

Online Retailers based on Different Consumer Types Discount Pricing Strategy Research

Duo Tang *, Jitong Zhang

School of Economics and Management, Southwest Petroleum University, Chengdu Sichuan, 610500, China

* Corresponding author: Duo Tang (Email: 1035610320@qq.com)

Abstract: In recent years online, retailers have continuously conducted discount sales to stimulate consumers' shopping desire. In this paper, we consider the different responses of three types of consumers: short-sighted, strategic, and discount-seeking consumers to the sales discount period, construct a Steinberg model for e-commerce platforms and online retailers with discount sales periods, and analyze the optimal pricing strategies of different consumer types for e-commerce platforms and merchants. Starting from consumer utility and combining optimization and game theory, it seeks to provide a reference for merchants and e-commerce platforms to make decisions.

Keywords: Pricing Strategies; Strategic Consumers; E-Commerce Platforms; Discount Sales Periods; Online Retailers.

1. Introduction

The development of Internet technology in recent years has vigorously promoted the development of the e-commerce industry, and the purchase method has gradually shifted from offline to online. With the rapid development of B2C e-commerce platforms, China has opened a new wave of consumer upgrading. More and more merchants utilize the large discount sales period of e-commerce platform to attract customers and improve sales performance. For example, the domestic "double 11". China Business Intelligence released data showing that in 2021, the transaction value of the whole network on double 11 was 965.12 billion yuan, an increase of 12.22% year-on-year. The growth is still maintained on the basis of a huge base, further expressing the advantages of the online discount period such as expanding market coverage, collecting more market information and closely contacting consumers, which makes more and more enterprises take it as an important channel to improve competitiveness.

In terms of promotion and operation, merchants and e-commerce platforms are each fully engaged through marketing programs. Taking "Double 11" as an example, on the one hand, merchants, on the basis of complying with the requirements of the platform, practiced on-site and off-site promotion in accordance with the store operation plan and the platform's progress requirements. Regardless of whether it is on or off site, most merchants are guided by good quality and low price, stimulating consumers' desire to buy through price discounts. On the other hand, Jingdong launched different campaign themes every day from November 1 to cover all kinds of customers with different needs. In addition, Jingdong vigorously promoted its own PLUS membership system during the event, and Jingdong PLUS members will enjoy more benefits during Double 11. Overall, it still focuses on full-price discounts and receiving coupons.

Double discounts are enough to stimulate consumer desire to buy, but with the development of "Double 11", gradually weaken the component of consumer luck, pay more attention to the degree of consumer patience. Consumers for their favorite products is no longer a simple lottery, fight luck, but more importantly than the competition patience, prior understanding of the rules of all kinds of promotions, in

accordance with the requirements of the operation. In recent years, it can be found that merchants and e-commerce platforms are constantly updating their promotions, and the rules are becoming more and more complex.

McWilliams points out that there are three types of consumers: the short-sighted, the tactical and the consumers looking for price discounts. Short-sighted, strategy-ignorant consumers, only focus on the immediate gains and satisfaction, for the "Double 11" activities, such as when consumers are "grass" or short video stimulation can not stand the pain of waiting, do not pay attention to the price of the strategy, the first choice to meet their own desires. Strategic consumers, before purchasing goods, will consider the possibility of price reductions, and the possibility of buying goods after price reductions, by comparing the size of the utility that may be obtained by buying immediately and waiting for discounts, to choose the best time to buy to maximize their own utility. Consumers who seek price discounts, referred to as low absorption consumers, choose to purchase goods only when they are on sale.

In response to the above, this paper introduces the game relationship between online retailers and e-commerce platforms, and also introduces three kinds of consumer purchasing behaviors, focusing on exploring the following problem: comparing the optimal decision-making of the three types of consumers when their types are short-sightedness, strategy, and discounts, respectively, and trying to provide a reference for the decision-making of online retailers and e-commerce platforms in terms of their consumer utility, combining optimization and game theory.

2. Literature Review and Related Theory

2.1. Harmonization of E-Commerce Platforms with Supply Chain Pricing

Existing literature closely related to this study focuses on e-commerce platform and supply chain pricing and coordination issues. Huang Hongwei [1] and others proposed a dual-channel supply chain pricing decision model based on sales effort and e-commerce platform deduction rate under the two-part coordination pricing mechanism. They compare and

analyze the optimal pricing strategies under decentralized decision-making and centralized decision-making, and the relationship between the overall supply chain profit with the level of sales effort and the e-commerce platform deduction rate, so as to achieve the coordination of the supply chain through the two-part coordinated pricing mechanism while satisfying the profit maximization of the supply chain members. Based on the mechanism of revenue sharing and cooperative efforts, Hu Wanting [2] and others study how the merchant and the e-commerce platform can achieve the decision problem of revenue maximization under the two strategies of single inventory and dual inventory through dynamic pricing and cooperative efforts. Li Chunfa [3] and others constructed the Steinberg model to give the optimal pricing strategy under the centralized and decentralized decision-making scenario and carried out the corresponding example analysis, and then designed the price-profit sharing and coordination mechanism to solve the problem of double marginal effect in the E-closed-loop supply chain. Wang Hongchun [4] and others constructed a three-level supply chain pricing and coordination model for manufacturers, retailers, and social e-commerce platforms to study the impact of social e-commerce platforms' sales efforts on supply chain pricing decisions under decentralized and centralized scenarios. Zhang Shen [5] and others studied the dual-channel supply chain coordination pricing problem under the influence of e-commerce platform withholding rate.

