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OPTIMAL CHANNEL STRATEGIES FOR SERVICE PROVIDERS WITH AVAILABILITY OF OPAQUE PP CHANNEL

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Abstract. *When the online travel agency (OTA) introduces the opaque PP channel in her platform, service providers must decide whether to participate in this channel or not. Because the lower price in the opaque channel will attract more customers to buy, also induce some customers to flow into the opaque channel from the direct distribution channel, the trade-off should be considered in the operations management for OTA and service providers. In this paper, we study the optimal strategies for the service providers by integrating the customer segmentation and its preference towards different service providers under the single-channel and dual-channel cases. We find that participating in the opaque PP channel will be more profitable when the price is relatively high in the direct distribution channel; otherwise, service providers can obtain more profits without the opaque PP channel.*
Keywords: Opaque selling, Posted-price (PP), Distribution channel, Online travel agency (OTA)

1. Introduction.

The online travel agencies (OTAs) are rapidly growing in recent years, such as Expedia, Inc. and The Priceline Group, the two leading players in the world, and the Chinese player Ctrip also has achieved the strongest growth to become the third global OTA giant. The customer can conveniently reserve or buy the travel packages on behalf of global consolidators of airlines, hotels, holiday packages, car rentals, cruise lines, railways and sightseeing packages via the OTA platform. In this practice, the OTA platform acts as an intermediary between the consumer and the wholesaler by displaying and selling the travel packages in the various marketing or distribution channels.

The OTA platform often provides the direct distribution channel to connect her suppliers (i.e., the service providers) and customers, in which the OTA platform lists all the information about the travel packages, such as the hotel location and its room price, and then the customer makes her purchase decisions. However, in recent years, the opaque channel is becoming more and more popular, in which some information is hidden before the order is confirmed by the customer, but there is no doubt that the room price is lower than that in the direct distribution channel. Priceline.com first gained prominence for its NYOP (name-your-own-price) system, which is the first idea and practice for the opaque channel. Under this system, the customer needs to name a price for her favorite product and the transaction then occurs at the consumer's named price only if the consumer's offer exceeds the threshold price set by the NYOP retailer. Most researches on the opaque channel focus on this channel, such as the work of [1-6].

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The PP (posted-price) model is another practice for the opaque channel, which is firstly adopted by Hotwire, an outstanding mobile website, owned by Expedia Group, Inc. In this channel, some attributes of product chosen by the service provider are covered and only the price is posted, the hidden information will be uncovered once the consumer pays for her reservation. Since the outstanding achievements that Hotwire has achieved, PP model is paid much attention in the research, but most of the researches are to investigate the difference between NYOP model and PP model. Chen et al. [7] found that the providers prefer that the opaque reseller uses a PP channel instead of a bidding model, and the dominance of PP over NYOP disappears when competition between sellers is minimal or absent. Stoel and Muhanna [8] investigated the impact of increased consumer information sharing on the viability, optimal pricing, and profit of NYOP intermediary, and examined the conditions under which NYOP may be more profitable for an intermediary compared to PP format. Xie et al. [9] indicated that both forms of opaque selling increase firm demand and that with appropriate pricing can also increase firm revenue by using two choice-based experiments. Feng et al. [10] studied which opaque channel is more profitable: PP or NYOP, when two collaborate service providers may use an opaque channel to satisfy demand from both leisure and business customers. They found that choosing NYOP channel enables service providers to optimize profits.

There is little literature to investigate solely the PP model from the perspective of operations management. Jiang [11] investigated when opaque PP channel can improve profits for service providers and how to set prices in the opaque channel and direct distribution channel. Lei et al. [12] studied the equilibrium price and equilibrium profit in the single direct distribution channel and the dual channel with the direct distribution channel and the opaque PP channel. They found that when the valuation of leisure consumers is relatively high, adding an opaque PP channel can effectively increase providers' equilibrium profit. Mao et al. [13] studied whether service providers with asymmetric capacities should introduce an opaque PP channel. They showed that the greater asymmetry between the providers' capacities, the lower likelihood that they will introduce an opaque PP channel. Similar to the work of [12,13], we study whether it is beneficial for service providers to participate in the opaque PP channel when this channel is available. However, different from their works, we pay more attention to the customer segmentation and its responding condition, and investigate the impact of introducing an opaque channel on the consumer's buying decisions and demand. To the best of our knowledge, this is the first paper to segment the consumer according to the consumer's decision thinking: the preference towards different service providers and the reservation price for the product.

