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Cooperative Advertising and Price Discount Strategy of O2O Tourism Dual-Channel Supply Chain

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Abstract: With the rapid development of online tourism platforms such as Ctrip and Qunar, tourists ' consumption patterns and consumption habits have begun to change, and the distribution channels and marketing models of scenic spots have also changed. In the supply chain, cooperative advertising is a common way to increase market share. Scenic spots reduce the advertising costs of OTA through cost sharing and revenue sharing, and encourage them to carry out promotional advertising. At the same time, based on the competitive pressure brought by the digital economy, scenic spots have to implement price discounts and brand advertising to consolidate their existing market share. The scenic spot and OTA have a common terminal market. The two cooperate vertically and compete horizontally. The imbalance of advertising investment between channels may lead to channel competition and disharmony. Based on this, considering the joint influence of price discount and advertising on visitor market, the cooperative advertising strategy between scenic spots and OTAs (Online Travel Agency) is studied, and the optimal advertising level, advertising cost sharing ratio and price discount level of both parties under the three modes of unilateral cooperative advertising, bilateral cooperative advertising and strategic alliance are worked out respectively, and the influence of price discount on demand and profit under different modes is analyzed. The research results show that, (1) In the unilateral and bilateral advertising cooperation mode, the joint impact of price discounts and brand advertising and promotional advertising on market demand is regulated by commissions. Appropriate commissions can promote the mutual sharing of advertising costs between scenic spots and OTA, and the smooth progress of cooperative advertising; (2) the price discount strength of the unilateral model is always the largest, and when the market is more sensitive to promotional advertising, the price discount strength of the bilateral cooperative model is greater than that of the strategic alliance model; (3) the bilateral cooperation model achieves a Pareto improvement on the unilateral cooperation model, and the strategic alliance model achieves a Pareto improvement on the bilateral cooperation model.

Keywords: Tourism O2O Dual-Channel Supply Chain, Bilateral Cooperation, Price Discount, Pareto Improvement

1. Introduction

With the rapid development of online travel platforms, such as Ctrip and Go To, more and more consumers are buying tourism products through online channels, and Online Travel Agency (OTA) is gradually becoming a trend, the distribution channels and marketing models of scenic spots have also changed. In the supply chain, cooperative advertising is a common way to increase market share [1]. Scenic spots reduce OTAs' advertising costs and incentivize them to conduct promotional advertising through cost-sharing and revenue sharing. At the same time, based on the competitive pressure brought by the digital economy, online channels have to implement price discounts and scenic spots also invest in brand advertising to consolidate their existing market share. On the one hand, under the joint influence of price discounts and advertising on market demand, sticking to the original advertising strategy is likely to lead to a waste of resources; on the other hand, scenic spots and OTAs share a common end market, and both of them cooperate vertically and present competition horizontally [19], and the imbalance of advertising investment between channels may lead to channel competition and dissonance. Therefore, the problems of cooperative advertising strategies, price discounts and optimal matching of advertising inputs between scenic spots and OTAs need to be solved urgently.

This study is mainly related to cooperative advertising strategies and price discounting strategies in the travel supply chain. One type of research on cooperative advertising strategies is on cooperative advertising in single-channel or dual-channel supply chains composed of manufacturers and offline retailers, such as He et al. explored the cooperative advertising and pricing strategies of manufacturers and retailers with manufacturers as the lead, and found that cooperative advertising is the most effective solution when the retailer's interest rate is lower than the manufacturer's [2]. He et al. studied cooperative advertising in a two-phase supply chain strategies and designed two-way subsidy contracts to coordinate the entire supply chain system [3]. Further, Qian et al. introduced online advertising marketing strategies in the dual-channel cooperative advertising problem and explored advertising decisions in cooperative, non-cooperative, and strategic alliance models, respectively [4]. Another category is the study of cooperative advertising strategy in O2O supply chain, such as Li et al. analyzed the impact of retailers' adoption of online order and offline pickup (BOPS) model on cooperative advertising strategy, and the study showed that the implementation of BOPS model can partially replace the incentive effect of cooperative advertising [5]; Shu Liangyou et al. analyzed the influence of cross-selling effect on cooperative advertising decision-making, and found that cooperative advertising can simultaneously increase the revenue of manufacturers and network platforms under certain conditions [6]. Li et al. studied the optimal cooperative advertising strategies under different cooperative models and analyzed the reasons why bilateral advertising cooperation is difficult to achieve in reality [7]. In addition, considering that retailers have both online and offline channels, Hu Jiao et al. explored the role of cooperative advertising in omnichannel supply chain coordination by taking omnichannel supply chain cooperative advertising as the target [8].

Regarding the price discount strategy, most of the existing studies consider it as an influential factor in decision making, considering its impact on decisions such as ordering [9, 10], product quality control [11], pricing [12, 13], and coordination of the supply chain [14, 15], and there is less literature related to this paper that considers both the price discount strategy and the cooperative advertising strategy, and the existing related literature mainly focuses on the unilateral cooperative advertising models, such as Yue et al. analyzed the optimal cooperative advertising strategy in a price-sensitive market when manufacturers offer discounts [16]. He et al. analyzed the optimal advertising strategy and price discount scheme under four game scenarios and achieved a "win-win-win" situation through Pareto improvement [17]. Chen et al. analyzed the cooperative advertising coordination problem when there is both price and advertising competition between channels, taking a dual-channel supply chain composed of a manufacturer opening an online channel and a traditional retailer as the target [18]. In addition, this paper takes tourism supply chain as the background, and the research on cooperative advertising in tourism supply chain is less and mostly takes single channel as the object, for example, Wang Jingjing et al. measured the bargaining power by channel power, designed the profit distribution scheme between scenic spots and travel agencies and used it to determine the optimal cooperative advertising strategy for both parties [19]. Zhao, Lai-Ming et al. considered the influence of tourists' consumption preferences on the market demand of group and casual tourists, and studied the vertical cooperative advertising strategies of scenic spots and travel agencies under different decision-making mechanisms and conducted a comparative analysis [20]. Ma et al. introduced consumer green preferences, considered a green tourism supply chain consisting of a single scenic spot and a single travel agency, and studied the joint service decision, pricing decision, and cooperative advertising of both parties when the tourism market has green preferences [20]. decisions, and cooperative advertising issues when the tourism market has green preferences [21].