2.2. Research on Pricing Strategies of Online Retailers on E-commerce Platforms

The research in this paper is related to the pricing strategy of retailers on e-commerce platforms. Based on the sales big data of China's mainstream e-commerce platforms and the Baidu index tool, Wang Daoping [6] et al. empirically analyze the impact of online shopping festivals on China's consumers' online shopping sentiment, and the online sales price of commodities through the double-difference model and the mediation effect test. Through the study of pricing strategies of e-tailers, Song [7] and others found that e-tailers can use the time-limited strategy to determine the optimal price of the two sales periods and the availability rate of the goods in the discount sales period to maximize the expected profit. Boqing Zhang [8] and others studied the dynamic pricing decision of e-retailers coordinating multiple online stores and the dynamic promotion decision of e-commerce platforms for three inventory strategies, namely, inventory independence, unidirectional association, and unified management of inventory, respectively. MA [9] and others focused on the situation where a retailer employs successive discounts to study the joint decision-making of the order quantity and the sales price. Guan Zhenzhong and Ren Jianbiao [10] studied the dynamic pricing strategy in the presence of strategic consumers, combined the strategic behavior of consumers and the reference price effect, established a multi-stage dynamic pricing model, and found that ignoring the influence of consumers' strategic behavior and the price reference effect would bring the retailer a loss in profit. Bi Gongbing [11] and others studied the dynamic pricing strategy in the presence of substitutes, taking into account the strategic behavior of consumers, and found that the strategic behavior of consumers reduces the additional revenue gained by vendors through dynamic pricing.

2.3. Discounts Related Research

Represented by coupons, coupons as an important marketing tool to stimulate consumers to generate purchasing behavior, e-coupons are the electronic form of traditional paper coupons, with the advantages of convenience and ease of access [12]. Foreign research on the coupon boom appeared in the 1980s and 1990s, with the progress of information network technology and the rise of e-commerce, the study of e-coupon has gradually gained the attention of scholars at home and abroad. For the research on coupon placement and pricing in network marketing enterprises, Li Zongwu [13] and others have studied the channels of coupon placement and pricing from offline, online and omni-channel perspectives, and Luo Meiling [14] and others have studied the main body of coupon placement and pricing from the perspectives of manufacturers, wholesalers, and retailers; for the research on short-term and long-term effects of coupons, Park [15] and others have studied the impact of e-coupons on consumer purchase decisions. For the short-term and long-term effects of coupons, Park [15] and others have studied the short-term and long-term effects of e-coupons on consumers' purchasing decisions. Chang Jun [16] investigates the use of e-coupons obtained by consumers on B2C e-commerce platforms, finds the problems and puts forward rationalization suggestions to improve the use efficiency of e-coupons on B2C e-commerce platforms and give full play to their proper promotional functions.

3. E-commerce Supply Chain Model Configuration Based on Different Consumer Types

3.1. Problem Description and Assumptions

Consider an e-commerce supply chain model consisting of an online retailer and an e-commerce platform in which the online retailer sells goods through the e-commerce platform, and the e-commerce platform establishes the commission f charged by the merchant for each single item sold.

Assuming that the product is homogeneous, it is assumed that the valuation v of the product obeys a uniform distribution on the interval $[0, 1]$ ($v \sim U [0, 1]$) due to the heterogeneity of consumers in reality, the willingness-to-pay tends to vary across consumers for the same product. For the sake of generality, it is assumed that the demand capacity of the entire market one is one.

Assume that the merchant uses a price commitment strategy, i.e., it announces the price for the discounted sales period in advance. There exist a total of two selling periods for the e-tailer: first is the normal selling period (denoted as Period 1), where the third-party seller sets the retail price per unit of the product at p , $0 < p < 1$. Thus the consumer's utility function in Period one is $u_1 = v - p$.

This is followed by a discounted sales period (noted as Period two): the online retailer's price in Period two is $p(1 - a)$, $0 < a < 1$, which a represents the percentage of discount.

Since the sales discount period's will consume the consumer's patience level, it is assumed that the utility gained by the consumer by purchasing the product through the sales discount period is to be less than v , as θv , where $\theta \in (0, 1)$ represents the consumer's convenience, or the consumer's

degree of strategy, and the larger θ represents the consumer's strategy, meaning that the more the consumer is inclined to delay the purchase. Discount: $\theta = 1$, Strategy: $0 < \theta < 1$.

Consumer utility function description:

Type of strategy $0 < \theta < 1$, utility function $u_2 = \theta v - p(1 - a)$.

Table 1. Main variables and their meanings

Notation	Hidden Meaning
p	Normal Sales Period Prices
a	Merchant's discount rate during discount sales period
θ	Patience of consumers
f	Merchant's commission to the e-commerce platform for each unit of product sold during the discounted sales period
v	Consumer valuation of the product
D	Market demand
π_R	Profit of the online retailer
π_p	Profit of the e-commerce platform
Superscript "ST"	Strategic Modeling
Superscript "SH"	Short-sightedness model
Superscript "DI"	Discount model
Superscript "**"	Optimal decision making

3.2. The Strategic Consumer

In this scenario, the consumer type is strategic, and the game decision is embodied as a vertical game decision between the e-commerce platform and the online retailer, the structure of which is shown in Figure 1.

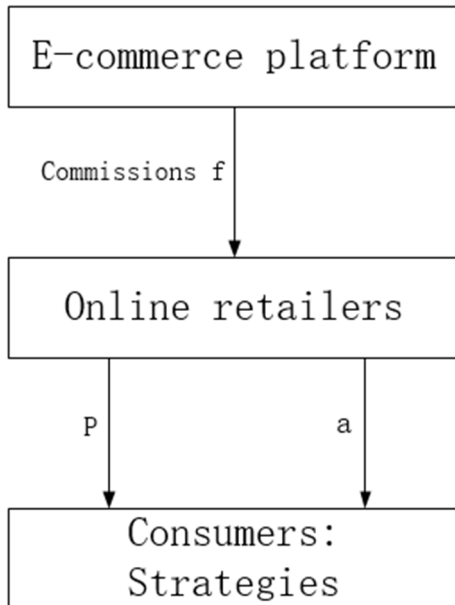


Fig 1. Consumer type as strategy structure

Definition (critical valuation): In the set of customers who have made a purchase, there exists a customer with the lowest valuation, and we define this lowest valuation as the critical valuation of the set of customers.