The remainder of the paper is organized as follows. Section 2 describes the problem. Section 3 presents the single channel case, in which providers only sell their products in the direct distribution channel, and the dual channel case is developed in Section 4, in which providers adopt both the direct distribution channel and the opaque PP channel. The optimal channel strategies for service providers are examined in Section 5. Finally, Section 6 presents the main findings and limitations of this paper.

2. **Problem Statement.**

We consider a two-stage supply chain with two service providers, S1 and S2, and an OTA platform in the market. Service providers sell their products with the same quality and price to customers by OTA platform, who provides two distribution channels: the direct distribution channel and the opaque PP channel. Providers need to decide whether to participate in the opaque PP channel when they are already in the direct distribution channel. The customers decide which channel (the direct distribution channel or the opaque PP channel) and provider (S1 or S2) to buy the travel packages.

Customers have heterogeneous preferences between providers because of loyalty or preference for brands. We invoke a horizontal differentiation model where the customers are located uniformly on a Hotelling line bounded between zero and one (see [14]). The market size of customers is normalized to one, and the customer's location is denoted by x, where $x \in [0, 1]$.

The customer's reservation price for her favorable product is V, which is uniformly distributed between 0 and 1. The customer with higher reservation price is more willing to purchase, while the customer with lower reservation price is less willing to purchase.

Let U_i $(i = 1, 2, N, 0)$ denote the customer's net utilities when she buys the travel packages from S1 via the direct channel, S2 via the direct channel, the OTA platform via the opaque PP channel, and nothing, respectively. For a customer at location x, the net utility of purchasing from S1 in the direct channel is given by $U_1 = V - P - tx$, the net utility of purchasing from S2 in the direct channel is given by $U_2 = V - P - t(1-x)$, and the net utility of purchasing in the opaque PP channel is given by $U_N = V - P_r - \frac{t}{2}$, where $P \in (0, 1)$ is the price in the direct distribution channel, P_r $(0 < P_r < P)$ is the price in the opaque PP channel, and t denotes the fit cost loss coefficient from not receiving the customer's ideal product. Without loss of generality, we assume $0 < t < \frac{1}{2}$ since it should be a very small value no matter from practical or theoretical perspective. Furthermore, we assume that the customer will get zero net utility if she buys nothing, i.e., $U_0 = 0$.

3. **The Segmentation and Profit in the Direct Distribution Channel.** Firstly, we consider the case with the sole direct distribution channel, i.e., the OTA platform only provides the direct distribution channel to customers. The customer must make her purchase decision (buy or not) and decide where to buy (S1 or S2) to maximize her net utility.

There is no doubt that the customer will buy the product from S1 if $U_1 > U_2$ and $U_1 > U_0$, and the customer will buy the product from S2 if $U_2 > U_1$ and $U_2 > U_0$. Therefore, the customer who buys product from S1 should satisfy $V > P + tx$ and $0 \le x < \frac{1}{2}$; the customer who buys product from S2 should satisfy $V > P + t(1-x)$ and $\frac{1}{2} < x \le 1$. The segmentation of customers in the market can be described in Figure 1 and Figure 2.