To sum up, related scholars have studied the cooperative advertising strategy, product pricing, price discount strategy, and coordination contract design in single-channel and dual-channel, but there is little literature that considers the impact of price discount and bilateral cooperative advertising on supply chain subjects at the same time, and there is no literature that places it in the context of tourism O2O supply chain. In view of this, this paper takes the tourism O2O dual-channel supply chain composed of scenic spots and OTAs as the object, considers the joint influence of promotional advertising, brand advertising and price discount, and addresses a series of questions such as how to determine the cooperative advertising strategy between scenic spots and OTAs under different cooperative modes, how to determine the price discount level for scenic spots under the established advertising input, and the influence of different cooperative advertising modes on the promotion methods.

2. Modeling

2.1. Models & Assumptions

This paper takes the O2O dual-channel supply chain consisting of the direct sales channel of scenic spot (SS) and the online distribution channel of OTA as the research object. Figure 1 shows the entire supply chain structure.

Scenic areas establish direct sales channels for ticket sales, while also entrusting OTAs with sales and determining commission rates r. In commission mode, Ticket prices p and price discounts σ are determined by the scenic area. And the actual purchase price of tourists is σp. The larger the price discount represents the smaller the price discount, the larger the σ represents the smaller the price discount, and vice versa, which $p \in (0,1]$, $\sigma \in (0,1]$. In order to increase market share, both scenic spots and OTAs carry out marketing activities through advertising. The level of brand advertising of scenic spots is A, and the level of promotional advertising of OTAs is a. Assume that the advertising cost A, $\lambda_1 a$ and $\lambda_2 A$ is proportional to the level of advertising, and the advertising cost is A and a, a respectively. Let $\lambda_1=\lambda_2=1$, the advertising costs are A and a, respectively. Under unilateral cooperative advertising, scenic spots share θ percentage of promotional advertising costs in order to incentivize OTAs to actively engage in promotional advertising. The proportion of promotional advertising costs borne by OTA is $1-\theta$. Under bilateral advertising cooperation, scenic spots and OTAs cooperate in both promotional advertising and brand advertising, and the ratio of scenic spots' share of OTAs' promotional advertising costs is θ, OTA's share of scenic brand advertising costs is $1-t$, the percentage of brand advertising costs borne by the scenic spot is t, $t\in(0,1)$, $\theta\in(0,1)$.

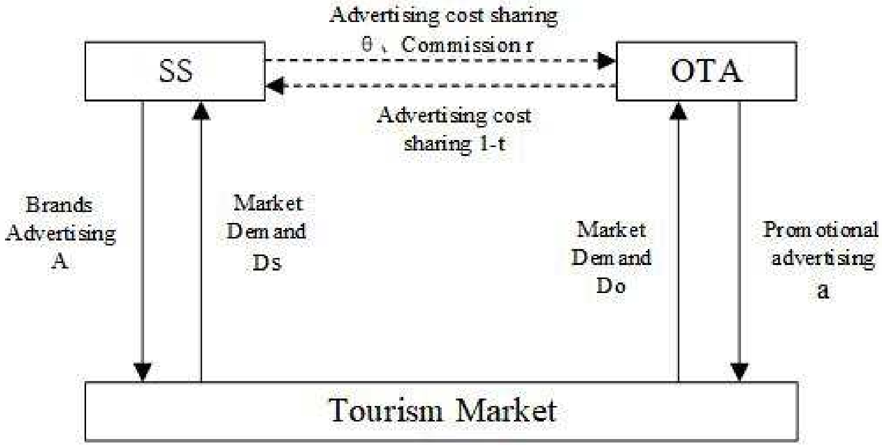

Figure 1. *Tourism O2O dual-channel supply chain structure.*

Assuming that the demand of both scenic spots and OTAs is jointly influenced by price discounts, brand advertising, and promotional advertising, with reference to the literature [22, 23] and in the context of this paper's research, the demand function is set here as:

$$\begin{cases} D_S = 1-\sigma p+\sqrt{A}+k_1\sqrt{a} \\ D_O = v-\sigma p+k_2\sqrt{A}+\sqrt{a} \end{cases} \tag{1}$$

1 and v denote the market size without any advertisement and with zero price and price discount respectively. Considering the broader consumer group targeted by OTA and the channel preference of the market, let $v>1$. k_1 and k_2 denote the influence factors of promotional advertising on scenic demand and brand advertising on OTA demand, i.e., the spillover effect of inter-channel advertising or the sensitivity of the market to advertising, respectively, which $k_1\in(0,1)$, $k_2\in(0,1)$, $k_1<k_2$.

2.2. Symbols and Meanings

The symbols and variables involved in this paper are shown in the following table.