According to this definition, customers whose willingness to pay is greater than the critical valuation must have made a

purchase. If we know the valuation distribution pattern of a certain customer group and its critical valuation, we can judge the number of customers who have made a purchase. Therefore, the critical valuation to a certain extent represents the market response characteristics of a particular set of customers to the enterprise's pricing strategy. Based on the above assumptions and definitions, as well as the fact that this paper focuses on the situation where demand exists in both normal and discounted sales periods, the process of corporate pricing decisions and the consequent response of consumers is specifically analyzed as follows.

Let $u_2 = 0$, find $v_2 = \frac{p(1-a)}{\theta}$ be the equivalence point

at which a consumer chooses to buy or not to buy during a discounted sales period strategy.

Let $u_1 = u_2$, find $v_{12} = \frac{pa}{1-\theta}$ be the equivalence point at

which a consumer's choice to buy in the normal sales period or the discount sales period.

In the normal sales period, the platform determines the commission f to be charged to the merchant for the two sales phases, the merchant determines the price p for the normal sales period and the discount rate a for the discounted sales period, and the strategic consumer decides whether to purchase the product in the normal sales period or in the discounted sales period, or not to purchase the product.

According to consumer utility theory, consumers will choose the channel according to the level of utility, if $u_1 > u_2$ and $u_1 > 0$, then consumers will choose the normal sales period to buy the product, if $u_2 > u_1$ and $u_2 > 0$, then consumers will choose the discounted sales period to buy the product, otherwise consumers do not buy the product, as shown in Figure 2.

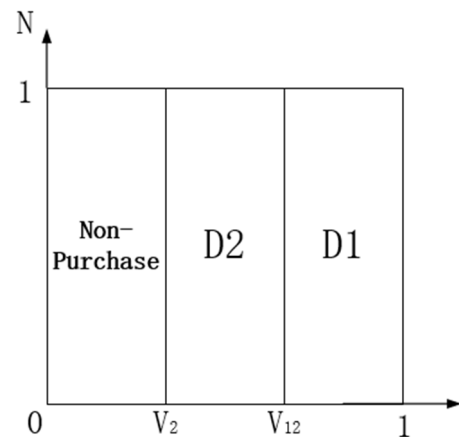


Fig 2. Consumer Demand Segmentation Schematic

Demand function for period 1:

$$D_1 = (1 - v_{12}) \tag{1}$$

Demand function for period 2:

$$D_2 = (v_{12} - v_2) \tag{2}$$

The subscript R stands for the merchant and the subscript P stands for the e-commerce platform:

Merchant's profit function:

$$\pi_R^{ST}(p, a) = (p(1-a) - f)D_2 + (p-f)D_1 \quad (3)$$

Profit function of the e-commerce platform:

$$\pi_p^{ST}(f) = f(D_1 + D_2) \quad (4)$$

Theorem 1: At that time $H_{11} < 0$, there exists an optimal decision for merchant R under the decentralized decision order, and the optimal decision for the e-commerce platform at that time is p^{ST^*} . The equilibrium result is as follows:

$$p^{ST^*} = \frac{\theta(-1+\theta)(a-3)}{(8a-4)\theta + 4(-1+a)^2} \quad (5)$$

$$f^{ST^*} = \frac{\theta}{2} \quad (6)$$

The different types as well as the different period needs are:

$$D_1^{ST^*} = \frac{a^2\theta + 4a^2 + 5a\theta - 8a - 4\theta + 4}{4a^2 + 8a\theta - 8a - 4\theta + 4} \quad (7)$$

$$D_2^{ST^*} = -\frac{(a+\theta-1)(a-3)}{4a^2 + (8\theta-8)a - 4\theta + 4} \quad (8)$$

The profit functions of the merchant and the e-commerce platform are, respectively:

$$\pi_R^{ST^*} = -\frac{\theta((\theta+7)a^2 + (10\theta-10)a + \theta-1)}{16a^2 + (32\theta-32)a - 16\theta + 16} \quad (9)$$

$$\pi_p^{ST^*} = \frac{\theta((\theta+3)a^2 + (4\theta-4)a - \theta + 1)}{8a^2 + (16\theta-16)a - 8\theta + 8} \quad (10)$$

3.3. Shortsighted Consumer

In this scenario, the consumer type is short-sighted, and the game decision is embodied as a vertical game decision between the e-commerce platform and the online retailer, the structure of which is shown in Figure 3.

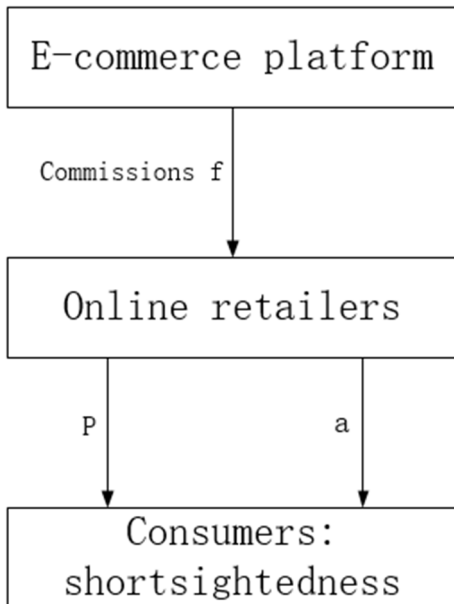


Fig 3. Consumer types are short-sighted structures

Period 1: According to the decision rule of the short-sighted customer, the purchase action occurs for any customer whose reservation price is not less than p . Therefore, the critical valuation of the short-sighted type is p . The expected number of short-sighted customers who take the purchase action in the normal selling period is $(1-p)$. Because of the short-sighted consumer, the first period is direct purchase.