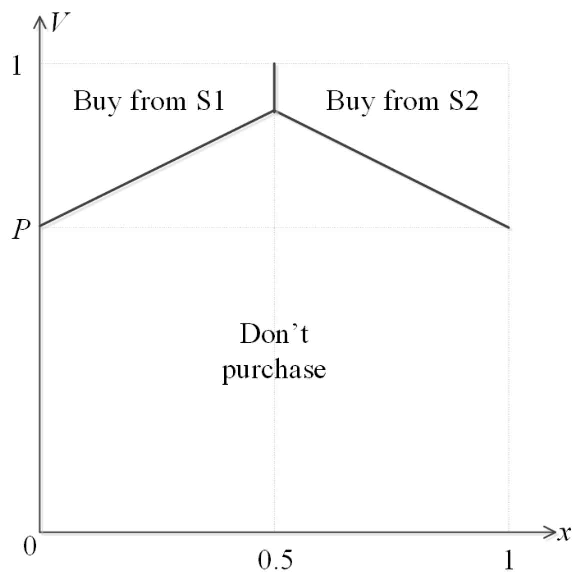

FIGURE 1. The segmentation when $P + t/2 < 1$

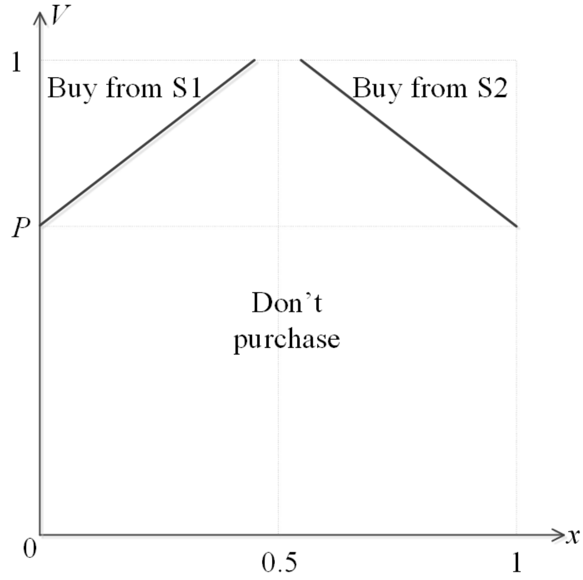

FIGURE 2. The segmentation when $P + t/2 > 1$

$V = 1$ represents the customer with highest reservation price who badly needs the product. From Figure 2, we can find that there will be customers who do not buy anything even if $V = 1$. Moreover, the customer's choice preference to the different providers is just a fraction of cost compared to the price when they make purchase decisions. Therefore, we only investigate the situation with $P + t/2 < 1$, which ensures the customer with highest reservation price will purchase.

Then, for the providers S1 and S2, they have the same profit:

$$\Pi = \frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{8}tP. \tag{1}$$

4. **The Segmentation and Pricing Strategy in the Dual Channels.** In this section, we consider the case that the providers participate in the opaque PP channel, and both two channels (direct distribution channel and PP channel) are available to the customer. The customer should decide whether to buy and from which channel to buy the product. Without loss of generality, we assume that two providers set the same price P_r in the opaque PP channel to make sure that they have the same chance to catch the customer's demand.

4.1. **The segmentation of customers.** For the customer who has higher preference for S1 (i.e., $0 \le x < \frac{1}{2}$), she will never buy product from S2, we can easily conclude the customer's decision cases: If $U_1 > U_N$ and $U_1 > U_0$, the customer will buy the product from S1 in the direct distribution channel; if $U_1 < U_N$ and $U_N > U_0$, the customer will buy the product in the opaque PP channel; there is no difference between buying in the direct distribution channel and in the opaque PP channel for the customer if $U_1 = U_N > U_0$. Therefore, the customer who satisfies $0 \le x < \frac{1}{2} - \frac{P-P_r}{t}$ and $V > tx + P$ will buy the product from S1 in the direct distribution channel, and the customer who satisfies $\frac{1}{2} - \frac{P-P_r}{t} < x < \frac{1}{2}$ and $V > \frac{1}{2}t + P_r$ will buy the product in the opaque PP channel; and the other customer located at $0 \le x < \frac{1}{2}$ will buy nothing to wait.

Similarly, we can get the segmentation of customer who has higher preference for S2 (i.e., $\frac{1}{2} < x \le 1$).

The segmentations for S1 and S2 are shown in Figure 3 and Figure 4.