Table 1. *Symbols and meanings.*

Symbol	Meaning	Symbol	Meaning
a	OTA's level of promotional advertising	A	The level of brand advertising of scenic spots
$1-\theta$	Proportion of promotional advertising undertaken by OTA	θ	The proportion of scenic spots sharing promotional advertising
$1-t$	Percentage of OTAs taking on brand advertising	t	Scenic area share brand advertising ratio
k_1	Influence factors of promotional advertising on market demand in scenic spots	k_2	Influence factors of brand advertising on OTA market demand
D_S, D_O	Market demand of scenic spots and OTAs	π_S, π_O	Profits for scenic spots, OTAs

3. Unilateral Cooperative Advertising Mode

3.1. Stackelberg's Game Equilibrium

In the unilateral cooperative advertising model, with reference to the literature [16, 18], the price discount is determined by the competitive market situation and does not change easily. Without affecting the results and assuming that other costs are zero, the profit function between scenic spots and OTAs under the Unilateral co-op model can be obtained as

$$\pi_S = \sigma p\left(\begin{pmatrix}1-\sigma p+\\ \sqrt{A}+k_1\sqrt{a}\end{pmatrix}+ \\ (1-r)\begin{pmatrix}v-\sigma p+\\ k_2\sqrt{A}+\sqrt{a}\end{pmatrix}\right)-A-\theta a \tag{2}$$

$$\pi_O = r\sigma p\left(v - \sigma p + k_2\sqrt{A} + \sqrt{a}\right) - (1-\theta)a \tag{3}$$

In the unilateral cooperative advertising model, scenic spots and OTAs cooperate only on promotional advertising, and the decision-making sequence between the two parties is that the scenic spots decide first on θ and A, and then the OTAs decide on a. Both parties make independent decisions with the goal of profit maximization. Also, to make the equilibrium results meaningful, let $r < \frac{2+2k_1}{3}$. The optimal strategy is denoted by the superscript "*", The superscript "U" indicates a unilateral cooperative advertising model. From the inverse induction method, we get:

Proposition 1 Under the Stackelberg game, the optimal promotional advertising level of OTAs, the optimal brand advertising level of scenic spots and the promotional advertising undertaking ratio are

$$a^{U*} = \frac{\sigma^2 p^2 (2k_1 + 2 - r)^2}{16} \tag{4}$$

$$A^{U*} = \frac{(1+(1-r)k_2)^2\sigma^2 p^2}{4} \tag{5}$$

$$\theta^{U*} = \frac{2k_1 + 2 - 3r}{2k_1 + 2 - r}, \text{s.t}: r < \frac{2+2k_1}{3} \tag{6}$$

From Proposition 1, it can be seen that the scenic brand advertising level and OTA promotional advertising level are both increasing functions of price discounts and decreasing functions of commissions, and the ratio of the scenic area's commitment to promotional advertising costs is a decreasing function of commissions. This shows that, as the commission increases, scenic spots will reduce the proportion of promotional advertising costs borne and brand advertising level, and as the proportion borne by scenic spots decreases OTA also reduces its promotional advertising level, and when the commission exceeds a certain proportion it may also lead to a breakdown of cooperation, e.g.: $r \geq \frac{2+2k_1}{3}$.

Proposition 2 Under the optimal advertising input of unilateral cooperative advertising, the demand of scenic spots and OTAs are

$$D_S^{U*} = 1 + \frac{\begin{pmatrix} 2k_1^2 + (2-r)k_1 - \\ 2 + (2-2r)k_2 \end{pmatrix} p\sigma}{4} \tag{7}$$

$$D_O^{U*} = v + \frac{p((1-r)k_2^2 + k_2 + k_1 - \frac{r}{2} - 1)\sigma}{2} \tag{8}$$

The equations (4)-(6) can be brought into the demand function to get (7) and (8). Proposition 2 shows that the demand of scenic spots and OTAs is an increasing function of the market effect of advertising k_1 and k_2, and a decreasing function of commission r. Combined with Proposition 1, the lower the commission, the higher the advertising level of scenic spots and OTAs, the more sensitive the market is to advertising, the better the market advertising effect, and the higher the market demand of both parties. The relationship between demand and price discount is related to several parameters, and by discussing the coefficients before the price discount in equations (7) and (8) with the constraints of equation (6), We can draw the following corollaries.

Corollary 1:

(1) Let $r_0 = \frac{2(k_1^2 + k_1 + k_2 - 1)}{k_1 + 2k_2}$, $R = \min\{\frac{2+2k_1}{3}, 1\}$. When $r_0 \in (0, R)$, D_S^{U*} is an increasing function of the price discount on $r \in (0, r_0)$ and a decreasing function of the price discount on $r \in (r_0, R)$, when $r = r_0$, $D_S^{U*} = 1$. When $r_0 < 0$, D_S^{U*} is a decreasing function of price discount on $r \in (0, R)$. When $r_0 > \frac{2+2k_1}{3}$, D_S^{U*} is an increasing function of price discount on $r \in (0, R)$.

(2) Let $r_1 = \frac{2(k_2^2 + k_1 + k_2 - 1)}{2k_2^2 + 1}$, when $r_1 \in (0, R)$, D_O^{U*} is an increasing function of price discount on $r \in (0, r_1)$ and a decreasing function of price discount on $r \in (r_1, R)$, and when $r = r_1$, $D_O^{U*} = v$. When $r_1 < 0$, D_O^{U*} is a decreasing function of price discount. When $r_1 > \frac{2+2k_1}{3}$, D_S^{U*} is an increasing function of price discount on $r \in (0, R)$.