Demand function for period 1:

$$D_3 = (1-p) \quad (11)$$

Profit function of the merchant:

$$\pi_R^{SH}(p, a) = (p-f)D_3 \quad (12)$$

Profit function for e-commerce platforms

$$\pi_p^{SH}(f) = fD_3 \quad (13)$$

Theorem 2: There exists an optimal decision x for merchant R under decentralized decision ordering, when the optimal decision of e-commerce platform p is x . The equilibrium results are as follows:

$$p^{SH^*} = \frac{3}{4} f^{SH^*} = \frac{1}{2} \quad (14)$$

The different types as well as different periods of demand are:

$$D_3^* = \frac{1}{4} \quad (15)$$

The profit functions of the merchant and the e-commerce platform are, respectively:

$$\pi_R^{SH^*} = \frac{1}{16}, \pi_p^{SH^*} = \frac{1}{8} \quad (16)$$

3.4. Consumer Type of Discount

In this scenario, the consumer type is discount, and the game decision is embodied as a vertical game decision between the e-commerce platform and the online retailer, the structure of which is shown in Figure 4.

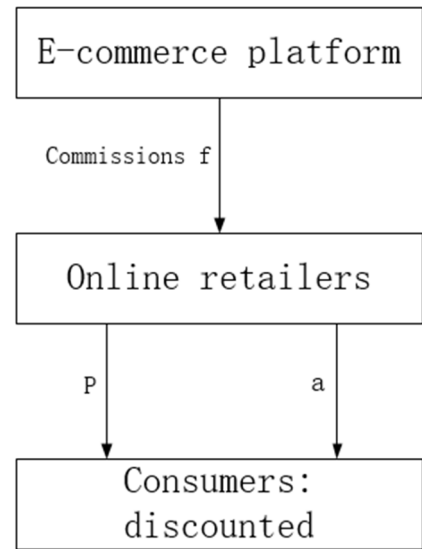


Fig 4. Consumer type is a discount structure

Assume that there are no necessities and that goods can all

wait for a price reduction to be purchased, so that only period 2 exists:

Let $u_3 = 0$, find $v_2 = \frac{p(1-a)}{\theta}$ to be the equivalence

point at which the consumer chooses to buy or not to buy during the discount sales period.

If $u_3 > 0$, then the consumer will choose to purchase the product during the discount sales period, otherwise the consumer will not purchase the product, as shown in Figure 5.

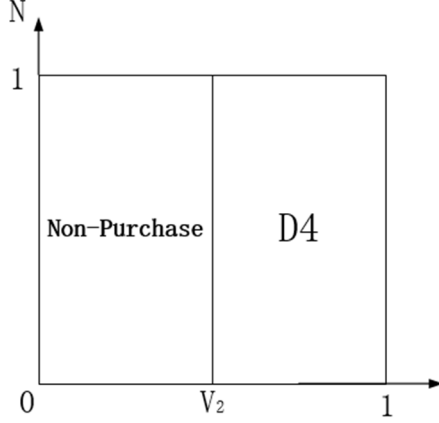


Fig 5. Consumer Demand Segmentation Schematic

Demand function for period 2:

$$D_4 = 1 - v_2 \quad (17)$$

Profit function for merchants:

$$\pi_R^{DI}(p, a) = (p(1-a) - f)D_4 \quad (18)$$

Profit function for e-commerce platforms:

$$\pi_p^{DI}(f) = fD_4 \quad (19)$$

Theorem 3: There exists an optimal decision for merchant R under the decentralized decision order, when the optimal decision for e-commerce platform p is, and the equilibrium result is as follows:

$$p^{DI*} = \frac{3\theta}{4-4a}, \quad f^{DI*} = \frac{\theta}{2} \quad (20)$$

The different types as well as the different periods of demand are:

$$D_4^* = \frac{1}{4} \quad (21)$$

The profit functions of the merchant and the e-commerce platform are, respectively:

$$\pi_R^{DI*} = \frac{\theta}{16}, \quad \pi_p^{DI*} = \frac{\theta}{8} \quad (22)$$

3.5. Compare and Contrast the Three Consumer Types

Conclusion 1: The magnitude relationship for pricing p in the normal selling period for an online retailer under different consumer types is $p^{ST*} > p^{SH*} > p^{DI*}$, if $0 < a < 1 - \theta$

and $0 < a < \frac{2-2\theta}{\theta+2}$, then x ; if $1 - \theta < a < 1$ and $\frac{2-2\theta}{\theta+2} < a < 1$, then $p^{ST*} < p^{SH*} < p^{DI*}$.

From Conclusion 1, it can be seen that the pricing gap under the three consumer types of online retailers is determined by the magnitude of the relationship between the patience level and the discount rate. Conclusion 1 reveals the following managerial implications: when patience level and discount rate are high, pricing is highest under the discount consumer model, followed by short-sighted consumers and lowest for strategic consumers; on the contrary, if patience level and discount rate are low, pricing is highest under the strategic consumer model, followed by short-sighted consumers and lowest for discount consumers.

Conclusion 2: There is $f^{ST*} = f^{DI*} < f^{SH*}$ relationship between the size of commissions set by e-commerce platforms for different consumer types.

From Conclusion 2, it can be seen that when the type of consumer faced by the online retailer is short-sighted, the e-commerce platform has the highest commission rate at this time, and when the type of consumer is strategic and discounted, the e-commerce platform's commission is set to be equal but smaller than that of the short-sighted consumer. Firstly, because the short-sighted type means that the online retailer doesn't need to drive traffic by issuing coupons and setting up promotions, etc., the profit on a single item will be higher compared to the other two. Secondly e-commerce platforms will assist online retailers to reduce the price of goods by lowering the commission rate when faced with promotions, thus achieving the state of attracting traffic.

Conclusion 2 reveals the following managerial implications: the commission rates set by e-commerce platforms are equal in the strategic and discounted consumer models, and the commission rates set by e-commerce platforms are higher in the short-sighted model compared to the first two.

