emerged as the times require. Cross-store full-reduction promotion is that the online shopping platform breaks through the boundary of online stores and organizes the network alliance retailers to jointly carry out cross-store promotion activities. When consumers' shopping amount achieves the full-reduction threshold, consumers qualify for the price discounts, and the discount amount is allocated to each commodity in proportion (for example, in the cross-store "300 minus 30" activity implemented by Tmall.com, settled retailers sell products in accordance with the rule of "300 minus 30", that is, if the consumers' purchase amounts are greater than or equal to 300 yuan, they can enjoy 30-yuan discounts, and the discounts will be allocated to each commodity[2]). Otherwise, consumers will face two choices: purchase at the original price, or in order to enjoy the price discounts to increase the amount of shopping, which shows that the implementation of cross-store full-reduction promotion will affect consumers' purchase behavior. In addition, the relationship between online shopping platforms and settled retailers is generally based on the revenue sharing contract mechanism [1, 2], that is, the platform will charge a certain proportion of commission from settled retailers according to the actual transaction amount, and the commission rate varies according to the type of goods, for example, the commission rate charged by Tmall.com is between 0.5% and 5%.

Although cross-store full-reduction promotion can stimulate consumers' extra purchase and increase product sales [3–5], it also breeds the add-on items return behavior of speculative consumer whose purchase amounts are less than the full reduction threshold. Taking JD.com and Tmall.com as examples, at 0:00 on November 12, 2020, the two platforms officially announced that the total transaction volume of the "Double 11" was up to 769.7 billion yuan, but on the first day after the "Double 11" promotion festival, the topic of "refund" airborne the top of the microblog hot search list[4]. In the discussion area of this topic, there is a voting activity about "reasons for refund". The result shows that the vote for a refund reason that intentionally purchase add-on items to get discounts and then return the add-on items after successful payment ranks third, which means that the add-on items return behavior has become a common phenomenon. However, for retailers, due to the surge of customers' purchasing behavior during "Double 11", which involves a large amount of storage costs and labor costs, they often need to increase staff in advance to cope with "Double 11"[3]. The customers' add-on items return behavior on the one hand will affect retailers' calculation of inventory resources. On the other hand, the behavior of "customers who choose the add-on item deliberately" also inhibits the normal online shopping of other consumers to some extent. Especially for some small and medium-sized retailers, participating in "double 11" "cross-store full-reduction" promotion activity to a large extent is just for advertising. However, they will encounter such "add-on items refund", which is quite helpless.

Therefore, to maximize platform and two retailers' profits, it is a key problem to explore how to reasonably set the prices of the two products for two retailers and commission fees for the platform considering the existence of the customers' add-on items return behavior. For the purpose, this paper constructs the single-cycle sales decision models based on the revenue sharing contract to investigate the optimal promotion price strategies and the critical conditions for the platform to adopt cross-store full-reduction promotion in the online retail market.

The main research streams related to this paper are as follows: (i) the promotion strategy, and (ii) the consumer return.

Related researches on promotion strategies mainly include two aspects: The first is to study the impact of different promotion patterns on consumer behavior. Such as Lim [6] took the hotel industry as an example to explore the impact of different types of promotional activities on consumer behavior. The results show that discount promotion is usually more effective than surcharge free promotion in stimulating consumers' reservation intention. Hardesty and Bearden [7] proposed that under the same promotion level, consumers' purchase intentions are significantly different under different promotion methods. Further, Liang *et al.* [8] explored the impact of limited time promotion vs limited sales promotion on the share willingness of green products. The results show that limited time promotion can promote the share willingness of green products more, and consumers' environmental awareness plays a mediating role. Based on situational experiments, Winterich *et al.* [9]

[2]https://www.sohu.com/a/431950057_641950

explored the influence of consumers' self-construction types on their promotion preferences. The results show that consumers with independent characteristics prefer discounts. Consumers with dependent characteristics are more likely to choose donation promotion. Yoo *et al.* [10] put forward that price promotion can lead to a lower evaluation of the brand products by consumers compared with gift promotion. Zhou *et al.* [11] proposed that in both centralized and decentralized decision-making situations, the increase of promotion channels can stimulate the increase of demand.

The second is to study the retailers' promotion pricing decision. Retailers' frequent sales promotion makes consumers more and more predictable and strategic. In recent years, strategic customer behavior has attracted the attention of operations management researchers, and a lot of research literatures have emerged considering strategic customers and retailers promotional pricing decisions [12, 13]. Such as Aviv *et al.* [14] took retailers selling seasonal products as the research object to analyze how retailers should price during the promotion period when facing strategic consumers. The result shows that retailers' dynamic pricing and quick response can mitigate the impact of customers' strategic waiting behavior on their own revenue, and then improve their revenue. Furthermore, Li *et al.* [15] based on three different online coupon models, explored a platform's discount pricing strategy by constructing two cycle models in the face of strategic consumers. Demiriz [16] established a dynamic price model of products based on the demand function of linear regression prediction in order to optimize price decisions. Choi [17] takes fashion products as the research background, introduces the two-cycle inventory strategy, and analyzes the optimization mechanism of inventory and pricing strategies using Bayesian methods based on the actual demand in a specific period. Osadchiy and Bendoly [18] found that up to 79% of consumers showed strategic waiting behavior when faced with future purchase opportunities. Yu *et al.* [19] studied how retailers choose business models when facing strategic consumers under the price reduction strategy, and pointed out that when strategic consumers have a high level of patience, retailers tend to reduce prices in both stages. These studies mainly focus on the effect of different promotion patterns on consumer behavior, as well as strategic consumer and retailer pricing decisions [20]. However, there is a lack of quantitative and mathematical modeling to analyze the impact of the threshold promotion of full-reduction on consumers' purchase willingness. Moreover, there are few studies on the optimal promotion price decision of retailers considering the customers' speculative behavior when the platform implements full-reduction promotion strategy.

In studies of consumer returns, Akcay *et al.* [21] explored the impact of two processing methods of returned products (*i.e.* residual value processing or resale at discount) on retailers, and found that allowing returns increased the total revenue of retailers. Suwelack *et al.* [22] believe that money-back guarantees provided by the retailer can reduce consumers' perception of purchase risk, thus affecting consumers' purchase intention. Wan *et al.* [23] propose that that even if retailers cannot effectively handle customer returns, if the cost of checking returns is low, it is beneficial for retailers to choose to provide money-back guarantees return policies. Mcwilliams [24] compared the competition between high-quality enterprises and low-quality enterprises in the case with money-back guarantees (MBG), and concluded that it is the optimal Nash equilibrium for two types of enterprises to provide money-back guarantees at the same time. The research of Li *et al.* [25] also show that in some cases, retailers' adoption of money-back guarantees and personalized pricing strategy, as well as manufacturers adoption of money-back guarantees in their direct channels may lead to a win-win situation. There are also a small body of literatures that concludes that no-return is the optimal model for retailers. Hsiao and Chen [26] explored the situation that retailers are not allowed to return goods, and found that this model can bring higher profits to retailers under certain conditions. Petersen and Kumar [27] believe that when returns become a large probability event, retailers will suffer huge loss costs.

Table 1 compares this work with related previous researches regarding research context, research focus, and identified determinants for the optimality of the promotional strategies. A few key differences are worth highlighting. First, this paper describes the interest relationship between shopping platform and retailers settled based on revenue sharing contract, and explores the supply chain optimal decisions problems by constructing theoretical model.