From Corollary 1, it is clear that when the commission is low, the market demand is an increasing function of price discount. Because under the low commission scenario, scenic spots are willing to bear certain promotional advertising costs and incentivize OTAs to improve their promotional advertising level, the increase in demand relies more on advertising, so their market demand increases with the increase in price discount, i.e., the smaller the price discount, the larger the market demand; while with the increase in commission, the proportion of promotional advertising costs borne by scenic spots keeps decreasing, and although the marginal revenue of OTAs increases, the will still reduce its level of promotional advertising. When the commission is above a certain threshold, such as when $r > \max\{r_0, r_1\}$, the market demand of both scenic spots and OTAs is a minus function of price discount, i.e. the stronger the price discount, the higher the market demand. Both sides of the channel rely more on price discount to stimulate market demand, which illustrates the effectiveness of cost sharing in cooperative advertising.

3.2. Optimal Price Discount Strategy

To simplify the expression, let

$$M_1 = 6 - \begin{pmatrix} (k_2^2 + \frac{1}{4})r^2 + k_1^2 + k_2^2 + 2k_1 + \\ 2k_2 + (-2k_2^2 - k_1 - 2k_2 + 3)r \end{pmatrix}, M_2 = \begin{pmatrix} \frac{3}{2} + \frac{r}{4} - k_2 - \\ (1-r)k_2^2 - \frac{k_1}{2} \end{pmatrix}.$$

Bringing equations (4)-(6) into equations (1) and (2), we can get that the revenue of scenic spots and OTAs under equilibrium advertising input are

$$\pi_S^{U*} = \frac{(-M_1 p\sigma - 4rv + 4v + 4)\sigma p}{4} \tag{9}$$

$$\pi_O^{U*} = \frac{(-M_2 p\sigma + 2v)rp\sigma}{2} \tag{10}$$

If price discounts can increase the profit level of the scenic spot, then it is necessary for the scenic spot to make decisions on price discounts to maximize profits. Let $\frac{\partial \pi_S^{U*}}{\partial \sigma} \geq 0$, the optimal discount can be found.

Proposition 3 In the unilateral cooperative advertising model, the optimal discount is

$$\sigma^{U*} = \begin{cases} \frac{2(v+1-vr)}{pM_1}, if\ p < \hat{p} \\ 1 \qquad ,if\ p \geq \hat{p} \end{cases} \tag{11}$$

In formula (11), $\hat{p} = \frac{2(v+1-vr)}{M_1}$. Obviously, it is clear from Proposition 3 that price discounts are regulated by price, the reason is not only that price determines the space of price discounts, but also price is about the advertising level of scenic spots and OTAs, too low pricing will reduce the willingness of both parties to improve the advertising level and compress the profits of scenic spots and OTAs.

4. Bilateral Cooperation Advertising Mode

4.1. Stackelberg's Game Equilibrium

Under the Bilateral co-op advertising model, scenic spots and OTAs cooperate in brand advertising and promotional advertising at the same time. Unlike the unilateral co-op advertising model, the OTAs also bear part of the brand advertising costs while the scenic spots bear the promotional advertising costs, and the profit function of both parties is as follows.

$$\pi_S^B = \sigma p \begin{pmatrix} (1-r)\begin{pmatrix} v - \sigma p + \\ k_2\sqrt{A} + \sqrt{a} \end{pmatrix} \\ + \begin{pmatrix} 1 - \sigma p + \\ \sqrt{A} + k_1\sqrt{a} \end{pmatrix} \end{pmatrix} - tA - \theta a \tag{12}$$

$$\pi_O^B = \begin{pmatrix} \sigma pr \begin{pmatrix} v - \sigma p + \\ k_2\sqrt{\mathrm{A}} + \sqrt{\mathrm{a}} \end{pmatrix} - \\ (1-\theta)a - (1-t)A \end{pmatrix} \tag{13}$$

The superscript "B" indicates the bilateral cooperation advertising model. In the bilateral advertising cooperation model, the decision sequence between scenic spots and OTAs is as follows: first, the OTAs make decisions $1-t$, the scenic spots make decisions θ and A, and finally, the OTAs make decisions a.

To make the equilibrium solution meaningful, let $r \in (\frac{1+k_2}{3}, \frac{2+2k_1}{3})$, $s.t: k_2 > \frac{1}{1+2k_1}$. The following proposition can be obtained by reverse induction.

Proposition 4 Under the bilateral cooperative advertising model, the optimal advertising level and advertising cost sharing ratio between scenic spots and OTAs are

$$a^{B*} = \frac{\sigma^2 p^2 (2k_1 + 2 - r)^2}{16} \tag{14}$$

$$A^{B*} = \frac{\sigma^2 p^2 (k_2 r + k_2 + 1)^2}{16} \tag{15}$$

$$\theta^{B*} = \frac{2k_1 + 2 - 3r}{2k_1 + 2 - r}, s.t: r < \frac{2+2k_1}{3} \tag{16}$$

$$(1-t)^{B*} = \frac{3k_2 r - k_2 - 1}{1 + (r+1)k_2}, s.t: r > \frac{1+k_2}{3k_2} \tag{17}$$

From Proposition 4, it is clear that under bilateral cooperative advertising, the level of scenic brand advertising and OTA promotion advertising are incremental functions of price discount. Meanwhile, appropriate commission is the key to guarantee the smooth operation of cooperative advertising. For example, when $r \in (\frac{1+k_2}{3k_2}, \frac{2+2k_1}{3})$, both scenic spots and OTA are willing to bear each other's advertising costs.