Conclusion 3: The size relationship for market demand D under different consumer types has, when $\frac{2-2\theta}{\theta+2} < a < 1$,

$$D^{ST*} > D^{SH*} = D^{DI*}.$$

From conclusion 3, it can be seen that when the type of consumers faced by online retailers are short-sighted and discounted, the market demand for both is equal. This is because when the online retailer's entire sales period is divided into normal sales period and discount sales period, short-sighted consumers mean that they buy only in the first stage and discount consumers mean that they buy only in the second stage, in short, both types of consumers choose to buy, so the market demand for both is equal. In addition, when the type of consumer faced by the online retailer is strategic, whether he/she generates a purchase is a combination of the degree of patience and the discount rate, i.e., it is fully taken into account whether the purchase behavior in generated is self-serving or not, so it is related to the size of a and θ .

Conclusion 4: The size of profit for e-commerce platform retailers under different consumer types has when $\frac{2-2\theta}{\theta+2} < a < 1$, $\pi_p^{ST*} > \pi_p^{SH*} > \pi_p^{DI*}$.

From conclusion 4, it can be seen that when the type of

consumer faced by the online retailer is short-sighted and discounted, the profit size of the e-commerce platform is higher for short-sighted than discounted. This is because for short-sighted consumers, the e-commerce platform does not need to take the corresponding promotion strategy that spends a certain amount of money, although the e-commerce platform will increase the commission rate of the online retailer in the discount pricing period, but for the e-commerce platform, compared with the discount promotional costs, it is clear that the commission rate is not enough to fully compensate for the promotional costs. In addition, the e-commerce platform is most profitable when the discount rate, patience level is high and the consumer type is strategic, short-sighted type is second and discounted type is the lowest.

Different consumer types have when it comes to the size of an online retailer's profits at the When $\frac{12-12\theta}{\theta+8} < a < 1$,

$$\pi_R^{ST^*} < \pi_R^{DI^*} < \pi_R^{SH^*}.$$

From conclusion 5, it can be seen that when online retailers are faced with short-sighted and discounted consumer types, the profit size of online retailers is higher for short-sighted than discounted. This is because for short-sighted consumers, merchants do not need to adopt appropriate promotional strategies i.e. spend a certain amount of money, and although the commission rate of short-sighted type is higher, it is still much lower than its promotional costs. In addition, when the discount rate, patience level is high and the consumer type is strategic, the online retailer's profit is the lowest, the discount type is the second highest and the short-sighted type is the highest.

4. Calculus Analysis

4.1. The Effect of Changes in a on Optimal Decision Making

This subsection is to explore the effects on the optimal decisions of a different consumer models. The price discount rate a will be used as a variable factor to explore the changes in optimal pricing, optimal demand, optimal profit of e-commerce platforms, and optimal profit of online retailers of the three consumer type models with the changes of related variables, and further verify the validity of the propositional conclusions made in Chapter 3 through dynamic changes.

From Fig. 6, we can see that with the increasing value of price discount rate a , the price under the discount consumer model increases and the growth rate keeps increasing; the price under the short-sighted consumer model remains unchanged because it will only choose period 1 to buy, which has nothing to do with a ; the price under the strategic consumer model decreases, and the decrease rate is still decreasing.

From Figure 7, we can see that as the value of price discount rate a increases, the demand under the strategic consumer model increases and the rate of increase decreases, and eventually the market demand tends to be 1. The market demand of the short-sighted and discounted models remains unchanged, which indicates that the price discount rate is irrelevant to the demand.

From Fig. 8, we can see that the profit of e-commerce platforms under the strategic consumer model increases and the growth rate decreases as the value of price discount rate

a increases; the profit of e-commerce platforms under the short-sighted and discounted consumer models remains unchanged.

From Fig. 9, we can see that the profit of online retailers under the strategic consumer model increases and then decreases with the increasing value of price discount rate a ; the profit of e-commerce platforms under the short-sighted and discounted consumer models remains unchanged.