TABLE 1. Comparison with related studies.

| Articles | Promotion type | Return policy | Revenue sharing contract | Consumer behavior | Research question | Key determinants of promotional strategies |
|---|---|---|---|---|---|---|
| Hardesty and Bearden [7] | Discount & bonus pack | No | No | – | The effects of price discounts *vs.* bonus packs and price presentation | (a) The promotional bene-fit level, (b) promotion type |
| Liang *et al.* [8] | Limited-time and limited-quantity promotions | No | No | – | The effect of the limited-time *vs.* limited-quantity on sharing intention | (a) Products' identity signaling attributes, (b) sharing intention |
| Winterich *et al.* [9] | Donation *vs.* discount promotion | No | No | – | Vary in their propensity to choose donation versus discount promotions | (a) Different consumer segmentation, (b) gender and residence |
| Zhou *et al.* [11] | Cashback | No | Yes | – | The value of the CW to the e-shop in both centralized and decentralized settings | (a) Commission rate, (b) rebates |
| Aviv *et al.* [14] | Discount | No | No | Strategic behavior | Responsive pricing strategies of fashion product | (a) The spread effect and information shaping, (b) responsive pricing, (c) demand learning |
| Li *et al.* [15] | Coupon | No | No | Strategic behavior | Platform's discount pricing strategies | (a) The fraction of strategic consumers, (b) the degree of consumer penitence |
| Osadchiy and Bendoly [18] | Markdown pricing | No | Yes | Strategic behavior | The effect of DEU model to the retail pricing optimization | (a) Individual perception of risk associated with the wait option, (b) revenue management |
| Akcay *et al.* [21] | N/A | Yes | No | – | The influence of MBG on optimal decision | N/A |
| Wan *et al.* [23] | N/A | Yes | No | – | A monopolistic retailer's returns management strategy | N/A |
| This study | Cross-store full-reduction promotion | Yes | Yes | Speculative behavior | Optimal pricing strategy of retailers considering consumers' speculative behavior | (a) The proportion of speculative consumer, (b) discount amount allocated to a product, (c) commission rate |

Second, most of the prior researches concentrates on the consumer's strategic behavior, while we extend the research on consumers' speculative behavior, and reveal that the behavior plays a critical role in making the optimal strategies for supply chain members in cross-store full-reduction promotion mode.

Finally, we provide new insights into the literature on cross-store full-reduction promotion. That is, we not only consider the positive effect of cross-store full-reduction promotion on retailers and platform, but also analyze the negative effect of speculative customers' add-on items return behavior bred by cross-store full-reduction promotion. And we identify three key determinants for the success of the shopping platform's full-reduction promotion: proportion of speculative consumer, discount amount allocated to a product, and commission rate, while none of the previous studies covers three of them at the same time.

## 2. Problem description and notations

This paper considers two retailers selling complementary goods (retailer $R_1$ and retailer $R_2$ sell commodity 1 and commodity 2, respectively) and an e-commerce platform (EP). Before the sales period comes, the two retailers both purchase a certain number of products with unit $C_i, \imath = 1, 2$, and sell the products directly through the e-commerce platform at the price $p_i,\ i = 1, 2$. For each unit of goods sold, the two retailers should pay the commission fee rate of the platform as $\lambda$, which is an exogenous variable in this paper. In order to stimulate sales, the platform carries out cross-store full-reduction promotions and releases the full-reduction promotion threshold $T(p_i < T < p_1 + p_2,\ i = 1 \text{ or } 2)$ and discount amount $t(t > 0)$. Assume that this kind of promotion belongs to the direct deduction of consumption [28–30], which is equivalent to the direct price reduction promotion during the promotion period. And assume that the proportion of discount amount allocated to commodity 1 is $\eta(0 < \eta < 1)$. Accordingly, the proportion of discount amount allocated to commodity 2 is $(1 - \eta)$.

After knowing the retailers' sales price and promotion discounts, consumers decide whether to purchase and how to purchase. In a single purchase, assume that for each type of product, consumers purchase at most one unit of product (the main reason for putting forward this assumption is that it conforms to the basic form of e-commerce add-on items industry and is the basis for further research on the combination form of consumers' purchasing different quantities of products).

In the market, there are two types of consumers: one is the consumer who intentionally purchase the add-on items to obtain full-reduction discount and then refunds the add-on items after successful payment, which is defined as the speculative consumers. The other type is defined as ordinary consumers who will not make the deliberate add-on items to get full-reduction discount and then refunds the add-on item. Assume that the proportion of speculative consumers and ordinary consumers in the market is $\varepsilon(0 < \varepsilon < 1)$ and $1-\varepsilon$, respectively. Under the non-promotion mode, consumers are all regarded as ordinary consumers, that is, they may only buy one product, or they may buy two products (Products 1 and 2) at the same time [31]. Under the cross-store full-reduction promotion mode, for ordinary consumers, their purchase decision is consistent with that under the non-promotion mode. For speculative consumer, in order to obtain the price reduction, they will choose an additional item to make the add-on purchase, and then return the add-on item.

To simplify the model, assume that the commodity 2 is the add-on item selected deliberately by the speculative consumer. For returned commodity 2, assume that retailer $R_2$ suffers a unit return loss cost of $h(0 < h < C_2)$, while the return cost that consumers need to bear mainly includes the postages of logistics services. It is worth noting that the return cost of consumers is the expenses that consumers need to bear, not the expenses that platforms and retailers need to bear. At present, many platforms outsource their logistics services to professional logistics companies, such as JD.com and JD Logistics, Tmall.com and Cainiao Posthouse [32]. Therefore, the return cost of consumers (postages of logistics services paid to third-party logistics companies) will not affect the optimal decision of the platform and retailers, and then we assume that the return cost of consumers is 0. Commodities that are not sold at the end of the sales cycle are calculated as salvage value 0. The operating structure of the system consisting of two retailers and the platform is shown in Figure 1.

According to the above analysis, this paper adopts linear demand function to describe the relationship between demand and price of multiple products. When the platform does not implement the cross-store full-reduction promotion strategy, there are consumers who only buy products (product 1 or product 2) at the original price in the market (consumers who buy two products at the same time can be regarded as buying product 1 and product 2 at the original price, respectively). Referring to literature [33], the demand for a single product is not only related to its own price, but also affected by the price of complementary products. Therefore, the demand function of a single product is shown as follows:

$$D_i = a_i - \beta p_i - \theta p_{3-i}, \quad i = 1, 2 \tag{1}$$

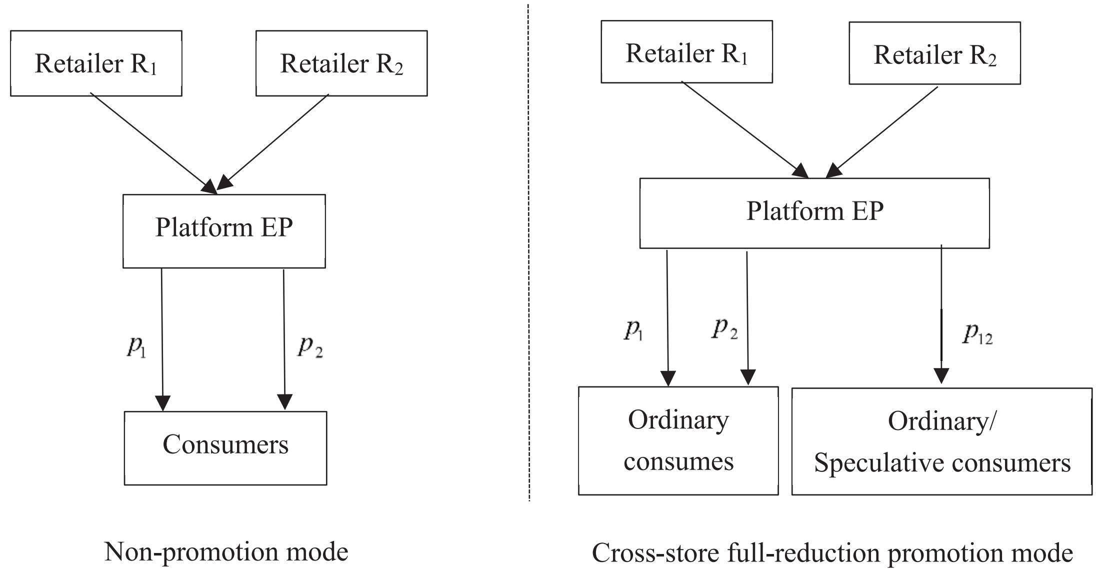



FIGURE 1. The operating structure of the system.