Proposition 5 The equilibrium market demand of scenic spots and OTAs under the optimal advertising investment and advertising undertaking ratio are

$$D_S^{B*} = 1 + \frac{\begin{pmatrix} 2k_1^2 + (2-r)k_1 \\ -3 + (r+1)k_2 \end{pmatrix} p\sigma}{4} \tag{18}$$

$$D_O^{B*} = v + \frac{\begin{pmatrix} (r+1)k_2^2 + k_2 - \\ r + 2k_1 - 2 \end{pmatrix} p\sigma}{4} \tag{19}$$

Clearly, both D_S^{B*} and D_O^{B*} satisfy the non-negativity. From Proposition 5, it can be seen that under the bilateral cooperative advertising model, the proportion of scenic spots sharing the cost of promotional advertising is inversely proportional to the commission and positively proportional to k_1. The proportion of OTAs bearing brand advertising is positively proportional to the commission r and k_2. That is, the more sensitive the OTA market demand is to brand advertising and the higher the marginal revenue, then OTAs have the responsibility to bear more brand advertising costs, and the same is true for scenic spots, whose share of promotional advertising The responsibility to undertake promotional advertising is proportional to its marginal revenue $1-r$ and the sensitivity of the market to promotional advertising k. A discussion of the coefficients before price discounts in equations (18) and (19) with the constraints in equations (16) and (17) leads to the following corollaries.

Corollary 2 (1) Let $r_2 = \frac{2k_1^2 + 2k_1 + k_2 - 3}{k_1 - k_2}$. When $r_2 \in (\frac{1+k_2}{3k_2}, R)$, D_S^{B*} increases with price discount on $r \in (\frac{1+k_2}{3k_2}, r_3)$ and decreases with price discount on $r \in (r_3, R)$. When $r = r_3$, $D_O^{B*} = v$, and when $r_3 < \frac{1+k_2}{3k_2}$, D_S^{B*} increases with price discount, when $r_3 > R$, D_S^{B*} increases with price discount on $r \in (\frac{1+k_2}{3k_2}, R)$.

From Corollary 2, it is clear that under bilateral cooperative advertising, there is a complementary effect between brand advertising and promotional advertising. From $k_2 > \frac{1}{1+2k_1}$, we get $k_1 > \frac{1-k_2}{2k_2}$. When the market is better for promotional advertising (brand advertising) market effect, scenic spots and OTAs can reduce the requirement for brand advertising (promotional advertising) market effect, so there is a complementary effect between the two. At the same time, commission has a moderating effect on the relationship between market demand and price discount, when commission is higher than a certain threshold, such as $r > \max\{r_2, r_3\}$, at this time, the scenic spot's advertising investment is low, and the price discount dominates the market demand; the greater the discount, the faster the demand growth.

4.2. Optimal Price Discount Strategy

Bringing (14)-(17) into (12) and (13), we can get the equilibrium profits of scenic spots and OTAs under bilateral cooperative advertising, respectively.

$$\pi_S^{B*} = \frac{(-M_3 p\sigma - 8rv + 8v + 8)p\sigma}{8} \tag{20}$$

$$\pi_O^{B*} = \frac{(-M_4 p\sigma + 16rv)\sigma p}{16} \tag{21}$$

In formulas (20) and (21),

$$M_3 = 13 - \begin{pmatrix} (\frac{1}{2} - k_2^2)r^2 + (6 - 2k_1)r \\ +2k_1^2 + k_2^2 + 4k_1 + 2k_2 \end{pmatrix},$$

$$M_4 = \begin{pmatrix} (12 - 2k_2^2 - 4k_1 - 2k_2)r \\ +(2 - k_2^2)r^2 - (k_2 + 1)^2 \end{pmatrix}.$$

When the implementation of price discounts can bring incremental profits to the scenic area, it is necessary for the scenic area to make optimal decisions on price discounts to maximize profits. Let $\frac{\partial \pi_S^{B*}}{\partial \sigma} \geq 0$, the following proposition can be obtained.

Proposition 6 In the bilateral advertising cooperation model, the optimal discount is

$$\sigma^{B*} = \begin{cases} \frac{4(1-r)v+4}{M_3 p}, & if\ p > \frac{4(1-r)v+4}{M_3} \\ 1, & if\ p \leq \frac{4(1-r)v+4}{M_3} \end{cases} \tag{22}$$

From Proposition 6, it can be seen that under the condition of appropriate pricing, when the market is more sensitive to advertising, the price discount will be larger, i.e., the better the market effect of advertising, the smaller the discount of the scenic spot, and the stronger the substitution effect of advertising and discount. At the same time, if the pricing is too low, such as $p \leq \frac{-4rv + 4v + 4}{M_3}$, at this point the price discount converges to 1 and is not globally optimal.

5. Strategic Alliance Mode

5.1. Stackelberg's Game Equilibrium

In the strategic alliance model, scenic spots and OTAs are communities of interest to achieve the goal of maximizing overall supply chain benefits, with scenic spots determining their optimal brand advertising levels and price discounts and OTAs determining their optimal promotional advertising levels. As a result, the total profit of the supply chain system under the strategic alliance model is

$$\pi_T = \begin{pmatrix} \sigma p(1 + v - 2\sigma p + (k_1 + 1)\sqrt{a} \\ +(k_2 + 1)\sqrt{A}) - A - a \end{pmatrix} \tag{23}$$

The superscript "T" indicates the strategic alliance model. The following proposition can be obtained by reverse induction method.

