Research on promotion strategies of offline retailers considering the long-term effect of promotion in the new retail context

Yilin Zheng[a], Hai Shen[*], Xiaoying Cui[b]

[a]laney_z@foxmail.com, [*]shenhai@xisu.edu.cn, [b]cxy4070@outlook.com

Business School, Xi'an International Studies University, Xi'an, China

Abstract. [Objective] In the context of new retail, the research focuses on pricing and promotional decisions by platforms and retailers at different periods under varying levels of long-term promotional effects. **[Methodology]** Employing game theory, the study considers the continuity of promotions and introduces long-term promotional effects. It constructs a two-stage game model consisting of an international online platform and an offline retailer, addressing pricing and promotional decisions. **[Results]** (1)When the long-term promotional effect is positive, retailers increase selling prices to boost profits. (2) When the long-term promotional effect is negative, post-promotion demand surpasses demand during the promotional period. **[Conclusion]** The decision-making approach considering long-term promotional effects offers a novel avenue for optimizing pricing and promotional strategies for international online platforms and offline retailers.

Keywords: New retail, promotional strategies, long-term effects of promotions, Offline retailer

1 Introduction

Under the impetus of the global digital wave, the retail industry not only demonstrates a sustained recovery trend but also embraces new development opportunities, giving rise to a multitude of "new consumption, new business forms, and new models [1]. Simultaneously, the new retail model, guided primarily by consumer experience and integrating online and offline elements, accelerates the process of globalization. Offline enterprises actively integrate into and participate in the transformative phase of new business models [2]. In the context of the digital economy, the online shopping platform has become a crucial channel for consumers to compare products easily [3-5]. Online platforms (hereinafter referred to as "platform"), especially cross-border retail networks, often employ various promotional methods to attract consumers in intense market competition, aiming to stimulate consumption and enhance consumer experience. This activity results in short-term fluctuations in product demand, generating short-term promotional effects. However, businesses emphasize long-term growth under the new retail paradigm dominated by service-oriented development [6-9]. Therefore, when formulating promotional strategies, platforms or enterprises consider short-term effects and focus more on consumers' sustained demand for products after the conclusion of promotional activities, namely, long-term promotional effects [10-13].

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2 Inserting content elements

2.1 Question description

Consider an international online platform and an offline retailer, where the platform charges a commission to the retailer based on the transaction amount. Let the commission rate be θ, where $0 < \theta < 1$, and assume a relatively long-term contract between the platform and the retailer, making θ an exogenous variable. The platform initiates a promotion and provides consumers with discount coupons. Considering the long-term effect of promotions, this study will establish a two-period model, where t=1 represents the promotion period, and t=2 represents the late period after the promotion. In period 1, the platform first provides discount coupons, and the retailer then determines the pricing for the promotional period. In period 2, the platform no longer provides discount coupons, and the retailer prices the product based on the long-term effect of the promotion.

2.2 Considering the impact of exchange rates in the basic model

To determine the demand increment during the promotional period compared to the typical sales period and to conduct a comparative analysis between the platform-provided discount coupon model and the typical sales period model, the following establishes a two-period baseline model for the typical sales period. In the baseline model, promotional activities are not considered, representing the strategy for the typical sales period. This study first establishes a linear demand function form [14, 15], assuming, without loss of generality, that the demand for the product decreases as the price increases. As the study focuses on an international online platform and an offline retailer, and considering the different costs incurred by the retailer in cross-border sales activities compared to domestic sales, costs, including the wholesale price of retail goods (in local currency), the retail price of goods (in foreign currency), and the local currency to foreign currency exchange rate, are incorporated into the demand function at this stage [16].