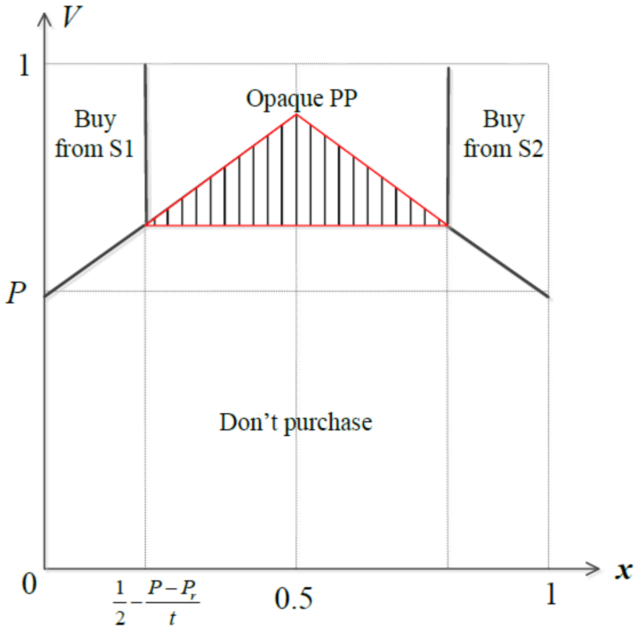

FIGURE 3. The segmentation when $\frac{1}{2} - \frac{P-P_r}{t} > 0$

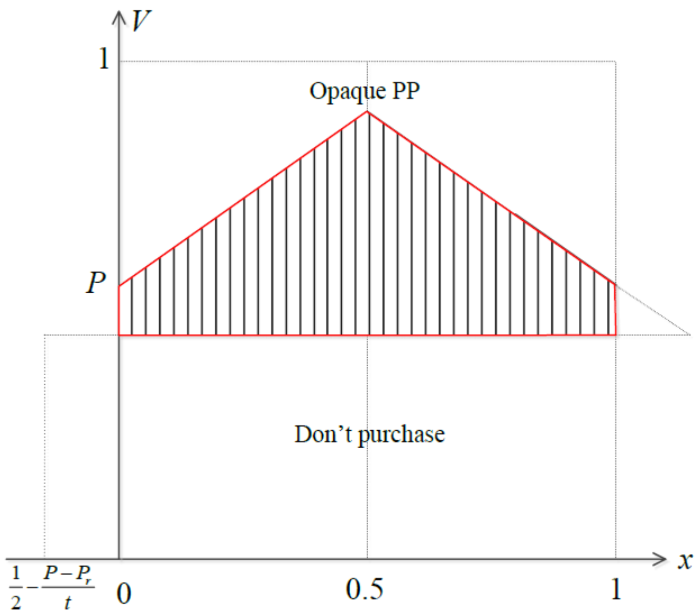

FIGURE 4. The segmentation when $\frac{1}{2} - \frac{P-P_r}{t} \leq 0$

The opaque PP channel brings the supply uncertainty to the customer, and the customer can enjoy a lower price for her shopping. From Figure 3 and Figure 4, we can clearly find that the customer will pay less attention to this supply uncertainty and have stronger desire to buy product in the opaque channel if the price in the opaque PP channel is much lower than the price in the direct distribution channel. We define $P - P_r$ represents the price differential between two channels and find that some customers still buy in the direct distribution channel while others buy in the opaque channel when the price differential is relatively small, i.e., $P - P_r < \frac{t}{2}$. On the contrary, when the price differential is greater than or equal to $\frac{t}{2}$, i.e., $P - P_r \geq \frac{t}{2}$, all the customers who decide to buy will choose the opaque channel.

In Figure 3 and Figure 4, the shadow areas indicate the new demand for the product when providers participate in opaque PP channel. It can be found that the lower price in the opaque PP channel will attract the more new customers to purchase in the OTA platform.

4.2. **Pricing strategy for the service providers.** The price in the opaque channel will affect the segmentation of customers and profits of service providers. In this section, we will investigate the optimal price decision when the service providers participate in the opaque channel.

(1) When $P - P_r < \frac{t}{2}$

Both channels have their customers in this case, and the service providers try to maximize their profits by the price decisions, we get the following optimization problem.

$$\begin{aligned} \Pi_1 = \Pi_2 = \Pi_r = \max_{P_r} \Bigg\{ & P\left[\frac{1}{2}\left(\frac{1}{2} - \frac{P - P_r}{t}\right)\left(1 - \frac{t}{2} - P_r + 1 - P\right)\right] \\ & + P_r\left[\frac{P - P_r}{t}\left(1 - \frac{t}{2} - P_r\right)\right]\Bigg\}, \end{aligned} \tag{2}$$

where $\frac{1}{2} - \frac{P-P_r}{t} > 0$.