Proposition 7: For a given price discount, the optimal level of advertising, market demand and overall optimal supply chain revenue for both parties are

$$a^{T*} = \frac{\sigma^2 p^2 (k_1 + 1)^2}{4} \tag{24}$$

$$A^{T*} = \frac{\sigma^2 p^2 (1+k_2)^2}{4} \tag{25}$$

$$D_S^{T*} = 1 + \frac{p(k_1^2 + k_1 + k_2 - 1)\sigma}{2} \tag{26}$$

$$D_O^{T*} = v + \frac{p(k_2^2 + k_1 + k_2 - 1)\sigma}{2} \tag{27}$$

Obviously, a^{T*}, A^{T*}, D_S^{T*}, D_O^{T*} satisfy non-negative.

Corollary 3:

(1) Under strategic alliance mode, when $k_1^2 + k_1 + k_2 - 1 > 0$, that is $k_1^2 + k_1 + k_2 > 1$, D_S^{T*} is an increasing function of price discount; When $k_1^2 + k_1 + k_2 < 1$, D_S^{T*} is a decreasing function of price discount. When $k_1^2 + k_1 + k_2 = 1$, $D_S^{T*} = 1$.

(2) Under strategic alliance mode, when $k_1^2 + k_1 + k_2 - 1 > 0$, D_O^{T*} is an increasing function of price discount; When $k_1^2 + k_1 + k_2 < 1$, D_O^{T*} is a decreasing function of price discount. When $k_1^2 + k_1 + k_2 = 1$, $D_O^{T*} = v$.

Corollary 3 shows that in the strategic alliance mode, the market demand of scenic spots and OTA is not related to commission, but only affected by the market 's sensitivity to advertising. At the same time, here more directly reflects the advertising and discount substitution effect. For example, when $k_1^2 + k_1 + k_2 > 1$, D_S^{T*} is an increasing function of price discount, the positive effect of advertising on market demand exceeds the negative effect of discount, even if the discount is reduced, the market demand still increases.

5.2. Optimal Price Discount Strategy

Bring Equations (24) - (27) into Equation (23), we can get

$$\pi^{T*} = \frac{p\sigma(\mu p\sigma + 4v + 4)}{4} \tag{28}$$

In formula (28), $\mu = \begin{pmatrix} k_1^2 + k_2^2 + 2k_1 \\ +2k_2 - 6 \end{pmatrix}$. When price discounts can bring incremental profits to the supply chain, it is necessary for scenic spots to make decisions on price discounts to maximize profits. Let $\frac{\partial \pi^{T*}}{\partial \sigma} \geq 0$, the following propositions can be obtained.

Proposition 8 The optimal price discount of supply chain system is

$$\sigma^{T*} = \begin{cases} \dfrac{2(1+v)}{p(6 - k_1^2 - k_2^2 - 2k_1 - 2k_2)}, & if\ p > \tilde{p} \\ 1 & , if\ p \leq \tilde{p} \end{cases} \tag{29}$$

In formula (29), $\tilde{p} = \frac{2(1+v)}{(6 - k_1^2 - k_2^2 - 2k_1 - 2k_2)}$. From proposition 8, it can be seen that under the strategic alliance model, the price discount is proportional to the basic market size of the scenic spot, OTA, and the sensitivity of the market to advertising, indicating that when the basic market size is large and the advertising effect is good, the price discount can be appropriately reduced.

5.3. Comparative Analysis

In order to better analyze the impact of different cooperative advertising models on O2O dual-channel supply chain, the advertising level and revenue of the three models are compared.

Proposition 9:

(1) Strategic alliance model and bilateral cooperation model, we have $\sqrt{a^{T*}} > \sqrt{a^{B*}}$; $\sqrt{A^{T*}} > \sqrt{A^{B*}}$; $D_S^{T*} > D_S^{B*}$; $D_O^{T*} > D_O^{B*}$; $\pi^{T*} > \pi_S^{B*} + \pi_O^{B*}$.

(2) Strategic alliance model and unilateral cooperation model, we have $\sqrt{a^{T*}} > \sqrt{a^{U*}}$; $\sqrt{A^{T*}} > \sqrt{A^{U*}}$; $D_S^{T*} > D_S^{U*}$; $D_O^{T*} > D_O^{U*}$; $\pi^{T*} > \pi_S^{U*} + \pi_O^{U*}$.

(3) unilateral cooperation mode and bilateral cooperation mode, we have $\sqrt{a^{B*}} = \sqrt{a^{U*}}$; $\sqrt{A^{B*}} > \sqrt{A^{U*}}$; $D_S^{B*} > D_S^{U*}$; $D_O^{B*} > D_O^{U*}$; $\pi_S^{B*} > \pi_S^{U*}$; $\pi_O^{B*} > \pi_O^{U*}$

According to Proposition 9, under the constraint condition $r \in (\frac{1+k_2}{3}, \frac{2+2k_1}{3})$, $s.t: k_2 > \frac{1}{1+2k_1}$. Whether from the market or from a profit point of view, strategic alliances are better than unilateral and bilateral cooperative advertising model, and bilateral cooperative advertising is better than unilateral cooperative advertising model. Therefore, from unilateral cooperative advertising to bilateral cooperative advertising to strategic alliance model is a Pareto improvement process. Because the price discount is more complex, it is placed in the simulation part for discussion.

6. Numerical Simulation

The cooperative advertising and price discount strategy between scenic spots and OTA are affected by many factors, and the relevant decisions and demand changes are more complicated. In order to more intuitively analyze the impact of discount level on different channel demand and compare the difference of optimal price discount under different cooperation modes, numerical simulation is used to verify the relevant inferences. Reference [23], take parameter $v = 1.1$. Due to the large difference between the problems, other parameters need to be set according to the specific situation.