Based on the above content, let's assume the demand for the product in period t (t=1,2) as follows:

$$D_t = g + (p_t – we) . \quad (1)$$

In this equation, represents the primary product demand, which can be understood as the maximum potential market size for the product. For model simplification, the price sensitivity of consumers in equation (1) is assumed to be 1. The profit functions for retailer R and platform S in period t are expressed as follows:

$$\prod_t^R = (1 – \theta)\ (p_t – we)\ D_t \quad (2)$$

$$\prod_t^S = \theta\ (p_t – we)\ D_t . \quad (3)$$

The retailer and the platform each aim to maximize their own interests, and their respective optimization problems are as follows, where $0 < \mu \leq 1$ is the discounting factor:

$$\max \prod^R = \prod_1^R + \mu \prod_2^R \quad (4)$$

$$\max \prod^S = \prod_1^S + \mu \prod_2^S . \quad (5)$$

Based on the above formula, the pricing for the retailer in the baseline model can be solved, denoted with a superscript "B" to represent the baseline model. It can be expressed as:

$$p_t^B = we + \frac{g}{2} \tag{6}$$

$$D_t^B = \frac{g}{2} \tag{7}$$

$$\prod^{RB} = (1 - \theta)\,(1 + \mu)\,\frac{g^2}{4} \tag{8}$$

$$\prod^{SB} = \theta\,(1 + \mu)\,\frac{g^2}{4}\,. \tag{9}$$

2.3 Platform-provided discount coupon promotion model

In period 1, the platform provides discount coupons denoted as, and the retailer decides on the product price, α ($\alpha > 0$) is the consumer promotion sensitivity factor. Currently, the product demand is given by:

$$D_1 = g - [\,(p_1\text{-}we) - \alpha n]\,. \tag{10}$$

Period 2 is the late period after the promotion ends, considering that the product price and the long-term effect of the promotion influence the product demand. The product demand during this time is given by:

$$D_2 = g - (p_2 - we) + \delta\,(D_1 - D_1^B)\,. \tag{11}$$

The coefficient of the long-term promotion effect represents the lasting impact of the promotion in period 1 on the demand for the product in period 2. The long-term promotion effect is related to the incremental demand during the promotion period, and to ensure the meaningfulness of the promotion, it must be satisfied. This study considers three scenarios for δ: ① when $\delta < 0$, it indicates a negative effect of the promotion on later demand; ② when $\delta = 0$, it signifies no effect of the promotion on later demand; ③ when $\delta > 0$, it suggests a positive effect of the promotion on later demand. To maintain generality, it is assumed that ensuring that the long-term promotion effect in period 2 is less than the impact of price on demand.

The optimal decision problem for the platform is then:

$$\begin{cases} \max\limits_{r} \prod^S = [\theta\,(p_1 - we) - n]\,D_1 + \mu\theta\,(p_2 - we)\,D_2 \\ \quad \text{s.t.} \quad D_1 - D^B \geq 0 \\ \quad\quad\quad n \geq 0 \end{cases} \tag{12}$$

The optimal decision problem for the retailer is:

$$\begin{cases} \max\limits_{p_1,p_2} \prod^R = (1 - \theta)\,(p_1 - we)\,D_1 + \mu\,(1 - \theta)\,(p_2 - we)\,D_2 \\ \quad \text{s.t.} \quad D_1 - D^B \geq 0 \\ \quad\quad\quad p_1 > 0 \end{cases} \tag{13}$$

3 Model analysis

The sequential timing of the promotion strategy is as follows: At the beginning of period 1, the platform first releases discount coupons, and the retailer subsequently makes pricing decisions for period 1. After the promotion ends, it enters period 2, where the retailer makes pricing decisions for period 2.

Through backward induction, the optimal pricing problem for the retailer in period 2 can be obtained:

$$\max \prod_2^R = (1 - \theta)(p_2 - we) D_2 . \tag{14}$$

It can be derived that $\frac{\partial^2 \prod_2^R}{\partial p_2^2} = -2(1-\theta) < 0$, indicating that $\prod_2^R$ is a concave function with respect to p_2. Setting the partial derivative of $\prod_2^R$ with respect to p_2 to zero, we obtain:

$$p_2 = \frac{g + 2we + \delta\left[\frac{g}{2} - (p_1 - we) + \alpha n\right]}{2}. \tag{15}$$

Substituting equation (13) into equation (11) and solving for the retailer's pricing problem during period 1, we can express the objective function of (12) as the Lagrangian function:

$$L = \max_{p_1, p_2} \prod^R + k_1 \left[g - (p_1 - we) + \alpha n\right] + k_2(-n). \tag{16}$$

Therefore, $\prod^R$ is a concave function with respect to p_1. Considering its Karush-Kuhn-Tucker (KKT) conditions, we can obtain the function for the promotional price of the retailer during period 1 as:

$$p_1 = \frac{2\delta g\mu - 8ew - 4\alpha n - 4g + \delta^2 g\mu + 2\alpha\delta^2 n\mu + 2\delta^2 e\mu w}{2(\delta^2\mu - 4)}. \tag{17}$$