By solving the above problem (2), we can get the optimal price P_r^* in the opaque PP channel, which is shown in Table 1.

Table 1. The optimal price in PP channel when $\frac{1}{2} - \frac{P-P_r}{t} > 0$

P	P_r^*	**The quantity of customer to buy**
$0 < P < \frac{2}{3} - \frac{1}{3}t$	P	The same as the single direct distribution channel, no customer buys product in the opaque PP channel
$\frac{2}{3} - \frac{t}{3} < P < \frac{2}{3} + \frac{t}{6}$	$\frac{2}{3} - \frac{t}{3}$	More than that in the single direct distribution channel, but less than $1 - P$
$\frac{2}{3} + \frac{t}{6} < P < 1 - \frac{t}{2}$	$P - \frac{t}{2}$	$1 - P$, the customer whose reservation price exceeds P will buy in the opaque PP channel

(2) When $P - P_r \geq \frac{t}{2}$

Similar to Case 1, we get the following optimization problem (3).

$$\Pi_1 = \Pi_2 = \Pi_r = \max_{P_r} \frac{1}{2}\left(1 - \frac{1}{2}t - P_r\right)P_r, \tag{3}$$

where $\frac{1}{2} - \frac{P-P_r}{t} \leq 0$.

The optimal price P_r^* in the opaque PP channel is shown in Table 2.

Table 2. The optimal price in PP channel when $\frac{1}{2} - \frac{P-P_r}{t} \leq 0$

P	P_r^*	**The quantity of customer to buy**
$0 < P < \frac{1}{4}t + \frac{1}{2}$	$P - \frac{1}{2}t$	$1 - P$
$\frac{1}{4}t + \frac{1}{2} < P < 1 - \frac{1}{2}t$	$\frac{1}{2} - \frac{1}{4}t$	$\frac{1}{2} - \frac{1}{4}t$, which is more than $1 - P$

5. **The Providers' Channel Selection and Buying Behavior of Customer.** Considering two cases of price differential in Section 4, the price of product in the direct distribution channel has significant impact on the optimal price in the opaque PP channel. Comparing the critical points of P: $\frac{1}{2}+\frac{1}{4}t$, $\frac{2}{3}-\frac{1}{3}t$ and $\frac{2}{3}+\frac{1}{6}t$, we have $\frac{2}{3}+\frac{1}{6}t > \frac{2}{3}-\frac{1}{3}t > \frac{1}{2}+\frac{1}{4}t$ if $0 < t < \frac{2}{7}$, and $\frac{2}{3}-\frac{1}{3}t < \frac{1}{2}+\frac{1}{4}t < \frac{2}{3}+\frac{1}{6}t$ if $\frac{2}{7} < t < \frac{1}{2}$.

Table 3 and Table 4 show the optimal price P_r^* and profit Π_r^* in the opaque PP channel when $0 < t < \frac{2}{7}$.

TABLE 3. The optimal price and profit in PP channel if $0 < t < 2/13$

P	P_r^*	**The service providers' optimal profits**
$0 < P < \frac{1}{4}t + \frac{1}{2}$	$P - \frac{1}{2}t$	$\frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{4}t + \frac{1}{4}tP$
$\frac{1}{4}t + \frac{1}{2} < P < 1 - \frac{1}{2}t$	$\frac{1}{2} - \frac{1}{4}t$	$\frac{1}{8} - \frac{1}{8}t + \frac{1}{32}t^2$