where, $D_i$ is the demand for commodity $i$; $a_i$ is the initial market demand of the commodity $i$; $\beta$ is the price elasticity coefficient of product demand; $\theta(0 < \theta < 1)$ is the complementary coefficient of two products, also known as cross elasticity coefficient.

When the platform implements cross-store full-reduction promotion strategy, based on the above analysis and the literatures [33, 34], the demand functions of products are respectively expressed as follows:

$$D_{iB} = a_i - \beta p_i - \theta p_{3-i} + \gamma p_{12}, \quad i = 1, 2 \tag{2}$$

$$D_{12B} = a_{12} - \beta p_{12} + \gamma p_1 + \gamma p_2 \tag{3}$$

where, $D_{iB}$ is the demand for only purchasing product $i$; $D_{12B}$ is the demand for consumers to purchase two products at the same time; $p_{12}(p_{12} = p_1 + p_2 - t)$ is the promotion price for purchasing two products at the same time; $t(0 < t < 1)$ is the discount amounts set by the platform; and $\gamma(0 < \gamma < 1)$ is the cross elasticity coefficient of demand for purchasing two products at the same time and only purchasing one product.

It should be pointed out to ensure that the impact of the price elasticity coefficient of demand on product demand is greater than that of the cross-elasticity coefficient on product demand, assume $\gamma < \beta, \theta < \beta$; Furthermore, in order to simplify the model, we assume $\gamma < \theta < \beta = 1$. This demand function has been adopted by a lot of scholars and is widely applicable to the study of pricing decision. Related parameters and variables used in this paper are shown in Table 2.

## 3. Model analysis

### 3.1. No cross-store full-reduction promotion strategy

In order to explore the impact of speculative consumers' add-on items return behavior on retailers' and platform's optimal decision under the cross-store full-reduction promotion mode, we need to analyze the optimal strategy of two retailers and the platform under the non-promotion mode as the benchmark model. In this case, consumers are all regarded as ordinary consumers. The profit function expressions of retailers and platform are

TABLE 2. The definitions and related variables.

| Variable name | Variable definitions |
|---|---|
| EP | E-commerce platform |
| $R_i$ | Retailer $i$, $i = 1, 2$ |
| $\lambda$ | The commission rate |
| $p_i$ | The price of commodity $i$, $i = 1, 2$ |
| $p_{12}$ | The promotion price for purchasing two products, $p_{12} = p_1 + p_2 - t$ |
| $\mathrm{C}_i$ | The unit cost of commodity $i$, $i = 1, 2$ |
| $t$ | Discount amount |
| $\eta$ | The proportion of discount amount allocated to product 1, $0 < \eta < 1$ |
| $\theta$ | The complementary coefficient of two products, $0 < \theta < 1$ |
| $\beta$ | The price elasticity coefficient of product demand, assume $\beta = 1$ |
| $\gamma$ | The cross-elasticity coefficient of demand for purchasing two products and only purchasing one product |
| $\varepsilon$ | The proportion of speculative consumers, $0 < \varepsilon < 1$ |
| $h$ | The retailer suffers a unit loss cost, $0 < h < C_2$ |

as follows, respectively:

$$\pi_{Ri} = ((1-\lambda)p_i - C_i)D_i \tag{4}$$

$$\pi_P = \lambda \sum p_i D_i \tag{5}$$

$$D_i = a_i - p_i - \theta p_{3-i}, \quad i = 1, 2. \tag{6}$$

**Proposition 1.** *When the platform doesn't implement the cross-store full-reduction promotion strategy, the optimal price and market demand of two retailers are respectively* $p_1^*,\ p_2^*,\ D_1^*, D_2^*$ *(as shown below), to obtain the maximum profits of the network platform and the two retailers. The optimal price and market demand of the two retailers are affected by the commission rate of the platform.*

$$p_1^* = \frac{2(1-\lambda)a_1 - (1-\lambda)a_2\theta + (2-\theta)C_1}{(1-\lambda)(4-\theta^2)} \tag{7}$$

$$p_2^* = \frac{2(1-\lambda)a_2 - (1-\lambda)a_1\theta + (2-\theta)C_2}{(1-\lambda)(4-\theta^2)} \tag{8}$$

$$D_1^* = a_1 - \frac{(2-\theta^2)(1-\lambda)a_1 + (1-\lambda)a_2\theta + (1+\theta)(2-\theta)C_1}{(1-\lambda)(4-\theta^2)} \tag{9}$$

$$D_2^* = a_2 - \frac{(2-\theta^2)(1-\lambda)a_2 + (1-\lambda)a_1\theta + (1+\theta)(2-\theta)C_2}{(1-\lambda)(4-\theta^2)}. \tag{10}$$

*Proof.* When the platform doesn't implement the cross-store full-reduction promotion strategy, by calculating the first partial derivative of $p_1$ and $p_2$ with respect to the equation $\pi_{R1}$ and equation $\pi_{R2}$ and then let them be equal to 0. We can obtain the following equation:

$$\frac{\partial \pi_{R1}}{\partial p_1} = (1-\lambda)(a_1 - p_1 - \theta p_2) - ((1-\lambda)p_1 - C_1) = 0 \tag{11}$$

$$\frac{\partial \pi_{R2}}{\partial p_2} = (1-\lambda)(a_2 - p_2 - \theta p_1) - ((1-\lambda)p_2 - C_2) = 0 \tag{12}$$

And because

$$\frac{\partial^2 \pi_{R1}}{\partial p_1^2} = -2(1-\lambda) < 0$$

$$\frac{\partial^2 \pi_{R2}}{\partial p_2^2} = -2(1-\lambda) < 0.$$

So, we get that $\pi_{R1}$ is a concave function of $p_1$, and $\pi_{R2}$ is a concave function of $p_2$. Therefore, the equations (11) and (12) both have a unique value, and the unique value is the optimal solution, which is:

$$p_1^* = \frac{2(1-\lambda)a_1 - (1-\lambda)a_2\theta - \theta C_1 + 2C_1}{(1-\lambda)(4-\theta^2)}$$
$$p_2^* = \frac{2(1-\lambda)a_2 - (1-\lambda)a_1\theta - \theta C_2 + 2C_2}{(1-\lambda)(4-\theta^2)}.$$

Bring $p_1$ and $p_2$ into equation (6), we can conclude $D_1^*,\ D_2^*$, then further bring $p_1^*, p_2^*,\ D_1^*,\ D_2^*$ into the equations (4) and (5), we can get the $\pi_{R1}^*$, $\pi_{R2}^*$ and $\pi_p^*$.