6.1. Impact of Price Discounts on Changes in Demand

From Corollary 1 and Corollary 2, we can see that the change of price discount and demand is adjusted by the proportion of commission. Considering the relationship between each parameter, we take $k_1 = 0.7$, $k_2 = 0.65$. Taking the dual channel Stackelberg game as an example, the relationship between the demand and price discount of the dual channel is discussed by adjusting the value. The simulation results are as follows.

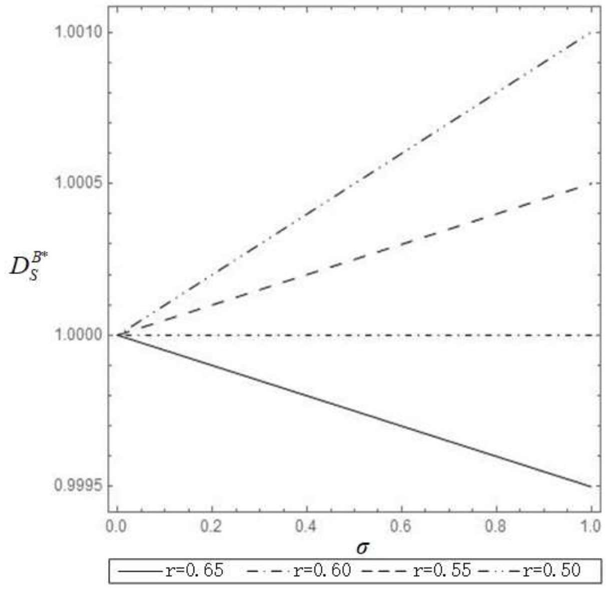

Figure 2. *Impact of price discount on scenic spot demand.*

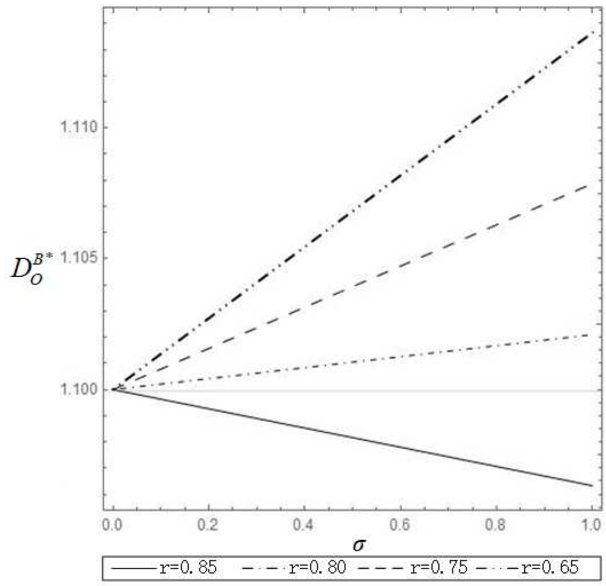

Figure 3. *Impact of price discount on OTA demand.*

As can be seen from Figure 2 and Figure 3, there is a threshold for the impact of commission on price discount and market demand, and the threshold of scenic spots is higher than OTA. With the increase of commission, the scenic spot will reduce its brand advertising level and the proportion of OTA promotional advertising, while OTA will also reduce the level of promotional advertising due to excessive advertising costs. When the commission is greater than the threshold, too low advertising level can no longer effectively stimulate the market demand. At this time, the market demand can only be expanded through price discounts, which is consistent with the results of Corollary 1 and 2.

6.2. Different Models of Price Discount Comparison

Since the price discount is affected by advertising, pricing and other factors, in order to consider these factors, here k_1, k_1 different values, and let $r = 0.3$, $\Delta\sigma_1 = \sigma^{U*} - \sigma^{T*}$, $\Delta\sigma_1 = \sigma^{T*} - \sigma^{B*}$, $\Delta\sigma_1 = \sigma^{U*} - \sigma^{B*}$. Discuss the relationship between the difference between different discounts and the price. The simulation results are as follows.

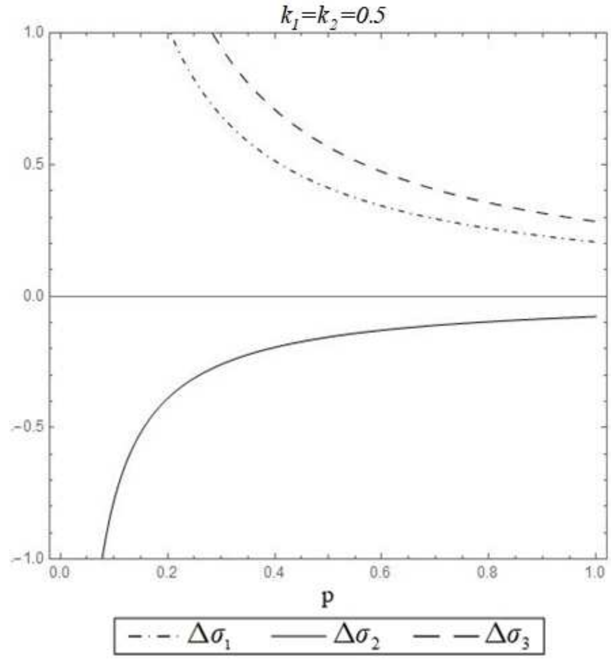

Figure 4. $k_1 = k_2$.