Substituting equation (18) into equation (16), we get:

$$p_2 = -\frac{-2\delta^2\mu w + an\delta + 2g + 4ew}{\mu\delta^2 - 4}. \tag{18}$$

Substituting equation (17) and (18) into equation (19), solving the platform's optimal decision problem during period 1, we can express the objective function of equation (14) as the Lagrangian function:

$$L = \max_{r} \prod^S + k_1\left[-\frac{g}{2} + \left(p_1 - \frac{w}{e}\right) + \alpha n\right] + k_2(-n). \tag{19}$$

Therefore, when $\alpha < \frac{1}{2-\theta}$, $\frac{\partial^2 \prod^S}{\partial n^2} < 0$, indicating that $\prod^S$ is a concave function with respect to n. This is deduced from its Karush-Kuhn-Tucker (KKT) conditions, the optimal discount coupon value for the platform is obtained as:

$$n^* = \frac{g(\alpha\theta - 1)(-\delta^2\mu + 2\delta\mu + 4)}{4\alpha(2 - \alpha\theta)}. \tag{20}$$

Substituting equation (20) into equation (17) and equation (18), we obtain:

$$p_1^* = \frac{2\delta g\mu - 8ew - 4g + \delta^2 g\mu + \frac{g\ (\alpha\theta - 1)\ (-\delta^2\mu + 2\delta\mu + 4)}{\alpha\theta - 2} - 2\delta^2 e\mu w - \frac{\delta^2\mu g\ (\alpha\theta - 1)(-\delta^2\mu + 2\delta\mu + 4)}{2\ (\alpha\theta - 2)}}{2\ (\delta^2\mu - 4)} \tag{21}$$

$$p_2^* = \frac{16g + 4\delta g + 32ew - 8\alpha\theta - 2\delta^2 g\mu + \delta^3 g\mu - 8\delta^2 e\mu w + 4\alpha\theta\delta g - 16\alpha\theta ew + 2\alpha\theta\delta^2 g\mu - \alpha\theta\delta^3 g\mu + 4\alpha\theta\delta^2\mu we}{\alpha e\ (\delta^2\mu - 4)\ (\alpha\theta - 2)} \tag{22}$$

Substituting equation (20), (17) and (18) into the demand function and profit function, we determine the optimal demand and optimal profit,

The demand for the product in period 1 is:

$$D_1^* = \frac{g\ (4 + 2\delta\mu - \delta^2\mu)}{2\ (\delta^2\mu - 4)\ (\alpha\theta - 2)}\ . \tag{23}$$

The demand for the product in period 2 is:

$$D_2^* = \frac{g\ (16 - \alpha\theta\delta^3\mu + 2\alpha\theta\delta^2\mu + \delta^3\mu - 2\delta^2\mu + 4\alpha\theta\delta - 4\delta - 8\alpha\theta)}{4\ (\delta^2\mu - 4)\ (\alpha\theta - 2)}\ . \tag{24}$$

The platform's profit is:

$$\prod^{S^*} = \frac{g\ (eg\ (16 + (-2+\delta)\ \mu\ (8\ (-2 + \alpha\theta) - 4\delta\ (2 + \alpha\theta\ (-2 + \alpha\theta)) + (-2 + \delta)\ \delta^2\ (-1 + \alpha\theta)^2\ \mu)) + 4\alpha\theta\ (-8 + 2\ (-8 + \delta^2 - 2a\ (-2 + \delta)\ \theta)\ \mu + (-2 + \delta)\ \delta^2\ (-1 + \alpha\theta)\ \mu^2)\ w + 4e^2\alpha\theta\ (8 + \mu\ (16 - 8\alpha\theta + \delta(-2\delta + 4\alpha\theta - (-2 + \delta)\ \delta\ (-1 + \alpha\theta)\ \mu)))\ w)}{16\alpha e\ (\delta^2\mu - 4)\ (\alpha\theta - 2)} \tag{25}$$

The retailer's profit is:

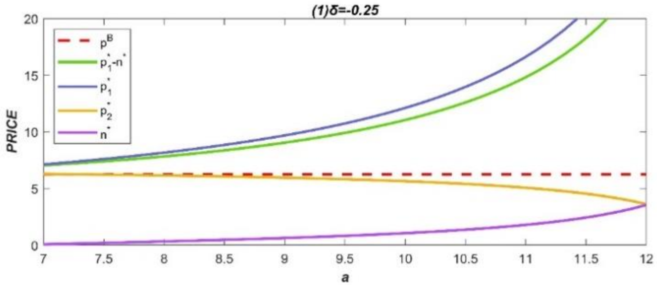
$$\prod^{R^*} = -\left(\frac{\left(g\ (-1 + \theta)\left(\begin{array}{c} eg\left(-16 - 4\ (-2 + \delta)\left(-2\ (-2 + \alpha\theta)^2 + \delta\left(2 - 4\alpha\theta + \alpha^2\theta^2\right)\right)\mu + (-2 + \delta)^2\ \delta^2\left(3 - 4\alpha\theta + \alpha^2\theta^2\right)\mu^2\right) + \\ 4\ (-2 + \alpha\theta)\left(-8 + 2\left(-8 + \delta^2 + 4\alpha\theta - 2\delta\alpha\theta\right)\mu + (-2 + \delta)\ \delta^2\ (-1 + \alpha\theta)\ \mu^2\right) w - \\ 4e^2\ (-2 + \alpha\theta)\left(-8 + 2\left(-8 + \delta^2 + 4\alpha\theta - 2\delta\alpha\theta\right)\mu + (-2 + \delta)\ \delta^2\ (-1 + \alpha\theta)\ \mu^2\right) w \end{array}\right)\right)}{\left(16e\ (-2 + \alpha\theta)^2\left(-4 + \delta^2\mu\right)\right)}\right). \tag{26}$$

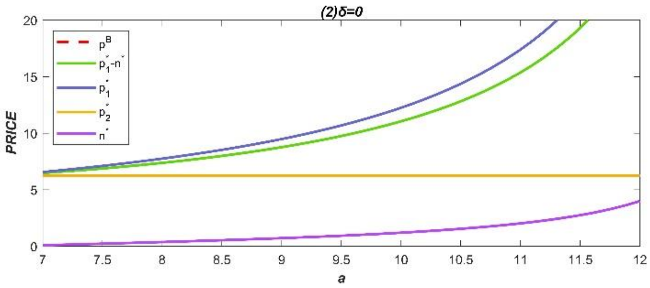
4 Numerical Simulation

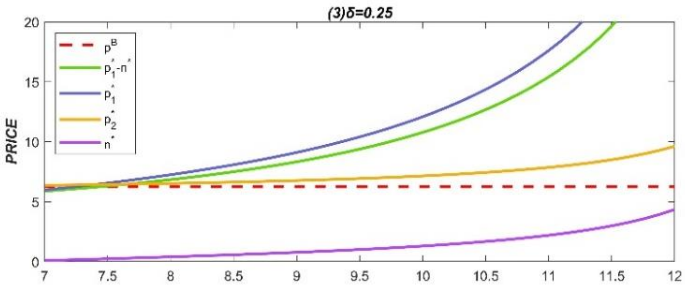
4.1 Optimal decision analysis

Taking $\delta = \{-0.25, 0, 0.25, 0.75, 1\}$ represents five different levels of long-term promotional effects, from low to high intensity. Analyzing the impact of long-term promotional effects on the decision-making of the e-commerce platform and offline retailers under the promotional strategy. Meanwhile, assuming that other parameters in the model are respectively: e=0.5, g=12, θ=0.15, μ=0.

In Figure. 1, Image (1) shows that when the value of the long-term promotional effect δ is negative, i.e., $\delta < 0$, with the continuous increase of the promotion sensitivity perception factor, the price in the post-promotion period gradually decreases. When consumers have a relatively low promotion sensitivity perception factor, the price in Period 2 remains essentially the same as the initial price. This is because in this scenario, the promotion sensitivity perception factor is low, and consumers have a low perception of promotions. Therefore, the issuance of discount coupons does not significantly impact demand, and retailers do not need to adjust prices to maximize profits. Image (2) shows that when the value of the long-term promotional effect is zero, δ = 0, the price in Period 2 remains consistent with the baseline price.As evident from Images (3) and (4), when the value of the long-term promotional effect is positive, δ > 0, with the continuous increase in promotion sensitivity perception factors and the strengthening of the long-term promotional effect, the discount intensity of platform coupons increases. The sales price of retailers in Period 1 continues to rise. This is because retailers, aiming for profit maximization crease the promotional price to compensate for the anticipated loss in consumer demand in the post-promotion period.