TABLE 4. The optimal price and profit in PP channel if $2/13 < t < 2/7$

P	P_r^*	**The service providers' optimal profits**
$0 < P < \frac{1}{4}t + \frac{1}{2}$	$P - \frac{1}{2}t$	$\frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{4}t + \frac{1}{4}tP$
$\frac{1}{4}t + \frac{1}{2} < P < \frac{2}{3} - \frac{1}{3}t$	$\frac{1}{2} - \frac{1}{4}t$	$\frac{1}{8} - \frac{1}{8}t + \frac{1}{32}t^2$
$\frac{2}{3} - \frac{1}{3}t < P < \tilde{P}$	$\frac{2}{3} - \frac{1}{3}t$	$\frac{1}{24}Pt - \frac{1}{6}P - \frac{1}{9}t + \frac{2}{9} + \frac{1}{54}t^2 + \frac{P^3}{2t} - \frac{P^2}{t} + \frac{2P}{3t} - \frac{4}{27t}$
$\tilde{P} < P < 1 - \frac{1}{2}t$	$\frac{1}{2} - \frac{1}{4}t$	$\frac{1}{8} - \frac{1}{8}t + \frac{1}{32}t^2$

In Table 4, $\tilde{P}$ is determined uniquely by $G(P) = 36P^3 - 72P^2 + (48 + 3t^2 - 12t)P - \frac{11}{12}t^3 + t^2 + 7t - \frac{32}{3} = 0$, where $P \in \left(\frac{2}{3} - \frac{1}{3}t, \frac{2}{3} + \frac{1}{6}t\right)$. Since $G(P)$ is monotone decreasing in $\left(\frac{2}{3} - \frac{1}{3}t, \frac{2}{3} + \frac{1}{6}t\right)$, $G\left(\frac{2}{3} - \frac{1}{3}t\right) = \frac{t(13t-2)(2-t)}{4} > 0$ and $G\left(\frac{2}{3} + \frac{1}{6}t\right) = -\frac{t(2-t)^2}{4} < 0$, $\tilde{P}$ exists and is unique.

From Equation (1), the optimal profit that the service provider gets in the single channel is

$$\Pi^* = \frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{8}tP. \tag{4}$$

From Table 3 and Table 4, we have the optimal profit Π_r^* that service provider gets in the dual channel.

Case 1: If $0 < t < 2/13$

When $0 < P < (t + 2)/4$, we have

$$\Pi_r^* - \Pi^* = \left(\frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{4}t + \frac{1}{4}tP\right) - \left(\frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{8}tP\right) = \frac{1}{8}t(3P - 2) < 0. \tag{5}$$

Then, the service provider can get more profit without participating in the opaque PP channel.

When $(t + 2)/4 < P < 1 - t/2$,

$$\Pi_r^* - \Pi^* = \frac{1}{2}\left(P - \frac{4 - t - \sqrt{8t - 3t^2}}{8}\right)\left(P - \frac{4 - t + \sqrt{8t - 3t^2}}{8}\right). \tag{6}$$

Therefore, the service provider can get more profit by participating in the opaque PP channel when $\frac{4-t+\sqrt{(8-3t)t}}{8} < P < 1 - \frac{1}{2}t$, and get more profit without participating in the opaque PP channel when $\frac{1}{4}t + \frac{1}{2} < P < \frac{4-t+\sqrt{(8-3t)t}}{8}$.

Case 2: If $2/13 < t < 2/7$

When $0 < P < \frac{1}{4}t + \frac{1}{2}$,

$$\Pi_r^* - \Pi^* = \frac{1}{8}t(3P-2) < 0. \tag{7}$$

Then, the service provider can get more profit without participating in the opaque PP channel.

When $\frac{1}{4}t + \frac{1}{2} < P < \frac{2}{3} - \frac{1}{3}t$

$$\Pi_r^* - \Pi^* = \frac{1}{2}\left(P - \frac{4-t-\sqrt{8t-3t^2}}{8}\right)\left(P - \frac{4-t+\sqrt{8t-3t^2}}{8}\right). \tag{8}$$

Since $\frac{4-t+\sqrt{8t-3t^2}}{8} > \frac{2}{3} - \frac{1}{3}t$ if $\frac{2}{13} < t < \frac{2}{7}$, the service provider can get more profit without participating in the opaque PP channel.