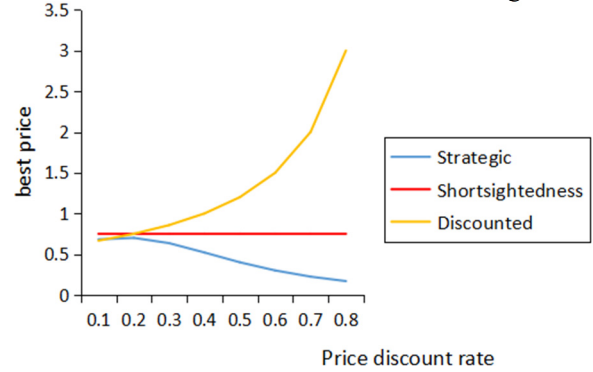


Fig 6. Impact of changes in a on the optimal price of the supply chain

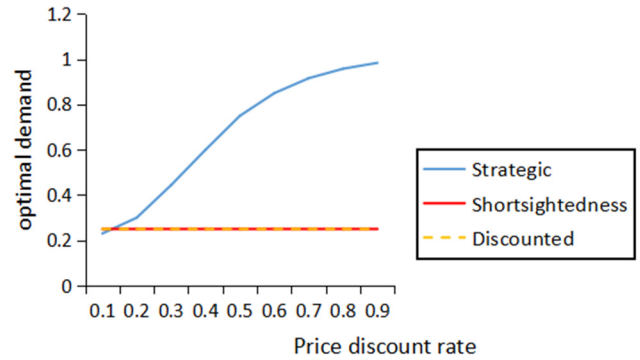


Fig 7. Impact of changes in a on supply chain optimal demand

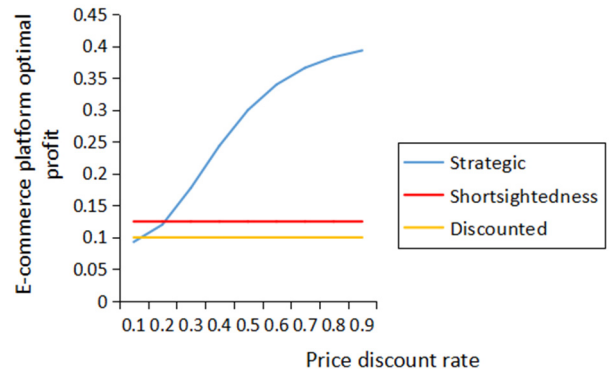


Fig 8. Impact of changes in a on e-commerce platforms' optimal profits

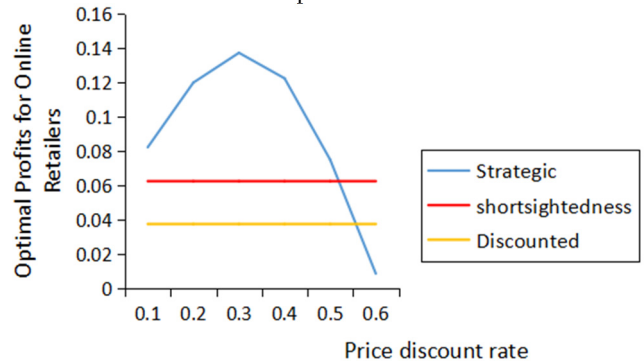


Fig 9. Impact of changes in a on merchants' optimal profits

4.2. Impact of θ Changes on Optimal Decision Makin

This subsection is to explore the effect of θ on the optimal decisions of different consumer models. The degree of patience θ will be used as a variable factor to explore the changes in optimal pricing, optimal demand, optimal profit of e-commerce platforms, and optimal profit of online retailers of the three consumer type models as the relevant variables change, and to further validate the validity of the conclusions of the propositions made in Chapter 3 through dynamic changes.

From Figure 10, we can see that as the value of patience θ increases, the price in the discount consumer model increases and the rate of increase remains the same, the reason for this may be that the discount consumer will only choose not to buy or buy in period 2, and when the patience level is increasing, the possibility of purchasing in period 2 is greatly increased, and therefore the merchant will increase its normal period sales price, increase Therefore, the merchant will increase its normal period selling price and increase the unit price of goods in the discount period in order to earn higher profits; the price in the short-sighted consumer model remains unchanged because it has nothing to do with θ ; the price in the strategic consumer model decreases and the rate of decrease continues to increase, which is probably because the merchant keeps decreasing the price in the hope that the strategic consumer will purchase in period 1.

From Figure 11, we can see that as the value of patience θ increases, the optimal commission rates under the strategic and discounted consumer models are equal and increase and the rate of increase remains constant; the optimal commission rate under the short-sighted consumer model remains constant because it is not related to θ , which may be due to the fact that the short-sighted model means that the online retailer does not need to attract traffic by giving out coupons and setting up full-price promotions, etc. to drive traffic, and the profit on a single item will be higher compared to the other two. Secondly, when e-commerce platforms are faced with promotions, they will assist online retailers in lowering the price of goods by lowering the commission rate, thus achieving the state of attracting traffic.

From Fig. 12, we can see that as the value of patience degree θ keeps increasing, the demand under the strategic consumer model increases and the growth rate keeps decreasing, and finally the market demand tends to 1. The reason for this situation may be that as the patience degree θ keeps increasing, some of the strategic consumers will choose to buy in period 1 when the price is low, and some of them will buy in period 2, and in a word, strategic consumers will all purchase the product; market demand for short-sighted and discounted types remains constant, indicating that the degree of patience is not related to demand.

From Fig. 13, we can see that the profit of e-commerce platforms under the strategic consumer model increases and the growth rate remains constant as the value of patience θ increases; the profit of e-commerce platforms under the short-sighted consumer model remains unchanged; and the profit of e-commerce platforms under the discount consumer model increases and the growth rate remains constant.