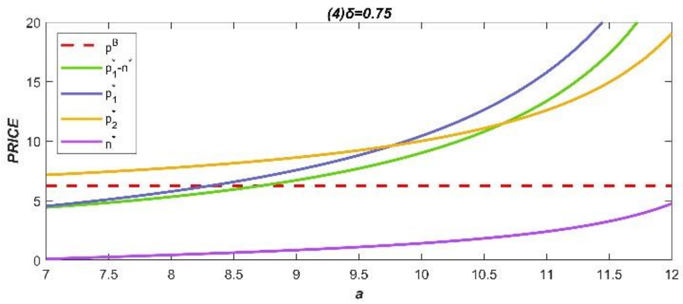
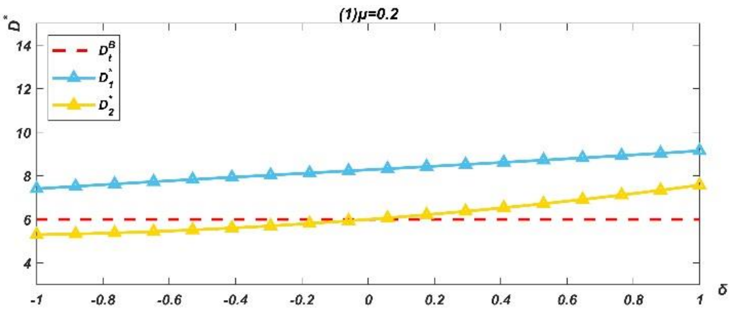


Fig. 1. Numerical analysis of decision variables

4.2 Demand analysis

Taking μ={0.2,0.4,0.6,0.8,1} represents five different levels of discount factors, from low to high intensity. Analyzing the impact of long-term promotional effects on the demand fluctuation of the e-commerce platform and offline retailers under the promotional strategy. Meanwhile, assuming that other parameters in the model irrespectively α=8.5, e=0.05, g=12, θ=0.15, w=0.5.

As shown in **Figure. 2**, the demand in period 1 increases with the growth of the long-term promotional effect, and the higher the discount factor μ, the more significant the change in dettmand in period 1. The demand fluctuation in period 2 increases with the increase in the discount factor. When the long-term promotional effect is negative, as the negative impact of the long-term promotional effect decreases, the demand in period 2 decreases and gradually approaches the demand level of normal sales. When there is no long-term promotional effect, the increase in the discount factor does not affect the demand for products. When the long-term promotional effect is positive, the demand in period 1 is always higher than the demand for products in period 2.