When $\frac{2}{3} - \frac{1}{3}t < P < \tilde{P}$,

$$\Pi_r^* - \Pi^* = \frac{1}{2}P^2 + \left(\frac{1}{6}t - \frac{2}{3}\right)P + \frac{2}{9} - \frac{1}{9}t + \frac{1}{54}t^2 + \frac{1}{54t}\left(27P^3 - 54P^2 + 36P - 8\right). \tag{9}$$

Since $\frac{d(\Pi_r^* - \Pi^*)}{dP} = \frac{3}{2t}\left[P - \frac{2}{3}(1-t)\right]^2 > 0$ and $(\Pi_r^* - \Pi^*)|_{P=\frac{2}{3}-\frac{1}{3}t} = 0$, the service provider can get more profit by participating in the opaque PP channel.

When $\tilde{P} < P < 1 - \frac{1}{2}t$,

$$\Pi_r^* - \Pi^* = \frac{1}{2}\left(P - \frac{4-t-\sqrt{8t-3t^2}}{8}\right)\left(P - \frac{4-t+\sqrt{8t-3t^2}}{8}\right). \tag{10}$$

Since $\tilde{P} \in \left(\frac{2}{3} - \frac{1}{3}t, \frac{2}{3} + \frac{1}{6}t\right)$ and $\frac{2}{3} + \frac{1}{6}t > \frac{4-t+\sqrt{8t-3t^2}}{8}$, the service provider can get more profit by participating in the opaque PP channel when $\frac{2}{3} + \frac{1}{6}t < P < 1 - \frac{1}{2}t$.

Besides, when $\tilde{P} < P < \frac{2}{3}+\frac{1}{6}t$, $\frac{1}{8}-\frac{1}{8}t+\frac{1}{32}t^2 > \frac{1}{24}tP-\frac{1}{6}P-\frac{1}{9}t+\frac{2}{9}+\frac{1}{54}t^2+\frac{P^3}{2t}-\frac{P^2}{t}+\frac{2P}{3t}-\frac{4}{27t}$ and $\frac{1}{24}tP - \frac{1}{6}P - \frac{1}{9}t + \frac{2}{9} + \frac{1}{54}t^2 + \frac{P^3}{2t} - \frac{P^2}{t} + \frac{2P}{3t} - \frac{4}{27t} > \frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{8}tP$, then we conclude that the service provider can earn more by participating in the opaque PP channel when $\tilde{P} < P < \frac{2}{3} + \frac{1}{6}t$.

From the above discussions and comparisons in Case 1 and Case 2, we obtain the following proposition, which tells the service provider how to choose her distribution channel.

Proposition 5.1. *(1) If $0 < t < \frac{2}{13}$, the service providers get more profits without participating in the opaque PP channel when $0 < P < \frac{4-t+\sqrt{(8-3t)t}}{8}$ and obtain more profits by participating in the opaque PP channel when $\frac{4-t+\sqrt{(8-3t)t}}{8} < P < 1 - \frac{t}{2}$. (2) If $\frac{2}{13} < t < \frac{2}{7}$, nonparticipation in the opaque PP channel is more beneficial for the service providers when $0 < P < \frac{2-t}{3}$ and the service providers can obtain more profits by participating in the opaque PP channel when $\frac{2-t}{3} < P < 1 - \frac{t}{2}$.*

Similarly, we have $\frac{2}{3} - \frac{1}{3}t < \frac{1}{2} + \frac{1}{4}t < \frac{2}{3} + \frac{1}{6}t$ if $\frac{2}{7} < t < \frac{1}{2}$, and the optimal price P_r^* and profit Π_r^* in the opaque PP channel are shown in Table 5.

In Table 5, $\tilde{P}$ is also determined uniquely by $G(P) = 36P^3 - 72P^2 + (48 + 3t^2 - 12t)P - \frac{11}{12}t^3 + t^2 + 7t - \frac{32}{3} = 0$ where $P \in \left(\frac{1}{2} + \frac{1}{4}t, \frac{2}{3} + \frac{1}{6}t\right)$. Since $G(P)$ is monotone decreasing