By calculating the first partial derivative of $\lambda$ with respect to the equation $p_1^*,\ p_2^*,\ D_1^*,\ D_2^*$ in the Proposition 1, we can get that: $\frac{\partial p_1^*}{\partial \lambda} = \frac{C_1}{(1-\lambda)^2(2+\theta)} > 0$, $\frac{\partial p_2^*}{\partial \lambda} = \frac{C_2}{(1-\lambda)^2(2+\theta)} > 0$, $\frac{\partial D_1^*}{\partial \lambda} = -\frac{(1+\theta)C_1}{(1-\lambda)^2(2+\theta)} < 0$, $\frac{\partial D_2^*}{\partial \lambda} = -\frac{(1+\theta)C_2}{(1-\lambda)^2(2+\theta)} < 0$. The above relationship shows that the optimal prices of the two commodities increase with the increase of the commission rate charged by the platform, while the optimal demand of the two commodities decreases with the increase of the commission rate charged by the platform, which is consistent with the reality. □

### 3.2. Cross-store full-reduction promotion strategy

This section analyzes the situation when the platform implements the cross-store full-reduction promotion strategy. In order to distinguish from the symbols in the basic decision model, the symbols used in this section are marked with a superscript "$B$".

According to the above description, when the platform implements cross-store full-reduction promotion strategy, there are not only consumers who buy a single product at the original price; There are also consumers who buy both product 1 and product 2 at the promotional price. The amount of discount allocated to product 1 is $\eta t$, and accordingly, the amount of discount allocated to product 2 is $(1-\eta)t$. For retailer $R_1$, cross-store full-reduction promotion improves consumers' purchasing confidence and thus increases the product demands; For retailer $R_2$, on the one hand, cross-store full-reduction promotion stimulates consumers' additional purchases and increases sales. On the other hand, cross-store full-reduction promotion also breeds the speculative behavior of customers who deliberately purchase an add-on item to reach the full-reduction threshold in order to enjoy price discounts and then return it after the successful payment, resulting in the loss of retailer $R_2$. In addition, the profit of the platform is equal to the product of commission fee and actual sales volume, which will also be affected by speculative consumers' add-on items return behavior. To sum up, the profit functions of retailer $R_1$, retailer $R_2$ and the network platform are respectively expressed as:

$$\pi_{R1}^B = \big((1-\lambda)p_1^B - C_1\big)D_1^B + \big((1-\lambda)(p_1^B - \eta t) - C_1\big)D_{12}^B \tag{13}$$
$$\pi_{R2}^B = \big((1-\lambda)p_2^B - C_2\big)D_2^B + (1-\varepsilon)\big((1-\lambda)(p_2^B - (1-\eta)t) - C_2\big)D_{12}^B - \varepsilon D_{12}^B h \tag{14}$$
$$\pi_p^B = \lambda p_1^B D_1^B + \lambda(p_1^B - \eta t)D_{12}^B + \lambda p_2^B D_2^B + (1-\varepsilon)\lambda\big(p_2^B - (1-\eta)t\big)D_{12}^B \tag{15}$$

$$D_i^B = a_i - p_i - \theta p_{3-i} + \gamma p_{12}, \quad i = 1, 2$$
$$D_{12}^B = a_{12} - p_{12} + \gamma p_1 + \gamma p_2.$$

**Proposition 2.** *When the platform implements the cross-store full-reduction promotion strategy, the optimal solutions of the two retailers can be obtained as* $p_1^{B^*}$, $p_2^{B^*}$, $D_1^{B^*}$, $D_2^{B^*}$, *respectively (as shown below), to obtain the maximum profits of the network platform and the two retailers.*

TABLE 3. Influence of relevant parameters on retailers' optimal decisions.

| | $p_1^{B*}$ | $p_2^{B*}$ | $D_1^{B*}$ | $D_2^{B*}$ | $D_{12}^{B*}$ |
|---|---|---|---|---|---|
| $\lambda$ | ↑ | ↑ | ↓ | ↓ | ↓ |
| $\eta$ | ↑ | ↓ | ↓ | ↑ | ↓ |
| $\varepsilon$ | ↑ | ↑ | ↓ | ↓ | ↓ |

$$p_1^{B^*} = \frac{\begin{array}{l}2(1-\gamma)(2-\varepsilon)(M+(1-\lambda)(1-\gamma)(1+\eta)t)+(2\gamma-\theta-1)(H+(1-\lambda)(1-\varepsilon-\gamma)t\\ \quad +(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)t)\end{array}}{(1-\lambda)A} \tag{16}$$

$$p_2^{B^*} = \frac{\begin{array}{l}4(1-\gamma)H-NM+4(1-\gamma)(1-\lambda)(1-\varepsilon-\gamma)t+4(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)^2t\\ \quad -(1-\lambda)(1-\gamma)(1+\eta)Nt\end{array}}{(1-\lambda)A} \tag{17}$$

$$\begin{aligned} D_1^{B^*} &= a_1-\gamma t+(\gamma-1)\frac{\begin{array}{c}2(1-\gamma)(2-\varepsilon)(M+(1-\lambda)(1-\gamma)(1+\eta)t)\\ +(2\gamma-\theta-1)(H+(1-\lambda)(1-\varepsilon-\gamma)t+(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)t)\end{array}}{(1-\lambda)A}\\ &\quad +(\gamma-\theta)\frac{\begin{array}{c}4(1-\gamma)H-NM+4(1-\gamma)(1-\lambda)(1-\varepsilon-\gamma)t\\ +4(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)^2t-(1-\lambda)(1-\gamma)(1+\eta)Nt\end{array}}{(1-\lambda)A}\end{aligned} \tag{18}$$

$$\begin{aligned} D_2^{B^*} &= a_2-\gamma t+(\gamma-\theta)\frac{\begin{array}{c}2(1-\gamma)(2-\varepsilon)(M+(1-\lambda)(1-\gamma)(1+\eta)t)\\ +(2\gamma-\theta-1)(H+(1-\lambda)(1-\varepsilon-\gamma)t+(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)t)\end{array}}{(1-\lambda)A}\\ &\quad +(\gamma-1)\frac{\begin{array}{c}4(1-\gamma)H-NM+4(1-\gamma)(1-\lambda)(1-\varepsilon-\gamma)t\\ +4(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)^2t-(1-\lambda)(1-\gamma)(1+\eta)Nt\end{array}}{(1-\lambda)A}\end{aligned} \tag{19}$$

$$\begin{aligned} D_{12}^{B^*} &= a_{12}+t+(\gamma-1)\frac{\begin{array}{c}2(1-\gamma)(2-\varepsilon)(M+(1-\lambda)(1-\gamma)(1+\eta)t)\\ +(2\gamma-\theta-1)(H+(1-\lambda)(1-\varepsilon-\gamma)t+(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)t)\end{array}}{(1-\lambda)A}\\ &\quad +(\gamma-1)\frac{\begin{array}{c}4(1-\gamma)H-NM+4(1-\gamma)(1-\lambda)(1-\varepsilon-\gamma)t\\ +4(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)^2t-(1-\lambda)(1-\gamma)(1+\eta)Nt\end{array}}{(1-\lambda)A}\end{aligned} \tag{20}$$

$$A = 8(1-\gamma)^2(2-\varepsilon)-(2\gamma-\theta-1)(\gamma-\theta+(1-\varepsilon)(\gamma-1)) \tag{21}$$

$$H = (1-\lambda)a_2+(1-\lambda)(1-\varepsilon)a_{12}+(1-\gamma)(2-\varepsilon)C_2+\varepsilon h(1-\gamma) \tag{22}$$

$$M = (1-\lambda)(a_1+a_{12})+2(1-\gamma)C_1 \tag{23}$$

$$N = \theta-\gamma+(1-\varepsilon)(1-\gamma). \tag{24}$$

We will analyze how commission rate $\lambda$, the proportion of discount amount allocated to product 1 $\eta$, and the proportion of speculative consumer $\varepsilon$ affect the optimal decisions of retailers when the platform implements the cross-store full-reduction promotion strategy. Table 3 summarizes the impact of $\lambda, \eta, \varepsilon$ on the optimal decisions of retailers.