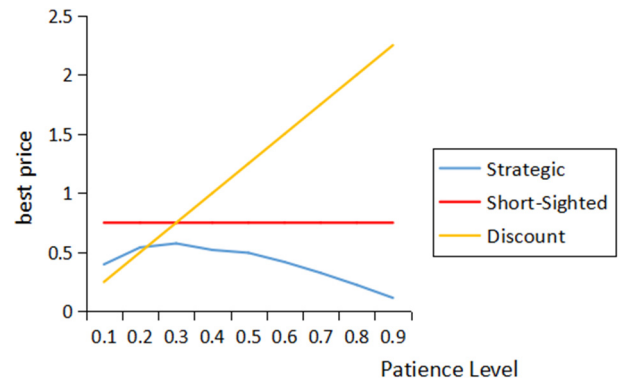


Fig 10. Impact of changes in θ on the optimal price of the supply chain

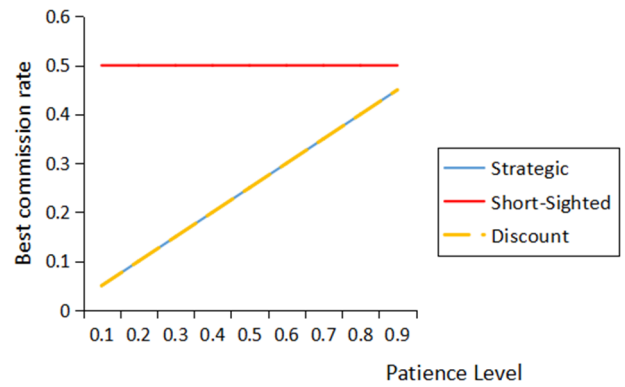


Fig 11. Impact of changes in θ on the Optimal Commission Rate

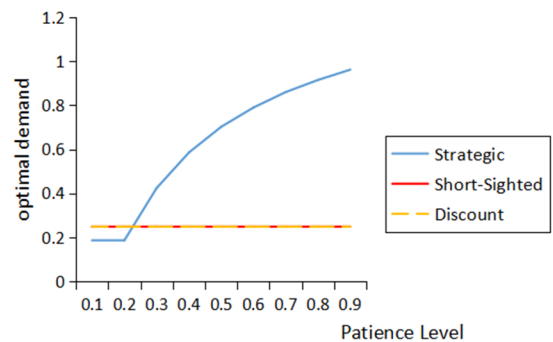


Fig 12. Impact of changes in θ on Optimal demand supply chain

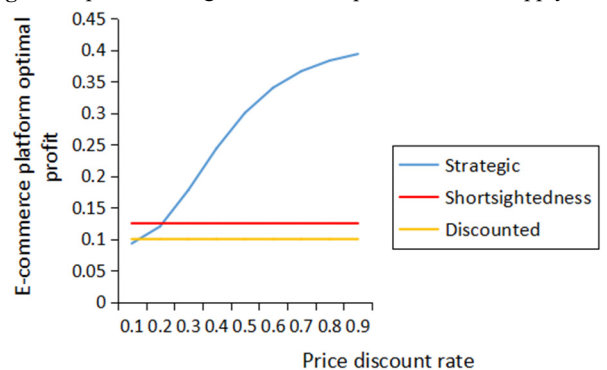


Fig 13. Impact of θ change on optimal of the profitability of e-commerce platforms

4.3. Comparative Analysis of Three Consumer Types

In the previous two sections, dynamic analysis of optimal price, optimal demand, optimal profit of e-commerce supply chain, optimal profit of e-commerce platform, and optimal profit of online retailer are discussed when a and θ are single independent variables, respectively, and next, the

graphs will be further analyzed to verify the reasonableness of the conclusions.

From Figure 6 and Figure 10, it can be seen that when the degree of patience and discount rate are high, the online retailer pricing is the lowest in the strategic consumer model, followed by the short-sighted consumer, and the discount consumer is the highest. It shows the reasonableness of conclusion 1.

As can be seen in Figure 11, when the degree of patience is high, e-commerce platforms set the highest commission rate under the short-sighted consumer model; compared to the short-sighted, the commission set by e-commerce platforms under the strategic and discounted consumer models is equal but smaller than the short-sighted consumer. It shows the reasonableness of conclusion 2.

From Figure 7 and Figure 12, it can be seen that when the degree of patience and discount rate are high, the two models of short-sighted and discount consumers are equal; compared to the first two, the market demand is the highest in the strategic consumer model. It shows the reasonableness of conclusion 3.

From Figure 8 and Figure 13, it can be seen that when the discount rate, the degree of patience, and the type of consumer is strategic, the e-commerce platform has the highest profit, the short-sighted type is second, and the discount type is the lowest. It shows the 4 reasonableness of the conclusion.

From Figure 9 and Figure 14, it can be seen that when the discount rate, the degree of patience is high and the consumer type is strategic, the online retailer has the lowest profit, the discount type is next and the short-sighted type is the highest. Explain the reasonableness of conclusion 5.

5. Conclusion

Based on the above conclusions, the following management implications are drawn: (1) In the phase of discount sales period, such as Taobao's double eleven, Jingdong's June 18th promotion, etc., e-commerce platforms and online retailers can appropriately set a certain amount of discounts for the customer's cost of the trouble, especially for the strategic consumers who have a high degree of patience, we should choose the discount rate should be lower in order to make up for the corresponding losses. At the same time, for the more patient customers, we should increase the cost of promotion, i.e., set up more steps to achieve the high effect of promotion, thus increasing the market demand and ultimately improving the profit of online retailers. (2) While e-commerce platforms pursue their own profit maximization, they should consider the profit of online retailers, especially in the face of strategic customers, the commission rate should be reduced accordingly, and help online retailers to improve their income under the premise of guaranteeing their own profit, so as to achieve a win-win situation.

Further exploration can be made in the following aspects in future research:(1) Existing research shows that there exists a vast majority of consumers who think of redeeming coupons when purchasing products but do not actually do so. When customers buy products, they are often attracted by momentary promotional activities, and when they pay, they may not be able to redeem the rebate or give up due to various reasons (e.g., forgetting, expiration of the coupon, purchase of inconsistent categories that can not be used, etc.), which is known as the phenomenon of "slippage". For example, a study by Consumer Intelligence showed that 40% of customers did not redeem their rebates due to tracking issues.

In the future, we can analyze the impact of the slippage rate on the optimal decision.(2) In this paper, we have only considered the situation where each of the three models exists, but in reality, online retailers are not likely to face a single customer, so this paper can consider the impact of different consumer compositions on e-commerce platforms and merchants' pricing strategies in the future.