Table 5. The optimal price in PP channel and profits when $2/7 < t < 1/2$

P	P_r^*	**The service providers' profits**
$0 < P < \frac{2}{3} - \frac{1}{3}t$	$P - \frac{1}{2}t$	$\frac{1}{2}P - \frac{1}{2}P^2 - \frac{1}{4}t + \frac{1}{4}tP$
$\frac{2}{3} - \frac{1}{3}t < P < \tilde{P}$	$\frac{2}{3} - \frac{1}{3}t$	$\frac{1}{24}Pt - \frac{1}{6}P - \frac{1}{9}t + \frac{2}{9} + \frac{1}{54}t^2 + \frac{P^3}{2t} - \frac{P^2}{t} + \frac{2P}{3t} - \frac{4}{27t}$
$\tilde{P} < P < 1 - \frac{1}{2}t$	$\frac{1}{2} - \frac{1}{4}t$	$\frac{1}{8} - \frac{1}{8}t + \frac{1}{32}t^2$

in $\left(\frac{1}{2} + \frac{1}{4}t, \frac{2}{3} + \frac{1}{6}t\right)$, $G\left(\frac{1}{2} + \frac{1}{4}t\right) = \frac{(t-2)^2(19t-2)}{48} > 0$ and $G\left(\frac{2}{3} + \frac{1}{6}t\right) = -\frac{(t-2)^2 t}{4} < 0$, $\tilde{P}$ exists and is unique.

Like Proposition 5.1, by comparing the profits in the single direct distribution channel and the dual channel, we have the following proposition, which tells the service provider how to choose the distribution channel.

Proposition 5.2. *If $2/7 < t < 1/2$, the service providers get more profits without participating in the opaque PP channel when $0 < P < (2-t)/3$, and get more profits by participating in the opaque PP channel when $(2-t)/3 < P < 1 - t/2$.*

From the above Proposition 5.1 and Proposition 5.2, we can find that the service provider will get less profit by participating in the opaque channel when the price in the direct distribution channel is relatively low. The reason is that there has already been most of the customers buying the product in the direct distribution channel, and the extra profit from the new customers by participating in the opaque PP channel cannot cover the loss that some customers flow into the distribution channel with lower price. On the contrary, if the price in the direct distribution channel is relatively high, the service provider can join in the opaque PP channel to gain more profit, because the extra profit from the new customers is more than the loss caused by the customers who flow into the opaque PP channel with lower price.

Moreover, we also conclude the customer's buying behavior from the above two propositions, which is determined by the fit loss coefficient t and the price P in the direct distribution channel.

(1) If the fit cost loss coefficient is relatively small (i.e., $0 < t < 2/13$). The customer will not buy the travel packages in the opaque PP channel when the price in the direct distribution channel P is relatively low, this is because the PP channel is not available to the customer at that time. The customer will not buy in the direct distribution channel when the price in the direct distribution channel P is relatively high, because the service provider will participate in the opaque PP channel and the price in opaque PP channel is much lower than that in the direct distribution channel, the lower price induces all the customers flowing into the opaque channel from the direct distribution channel.

(2) If the fit cost loss coefficient is relatively high (i.e., $2/13 < t < 1/2$). The customer will only buy the travel packages in the direct distribution channel when the price in the direct distribution channel P is relatively low, and only buy in the opaque PP channel when the price in the direct distribution channel P is relatively high; however, there is the case that both channels have customers to buy the travel packages when the price in the direct distribution channel is neither too low nor too high, i.e., $(2-t)/3 < P < \tilde{P}$.

6. Conclusion.

When the opaque PP channel is available to the service providers, they have to know whether or not participating in PP channel is more profitable. In this paper, we investigate two scenarios of distribution channel: the single-channel case with the direct distribution channel and the dual-channel case with the direct distribution channel and opaque PP channel. We find that, it will be less profitable for the service provider to participate in the opaque channel when the price in the direct distribution channel is relatively low; on the contrary, the service provider's participating in the opaque PP channel can obtain more profit when the price in the direct distribution channel is relatively high.

In this paper, our research is based on the following two assumptions: (1) There is no capacity constraint for the service provider; (2) The intermediary is only a non-profit platform to show the service provider's travel packages. In future research, we will consider the service provider's supply capacity, and extend the research to the case that the OTA platform is a decision role to pursue her profit in the supply chain.

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