**Inference 1.** *When the platform implements the cross-store full-reduction promotion strategy: (1) The prices of product 1 and product 2 increase with the increase of revenue sharing coefficient. (2) The price of product 1 increases with the increase of the proportion of its allocated discount amount; The price of product 2 decreases with the increase of the proportion of product 1's allocated discount amount. (3) The prices of product 1 and product 2 both increase with the increase of the proportion of speculative consumer.*

According to Inference 1: (1) When the commission rate of the e-commerce platform increases continuously, the marginal revenue of the retailers decreases. In order to ensure their own profit, the retailers will raise the price appropriately. (2) With a certain proportion of speculative consumer in the market, more consumers will be attracted to purchase product 1 in a bundled way (that is, purchase both product 1 and product 2 at the promotional price) with the increase of the allocated discount amounts of product 1. At this time, retailer $R_1$ will take the opportunity to increase the price of product 1; However, the discount amounts allocated to product 2 decreases with the increase of the discount amount of allocated to product 1. In this case, consumers' motivation to purchase product 2 in a bundled form (that is, purchase both product 1 and product 2 at the promotional price) is weakened, and retailer $R_2$ will reduce the price of product 2, thus leading more consumers to only purchase single product 2 at the original price, in order to achieve the balance of total profits with the increase of market demands. (3) The impact mechanism of the proportion of speculative consumer on the price of product 1 and product 2 is different. Specifically, for product 2, which is used for add-on items, when the proportion of speculative consumer gradually increases, it means that the full-reduction promotion strategy implemented by platform has breed a lot of speculative consumers' add-on item return behaviors. In order to mitigate the losses caused by the speculation behavior, retailer $R_2$ will continue to increase the price of product 2. However, for product 1, with the increase of the proportion of speculative consumer, the demand for purchasing product 1 in the bundling (discount) form increases. In order to further increase the total profit, retailer $R_1$ will adopt the pricing strategy of appropriately increasing the price of a single product during the full-reduction promotion period.

**Inference 2.** *When the platform implements the cross-store full-reduction promotion strategy: (1) The demand of only purchasing the product 1, only purchasing the product 2, and purchasing both product 1 and product 2 decreases with the increase of the revenue sharing coefficient. (2) The demand for only purchasing the product 1, and purchasing both product 1 and product 2 at the same time decreases with the increase of the proportion of product 1's allocated discount amounts; However, the demand for only purchasing the product 2 increases with the increase of the proportion of allocated discount amounts of product 1. (3) The demand for only purchasing product 1, only product 2, and both product 1 and product 2 at the same time decreases with the increase of the proportion of speculative consumer.*

Inference 2 shows that: (1) with the increase of commission rate, retailers need to split an increasing part of revenue from each transaction to platform, and its excessive service fee will greatly push up the product pricing of online retailers, resulting in severe demand restraint. (2) When the amounts of discount allocated to product 1 gradually increases, retailers will raise the price of product 1 by virtue of their promotional advantages, which will lead to a decrease in the demand for only purchasing product 1 and purchasing product 1 in bundled form (bundled form: that is, purchase both product 1 and product 2 at the promotional price). However, retailer $R_2$ will continue to reduce the price of product 2, stimulating more consumers to purchase single product 2 at the original price, thus increasing the demand for only product 2. (3) With the increase of the proportion of speculative consumer, the price of only purchasing product 1, only purchasing product 2, and the promotion price of purchasing two products at the same time are increasing, thus reducing their demand.

*Proof.* When the platform implements the cross-store full-reduction promotion strategy, by calculating the first partial derivative of $p_1^B$ and $p_2^B$ with respect to the equation $\pi_{R1}^B$ and equation $\pi_{R2}^B$, and then let them be equal to 0. We can obtain the following equation:

$$\begin{aligned}\frac{\partial \pi_{R1}^B}{\partial p_1^B} &= (1-\lambda)(a_1 - p_1^B - \theta p_2^B + \gamma p_{12}^B) + ((1-\lambda)p_1^B - C_1)(\gamma - 1)\\ &\quad + (1-\lambda)(a_{12} - p_{12}^B + \gamma p_1^B + \gamma p_2^B) + ((1-\lambda)(p_1^B - \eta t) - C_1)(\gamma - 1)\\ &= 0\end{aligned} \tag{25}$$

$$\begin{aligned}\frac{\partial \pi_{R2}^{B}}{\partial p_2^B} &= (1-\lambda)(a_2 - p_2^B - \theta p_1^B + \gamma p_{12}^B) + ((1-\lambda)p_2^B - C_2)(\gamma - 1)\\ &\quad + (1-\varepsilon)(1-\lambda)(a_{12} - p_{12}^B + \gamma p_1^B + \gamma p_2^B) + (1-\varepsilon)((1-\lambda)(p_2^B - (1-\eta)t)\\ &\quad - C_2)(\gamma - 1) - \varepsilon h(\gamma - 1) = 0\end{aligned} \tag{26}$$

And because

$$\begin{aligned}\frac{\partial^2 \pi_{R1}^B}{\partial p_1^2} &= -4(1-\lambda)(1-\gamma) < 0\\ \frac{\partial^2 \pi_{R2}^B}{\partial p_2^2} &= -2(1-\lambda)(1-\gamma)(2-\varepsilon) < 0.\end{aligned}$$

So, we get that $\pi_{R1}^B$ is a concave function of $p_1^B$, and $\pi_{R2}^B$ is a concave function of $p_2^B$. Therefore, the equations (25) and (26) both have a unique value, and the unique value is the optimal solution, which is:

$$p_1^{B^*} = \frac{\begin{array}{l}2(1-\gamma)(2-\varepsilon)(M + (1-\lambda)(1-\gamma)(1+\eta)t)\\ \quad +(2\gamma-\theta-1)(H + (1-\lambda)(1-\varepsilon-\gamma)t + (1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)t)\end{array}}{(1-\lambda)A}$$

$$p_2^{B^*} = \frac{\begin{array}{l}4(1-\gamma)H - NM + 4(1-\gamma)(1-\lambda)(1-\varepsilon-\gamma)t\\ \quad +4(1-\varepsilon)(1-\lambda)(1-\eta)(1-\gamma)^2 t - (1-\lambda)(1-\gamma)(1+\eta)Nt\end{array}}{(1-\lambda)A}.$$

Bring $p_1^B$ and $p_2^B$ into the equations (2) and (3), we can conclude $D_1^{B^*}$, $D_2^{B^*}$, $D_{12}^{B^*}$, then bring $p_1^{B^*}$, $p_2^{B^*}$, $D_1^{B^*}$, $D_2^{B^*}$, $D_{12}^{B^*}$ into the equations (13), (14) and (15), we can get the $\pi_{R1}^{B*}$, $\pi_{R2}^{B*}$ and $\pi_p^{B*}$ .