References

- [1] HUANG Hongwei, CHEN Zhensong, WU Sheng. Pricing and coordination of dual-channel supply chain based on selling effort under two-part pricing contract [J]. *Computer Integrated Manufacturing Systems*: 1-19.
- [2] HU Wanting, DING Jingjing, DING Tao. Research on dual-channel dynamic pricing strategy in the presence of revenue sharing and cooperative efforts [J]. *Journal of Management Engineering*, 2021, 35(05): 247-57.
- [3] LI Chunfa, XIE Wenqian, CHU Mingsen. Research on pricing and coordination of dual-channel E-closed-loop supply chain dominated by e-commerce platform [J]. *System Science and Mathematics*, 2020, 40(06): 1090-102.
- [4] WANG Hongchun, CHEN Yang, LIU Shuai. Research on supply chain pricing strategy of social e-commerce--an analysis based on platform sales efforts [J]. *Price Theory and Practice*, 2021, (03): 122-5.
- [5] ZHANG Shen, MENG Qingchun, AN Guozheng. Research on coordinated pricing of dual-channel supply chain under the influence of deduction rate of e-commerce platform [J]. *China Management Science*, 2019, 27(10): 44-55.
- [6] WANG Daoping, GUO Wenxuan. Pricing strategies of online retailers during online shopping festival - An analysis based on sales big data of e-commerce platform [J]. *China Circulation Economy*, 2021, 35(09): 95-106.
- [7] Song ZP. Research on Pricing Strategies of E-tailers--Analysis Based on Consumers' Time-Limited Buying Behavior [J]. *Price Theory and Practice*.
- [8] WANG Daoping, ZHANG Boqing, YANG Cen. Dynamic Pricing Strategies of E-tailers under Joint Promotion [J]. *Industrial Engineering and Management*, 2015, 20(04): 68-74.
- [9] SHOUYU M, ZIED J, QINGGUO B. Optimal pricing and ordering decisions for a retailer using multiple discounts [J]. *European Journal of Operational Research*, 2022, 299(3).
- [10] Guan Zhenzhong, Ren Jianbiao. Dynamic pricing strategies in the presence of strategic consumers [J]. *Systems Engineering Theory and Practice*, 2014, 34(08): 2018-24.
- [11] BI Gongbing, WANG Yixuan, DING Jingjing. Dynamic pricing considering consumer strategic behavior in the presence of substitutes [J]. *Journal of Systems Engineering*, 2013, 28(01): 47-54.
- [12] TIAN Yingdong, YANG Wensheng, WANG Yameng. A game study on the evolution of decision-making behaviors of subjects involved in e-coupon marketing market [J]. *Soft Science*, 2020, 34(08): 123-32.
- [13] LI Zongwu, YANG Wensheng, LIU Xiaohong. Channel Integration Strategies for Online Coupon Placement in Omni-Channel Retailers [J]. *Systems Engineering Theory and Practice*, 2020, 40(03): 630-40.
- [14] Luo Meiling, Li Gang, Zhang Wenjie. Research on multi-channel integration strategy based on e-coupon [J]. *Operations Research and Management*, 2017, 26(02): 192-9.
- [15] PARK C H, PARK Y-H, SCHWEIDEL D A. The effects of mobile promotions on customer purchase dynamics [J]. *International Journal of Research in Marketing*, 2018, 35(3).

- [16] Chang Jun. Research on the Problems and Countermeasures of E-Coupon Use on B2C E-commerce Platform [J]. Modern Business, 2020, (18): 21-2.
- [17] Li Hao, Qin Hong. Research on Price Reduction and Promotion Strategies in Internet Shopping Festival-An Analysis Based on the Perspectives of E-commerce Platforms and E-tailers[J]. Price Theory and Practice,2022(10):163-166.
- [18] Yang Man. Research on pricing decision and operation strategy of dual-channel supply chain under e-commerce environment [D]. Shanghai University of Finance and Economics, 2021.
- [19] TAO Yi, YANG Ruisi, LIN Qiang,WANG Fan. An e-commerce supply chain financing and pricing decision model considering competition and risk aversion behavior[J/OL]. China Management Science:1-15[2023-04-13].
- [20] Wang Daoping, Zhou Yu. Coordinated pricing of dual-channel supply chain considering collocation discounts on e-commerce platforms[J]. Journal of Systems Engineering,2022, 37(04): 535-548.
- [21] LI Chunfa, CUI Xin, ZHOU Chi,MI Xinxin. Timing pricing strategy of extended warranty service on e-commerce platform under wholesale and consignment model[J/OL]. Computer Integrated Manufacturing Systems:1-14[2023-04-13].
- [22] Kenji Matsui. when should a manufacturer set its direct price and wholesale price in dual-channel supply chains?[J]. European Journal of Operational Research, 2017, 258(2) : 501-511.
- [23] WANG Wenbin, DING Junfei. Research on the impact of hybrid sales channel on supply chain decision-making based on e-commerce platform[J]. Operations Research and Management, 2019,28(06):89-97.
- [24] Shan Zhenjie, Huang Hailing,Lin Qiang et al. Research on rebate promotion strategy of platform competing merchants [J/OL]. Systems Engineering:1-11[2023-04-13].
- [25] YU Niu, WANG Shumei,WANG Huiting. Supply chain pricing and rebate optimization strategy considering consumer behavior[J]. Systems Engineering,2020,38(04):87-94.
- [26] LIN Zhi-Bing. Research on manufacturer rebate strategy under information asymmetry[J]. Systems Engineering Theory and Practice,2020,40(02):324-333.
- [27] Nie Jiajia, Wang Qijun,Ding Long. Research on Corporate Rebate Strategy Considering Consumer Social Influence[J]. Operations Research and Management,2020,29(09):224-231.
- [28] ZHANG Zhijian, ZHOU Yadi,GUO Junhua,WANG Peng. A study of different online sales decisions considering platform coupons[J]. Operations Research and Management, 2023,32(01): 147-153.
- [29] Xiaogang Lin and Yong-Wu Zhou and Rui Hou. Impact of a "Buy-online-and-pickup-in-store" Channel on Price and Quality Decisions in a Supply Chain[J]. Decisions in a Supply Chain[J]. European Journal of Operational Research, 2020, 294(3) : 922-935.
- [30] Zhang H, Li L, Zhu XZ, et al. Optimal Price Promotion Strategy for Online Shopping Platforms: Price Discount or Cash Coupon? [J]. China Management Science,2022,30(10): 130-141.
- [31] GUO Guoqing, LEI Yushang,YANG Hailong. Long-term effects of different types of e-commerce promotions on purchasing behavior--Taking Amazon e-books as an example [J]. Economic Management,2020,42(04):106-123.
- [32] Yang Xue, Liu Xiaofeng. Research on dual-channel after-sales service pricing strategy of composite e-commerce platform[J]. Price Theory and Practice,2020(11):132-135+184.
- [33] SI Yinyuan, YANG Wensheng,LIU Sen et al. Corporate targeted coupon placement strategy considering consumers' online shopping preference behavior[J]. Systems Engineering, 2020, 38(01):36-44.
- [34] Zeng Yan, Wu Xuefeng,Kang Junqing et al. Optimal strategy and benefits of coupon distribution between e-commerce platforms and their merchants[J]. Systems Engineering Theory and Practice,2023,43(01):110-134.
- [35] LI Zongwu, YANG Wensheng,LIU Xiaohong et al. Channel integration strategy for online coupon placement in omnichannel retail enterprises[J]. Systems Engineering Theory and Practice, 2020,40(03):630-640.