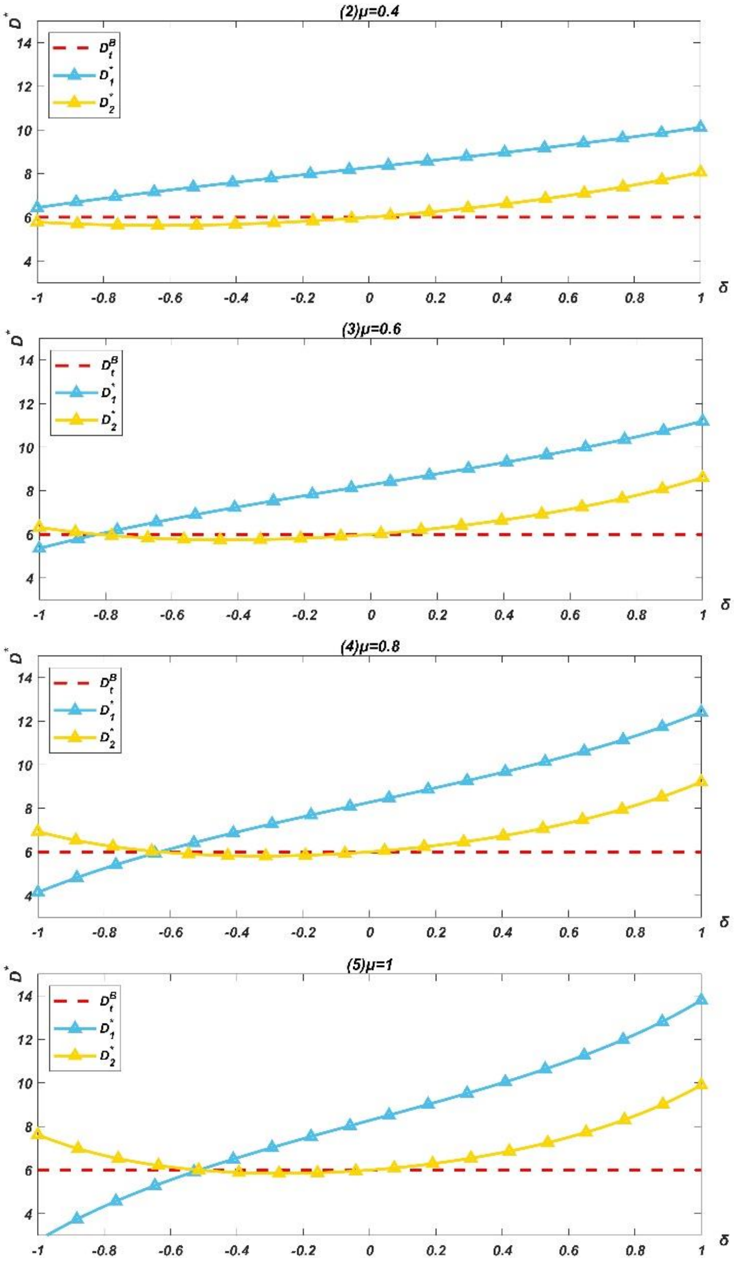


Fig. 2. Demand Numerical Analysis

4.3 Profit Analysis

Analysis of the Impact of Long-term Promotional Effects on Demand Fluctuations for E-commerce Platforms and Offline Retailers under Promotional Strategies. Assuming model parameters are: α=8, e=0.75, g=12, μ=0.75, θ=0.15, w=0.5.

As shown in **Figure. 3**, it is evident that the potential optimal profits for both the retailer and the platform may be lower than the profits during the regular sales period. This phenomenon arises because the platform, responsible for providing discounts, might engage in substantial promotions to attract consumers and stimulate demand. In doing so, there is a possibility of neglecting the interests of the retailer, leading to lower profits for the retailer during the promotional period compared to the regular sales period.

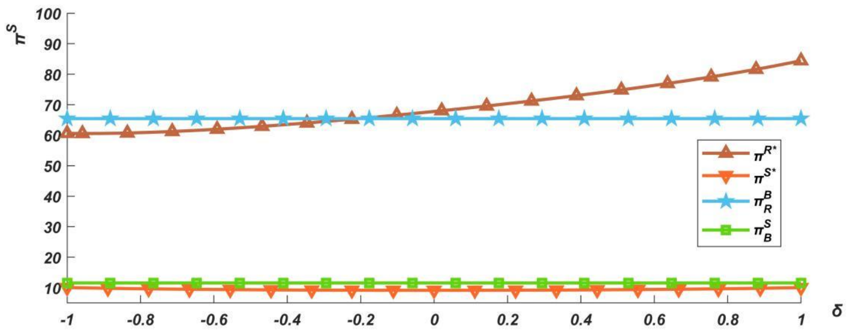


Fig. 3. Profit Numerical Analysis

5 Conclusion

This study considers a two-tier supply chain consisting of an international online platform and an offline retailer, taking into account the long-term effect of promotions. By constructing a two-stage game model involving the platform and the retailer, the research investigates its impact on the optimal pricing strategy for platform-retail promotions. The findings reveal that under certain conditions related to consumer sensitivity, long-term promotional effects, and discounting factors, retailers tend to increase product prices during promotional periods to maximize profits. Additionally, the study indicates that with an increase in long-term promotional effects and consumer sensitivity, retail prices, discounts, and demand during promotional periods all tend to rise. However, as discounting factors and long-term promotional effects increase, demand after the promotion period for the retailer initially decreases before increasing again.

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