Then by calculating the first partial derivative of $\lambda$ with respect to the equation $p_1^{B^*}$, $p_2^{B^*}$, $D_1^{B^*}$, $D_2^{B^*}$, $D_{12}^{B^*}$ in the Proposition 2, we can get that:
$\frac{\partial p_1^{B^*}}{\partial \lambda} = \frac{(1-\gamma)(4(1-\gamma)(2-\varepsilon)C_1 + (2\gamma-\theta-1)((2-\varepsilon)C_1+\varepsilon h))}{(1-\lambda)^2 A} > 0$, $\frac{\partial p_2^{B^*}}{\partial \lambda} = \frac{(1-\gamma)(4(1-\gamma)(2-\varepsilon)C_2 + 4\varepsilon h(1-\gamma) + 2(\gamma-\theta+(1-\varepsilon)(\gamma-1))C_2)}{(1-\lambda)^2 A} > 0$, $\frac{\partial D_1^{B^*}}{\partial \lambda} = -(1-\gamma)\frac{\partial p_1^{B^*}}{\partial \lambda} - (\theta-\gamma)\frac{\partial p_2^{B^*}}{\partial \lambda} < 0$, $\frac{\partial D_2^{B^*}}{\partial \lambda} = -(1-\gamma)\frac{\partial p_2^{B^*}}{\partial \lambda} - (\theta-\gamma)\frac{\partial p_1^{B^*}}{\partial \lambda} < 0$, $\frac{\partial D_{12}^{B^*}}{\partial \lambda} = -(1-\gamma)\left(\frac{\partial p_2^{B^*}}{\partial \lambda} + \frac{\partial p_1^{B^*}}{\partial \lambda}\right) < 0$. The above relationship shows that the optimal price of the two products increases with the increase of the commission rate charged by the platform, while the demand of the two products decreases with the increase of the commission rate charged by the platform, which is in line with the reality. The other proofs in Inferences 1 and 2 are similar and will not be repeated. □

## 4. Numerical analysis

On the one hand, the platform can attract consumers to purchase more and increase revenue by implementing the cross-store full-reduction discount promotion strategy; On the other hand, the implementation of this strategy has also bred the speculative customers' add-on items return behavior, thus causing losses. Therefore, which of the two plays a dominant role, and how the revenue of the platform and the retailers will change remains to be explored.

Due to the complexity of the model, we compare the profit level of each subject by means of numerical analysis. In the analysis, the simulation data is the processing data abstracted from the enterprise survey, which has the practical significance to some extent. Assume $C_1 = 0.5$, $C_2 = 0.5$, $a_1 = 10$, $a_2 = 10$, $a_{12} = 10$, $\theta = 0.8$, $\gamma = 0.6$, $h = 0.4$, $t = 5$, $\lambda \in [0,1]$, $\varepsilon \in [0,1]$, $\eta \in [01]$. Figure 2, Figure 3 and Figure 4 respectively analyze the influence of relevant parameters on the optimal price, demand and the optimal profit of retailers and platform under the two modes.

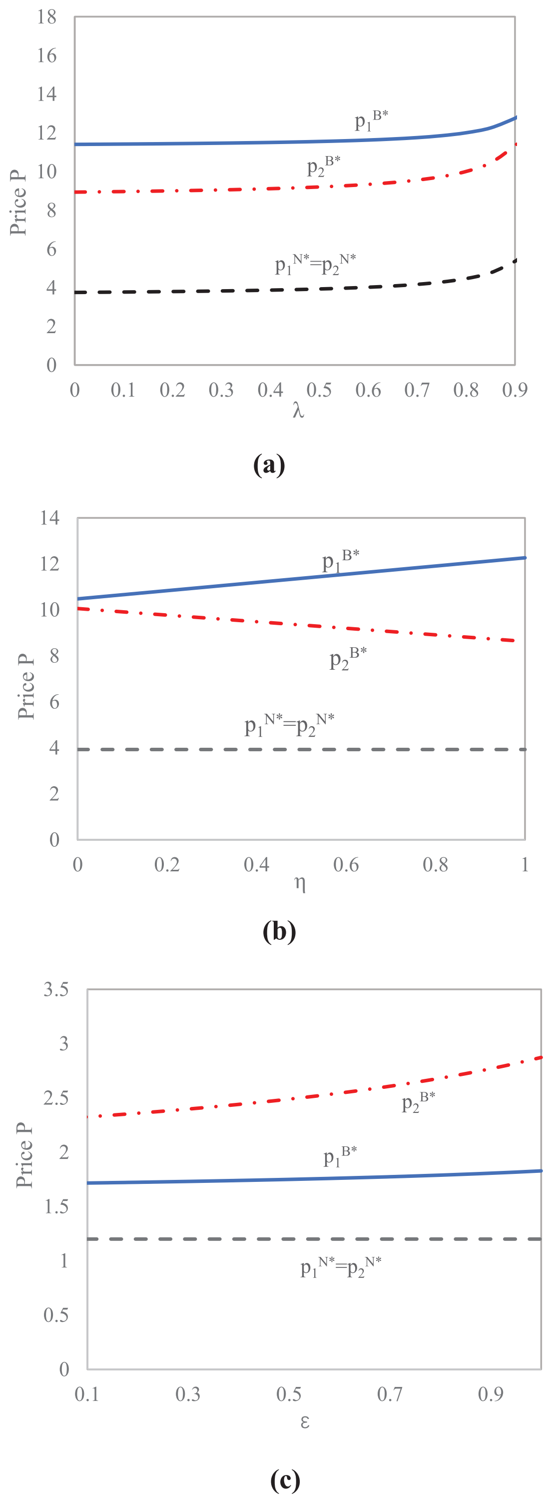
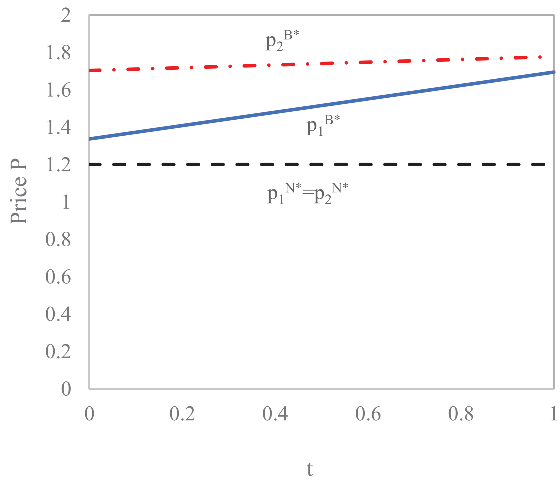



FIGURE 2. The influence of relevant parameters on the optimal price.




**(d)**

FIGURE 2. continued.

Figures 2(a) and 3(a) show that under the two sales modes, the prices of product 1 and product 2 increase with the increase of the revenue sharing coefficient; while the demand for product 1 and product 2 decreases with the increase of revenue sharing coefficient. This may be because when the revenue sharing coefficient (commission rate) is larger, it means that the operating costs of the two retailers are higher, retailer $R_1$ and retailer $R_2$ will appropriately raise the product price to reduce the loss caused by the commission rate expenditure. However, excessive product prices will inhibit the demand for products, which will lead to a decline in demand.