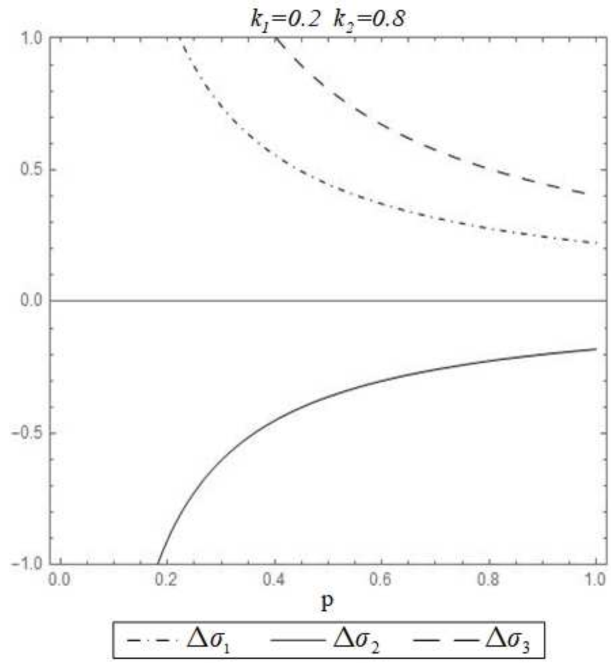

Figure 5. $k_1 < k_2$.

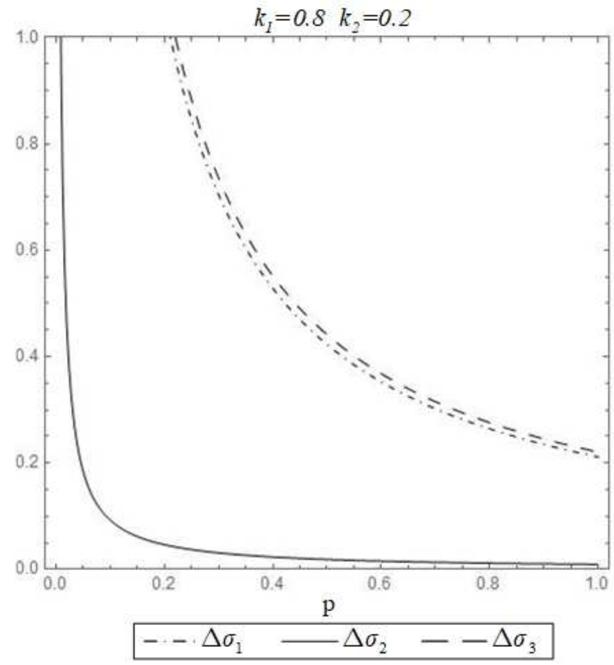

Figure 6. $k_1 > k_2$.

From Figure 4 and Figure 5, when $k_1 \le k_2$, the relationship between price discounts is $\sigma^{T*} > \sigma^{U*} > \sigma^{B*}$. Since the direct marketing channel market is less sensitive to promotional advertising, scenic spots must rely on brand advertising and discounts to increase their demand for direct marketing channels, and in order to maintain the level of profit scenic spots have to maintain appropriate price discounts. Under the bilateral advertising cooperation, because the market is more sensitive to brand advertising, scenic spots encourage OTA to bear more advertising costs by increasing commissions. As a result, the marginal cost of scenic spots increases, and only through discounts and advertising to stimulate market demand to maximize profits. In the strategic alliance mode, scenic spots and OTA, as a collective of interests, rely more on advertising to stimulate market demand to obtain the overall optimal profit.

From Figure 6, when $k_1 > k_2$, he relationship between price discounts is $\sigma^{U*} > \sigma^{T*} > \sigma^{B*}$. Under unilateral cooperation, due to promotional advertising in the scenic area and OTA on both sides of the market effect is strong, through promotional advertising and brand advertising, the scenic area can effectively increase market demand, access to optimal profits, so the discount rate is small; when the market effect of bilateral cooperative advertising on the OTA side of brand advertising is weak, OTA reduces the sharing of brand advertising costs, and scenic spots have to reduce the level of brand advertising and increase price discounts to expand the market to achieve their optimal returns. At the same time, from Figure 5, it can be seen that the discount under unilateral cooperation mode is slightly larger than that under strategic alliance mode, and both of them are much larger than the price discount under bilateral cooperation. It can be seen that the advertising cooperation under strategic alliance is more stable and less affected by the market 's sensitivity to advertising.

7. Conclusion

Price discount and advertising are common promotion methods. This paper takes the cooperative advertising of tourism O2O dual-channel supply chain composed of scenic spots and OTAs as the research object. For the cooperative advertising problem of unilateral cooperative advertising, bilateral cooperative advertising and strategic alliance under price discount, the equilibrium solution and optimal discount strategy under different modes are given, and the relationship between demand, profit, advertising level and price discount is analyzed. In addition, this paper compares the profit, market demand and advertising level of different models, further verifies the relationship between commission and demand and compares the optimal price discount of the three models by numerical simulation. The results show that: (1) In the unilateral and bilateral advertising cooperation mode, the joint impact of price discounts and brand advertising and promotional advertising on market demand is regulated by commissions. Appropriate commissions can promote the mutual sharing of advertising costs between scenic spots and OTA, and the smooth progress of cooperative advertising, and vice versa. In the strategic alliance model, the relationship between advertising and price discounts is not subject to commission constraints, and the increase in market demand is only related to advertising effectiveness. And no matter in which mode, advertising and price discounts have a substitution effect; (2) The optimal price strategy under the three modes is closely related to the price. Too low pricing will compress the decision space and profit space of the scenic spot price discount, which suggests that the scenic spot should consider the possible sales discount factor when pricing. At the same time, through simulation, it is found that if the market is more sensitive to promotional advertising, the price discount of bilateral cooperation mode is less than that of strategic alliance mode; if the market is more sensitive to brand advertising or as sensitive to both advertising.

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