It can be seen from Figures 2(b) to 3(b) that the price and demand of products (product 1 and product 2) are not affected by the proportion of discount amount allocated to product 1 under the non-promotion mode. Under the cross-store full-reduction promotion mode, the price of product 1 increases with the increase of the proportion of its allocated discount amount, while the demand for only purchasing product 1, as well the demand for purchasing both product 1 and product 2 decreases with the increase of the proportion of discount amount allocated to product 1; The price of product 2 decreases with the increase of the proportion of discount amount allocated to product 1, while the demand for only purchasing product 2 increases with the increase of the proportion of discount amount allocated to product 1. This may be because under the condition that the discount amount is given, when the proportion of the discount amount allocated to product 1 increases within a certain range, the utility of consumers to purchase product 1 in the bundling (discount) form increases. Retailer $R_1$ will take the opportunity to raise the price of product 1 in order to maximize its own interests, and the increase in price will inhibit the demand of some consumers to buy only product 1 and both products. However, when the proportion of discount amount allocated to product 1 ($\eta$) is larger, it means that the proportion of discount amount allocated to product 2 is smaller. With the gradual increase of the proportion of discount amount allocated to product 1 ($\eta$), retailer $R_2$ will continue to cut down the price of product 2, thereby increasing the market demand for only product 2.

According to Figures 2(c) and 3(c) that under the non-promotion mode, the price and demand of products (product 1 and product 2) are not affected by the proportion of speculative consumers. Under the cross-store full-reduction discount promotion mode, the prices of product 1 and product 2 increase with the increase of the proportion of speculative consumers, while the demand for only purchasing product 1, only purchasing product 2, and both product 1 and product 2 decreases with the increase of the proportion of speculative consumer. This may be because when the proportion of speculative consumers gradually increases in the market, it means that more consumers choose an add-on item to purchase, and the loss suffered by retailer $R_2$ increase. In order

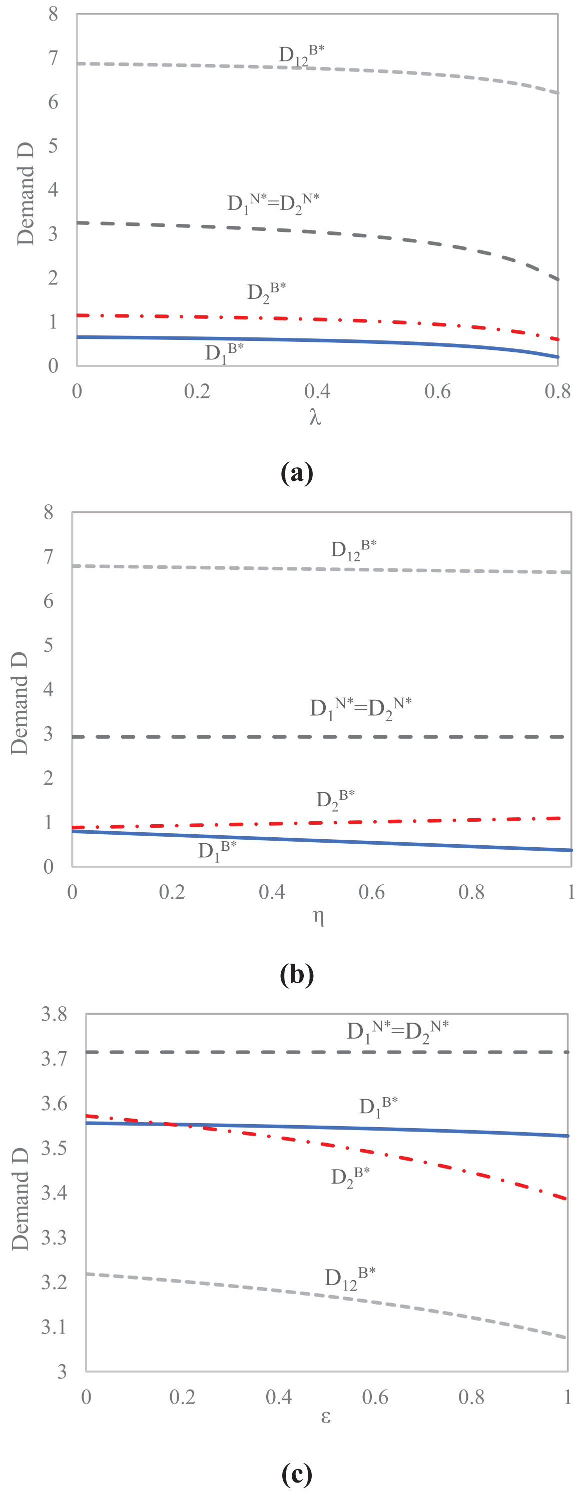



FIGURE 3. Influence of relevant parameters on demand.

to mitigate the loss caused by the speculative consumers' add-on item return behavior, retailer $R_2$ will raise the price, which will lead to a decrease in the demand for only purchasing product 2 ($D_2^{B^*}$). At the same time, retailer $R_1$ will also take the opportunity to raise the price in order to increase its own revenue, which will also reduce the demand for only purchasing product 1 ($D_1^{B^*}$). In addition, although the increase of speculative consumers will increase the demand of speculative consumers for purchasing both product 1 and product 2 at the same time, the increase in the price of product 1 and product 2 will weaken the demand of ordinary consumers for the both products to some extent. As the demand brought by the increase of speculative consumers cannot make up for the reduced demand of ordinary consumers, the demand for purchasing both product 1 and product 2 at the promotional price in a single purchase (that is $D_{12}^{B^*}$) decreases.

It can be also seen from Figure 2(d) that under the non-promotion mode, the price of products (product 1 and product 2) is not affected by the discount amount $t$. Under the cross-store full-reduction discount promotion mode, the prices of product 1 and product 2 increase with the increase of the discount amount $t$. The internal mechanism of this situation is the same as the impact trend of the proportion of discount amount allocated to product 1 ($\eta$) on the price of product 1 above.

In addition, the four scenarios in Figure 2 show that the price of only purchasing a single product in the cross-store full-reduction promotion mode is always higher than that in the non-promotion mode $\left(i.e.\ p_1^{B^*} > p_1^{N^*},\ p_2^{B^*} > p_2^{N^*}\right)$, which also explains a phenomenon in the actual trading market, that is, retailers may raise prices before adopting the cross-store full-reduction discount promotion mode. And the four scenarios in Figure 3 also show that the total demand for product 1 (product 2) in the cross-store full-reduction promotion mode is larger than the total demand in the non-promotion mode $\left(i.e.\ D_1^{B^*} + D_{12}^{B^*} > D_1^{N^*},\ D_2^{B^*} + D_{12}^{B^*} > D_2^{N^*}\right)$.

It can be seen from Figure 4(a) that in both cases, the profit levels of retailer $R_1$ and retailer $R_2$ decrease with the increase of revenue sharing coefficient (commission rate). When the commission rate is lower (that is, for retailer $R_1 : 0 < \lambda < 0.65$; for retailer $R_2 : 0 < \lambda < 0.5$), the profit under the cross-store full-reduction promotion mode is higher. On the contrary, the profits obtained by the retailers in the non-promotion mode are greater. The reason may be that the excessive commission rate will push up the product price and reduce the demand for products. As the profits brought by the increase in product prices can't make up for the losses caused by the reduction in demand, it leads to a decline in the profits of retailer $R_1$ and retailer $R_2$, and the changes in the profits of retailers are greater under the cross-store full-reduction promotion mode. It can be seen from Figure 4(b) that in both cases, the profit of the platform increases first and then decreases with the commission rate. Therefore, the platform can improve the income level by formulating the optimal commission rate. And when the commission rate is lower ($0 < \lambda < 0.65$), the profit under the cross store full-reduction promotion mode is higher; On the contrary, the platform can obtain greater profits under the non-promotion mode. Based on Figure 4(a) and 4(b), this can be seen that when the commission rate satisfies $0 < \lambda < 0.5$, the cross-store full-reduction promotion mode can simultaneously improve the revenue of the platform and retailers, and achieve Pareto improvement.

According to Figure 4(c) and 4(d) that under the non-promotion mode, the profits of the platform and the two retailers are not affected by the speculative consumer behavior. Under the cross-store full-reduction promotion mode, with the increase of the consumption proportion of speculative consumers, the profits of the platform and retailers are firstly higher and then lower than that of the non-promotion mode. This indicates that the cross-store full-reduction promotion mode does not necessarily increase the profit of supply chain members, and the non-promotion mode does not necessarily reduce the profit of supply chain members in the face of the speculative consumers' add-on item return behavior. Therefore, the best strategy of the platform is: when the proportion of speculative consumers in the market exceeds a specific threshold, the platform should try to choose the non-promotion mode, otherwise, the cross-store full-reduction promotion mode should be adopted to achieve the goal of increasing the profits of the platform and retailers at the same time.

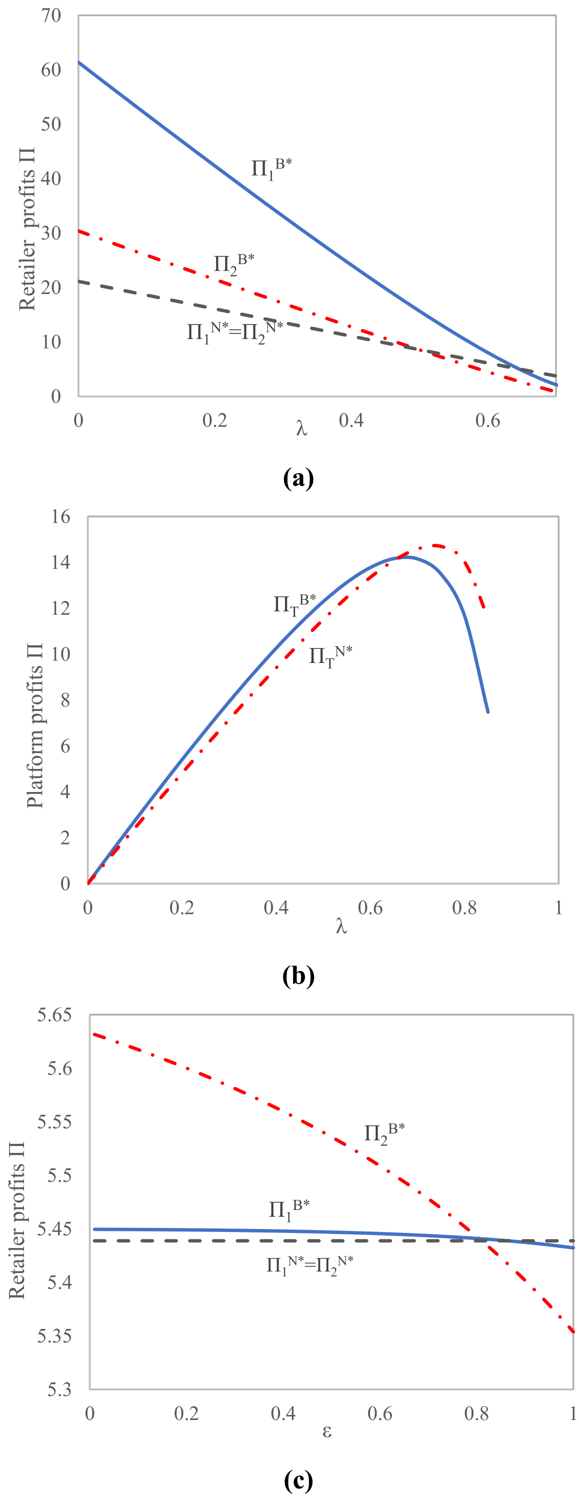
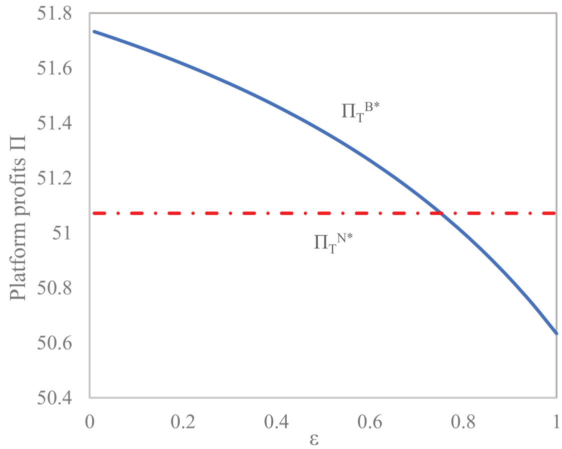



Figure 4. Influence of relevant parameters on the profits.




**(d)**

FIGURE 4. continued.

## 5. Conclusion

Cross-store full-reduction promotion has become an important strategy adopted by the platform, but it is also the implementation of this strategy that breeds the speculative consumers' add-on item return behavior. To solve the problem, we construct single-cycle sales models considering the speculative consumers' add-on items return behavior based on the revenue sharing contract, and explore the optimal promotion pricing decisions under two situations where the platform carries out cross-store full-reduction sales promotion and non-promotion respectively, which provides a reference for retailers to formulate product prices in different modes, and provides a theoretical basis for the implementation of cross-store full-reduction promotion strategies under specific conditions. The main research results are as follows: (1) In both cases, there is an optimal product price to maximize the profit of the retailers, and the price of only purchasing a single product in the case of cross-store full-reduction promotion is higher than that in the case of non-promotion. (2) Regardless of whether the platform implements cross-store full-reduction promotion strategy or not, the prices of product 1 and product 2 increase with the increase of revenue sharing coefficient. (3) Under the non-promotion mode, the prices of product 1 and product 2 are not affected by the product allocation discount amount and the proportion of speculative consumers; Under the cross-store full-reduction promotion mode, the price of product 1 increases with the increase of its allocated discount amount and the proportion of speculative consumer; however, the price of product 2 decreases with the increase of the allocation discount amount of product 1, and increases with the increase of the proportion of speculative consumers. (4) By comparing the profits of the platform and retailers under the two modes of non-promotion and cross-store full-reduction promotion, it is concluded that the two modes do not have absolute advantages. Based on the profit situation of the platform and retailers, the critical conditions for the platform to adopt different modes are given to achieve the goal of simultaneously improving the profits of retailers and the platform.

Based on the research conclusion, the management suggestions for the platform and online retailers are as follows:

(1) For online retailers, when formulating product prices, they should fully consider the impact of the discount amount of product allocation, commission rate and the proportion of speculative consumers on their optimal decisions.
(2) For the platform, when the commission rate is at the medium level, the platform can improve the revenue of itself and the retailers by implementing the cross-store full-reduction promotion strategy, and achieve Pareto

improvement; Otherwise, the platform's implementation of cross-store full-reduction promotion strategy can neither improve the revenue nor achieve Pareto improvement.

This paper also exists some limitations. In order to analyze the model and focus on the research purpose, this paper only considers the impact of consumers' psychology before purchasing on the platform and online retailers' decision-making, and does not further consider the situation that consumers return goods because they are not satisfied with the purchased products, which can be improved in the future. Secondly, in order to simplify the model, we directly assumed that commodity 2 is an add-on item, but in practice, every commodity may suffer from add-on items returns. How to consider this phenomenon will be the focus of our next research.

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