



COOPERATION CONTRACT IN TOURISM SUPPLY CHAINS: THE OPTIMAL PRICING STRATEGY OF HOTELS FOR COOPERATIVE THIRD PARTY STRATEGIC WEBSITES

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Abstract: This paper aims to find the optimal pricing strategy for tourism hotels when they operate their online distribution channel by cooperating with a third party website. The paper first gives the first-best solution when all the participants are integrated as a single system, and then leads to the second-best one under the decentralized scenario through a non-cooperative game model composed by a Stackelberg game between the hotels and the website and a Nash game among the hotels. Through a numerical example, we analyze the decision making process of the players; and give the service providers some useful suggestions for operating their cooperative relationship successfully. **Keywords:** hotel pricing, e-commerce, online distribution, revenue management, cooperative relationship. © 2012 Elsevier Ltd. All rights reserved.

INTRODUCTION

Motivation and Research Questions

Along with the growth of e-commerce, business and marketing models have invaded into a wide variety of industries. On the one hand, in order to reduce marketing cost and improve revenue, more and more traditional providers begin to establish internet channel to sell their products or services to customers directly. On the other hand, as retailers, taking the example of Bloomingdales and Best Buy etc., they open

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internet channel to meet the demands of those consumers who like shopping online. For example, in order to increase its operational efficiency and for the convenience of the tourists, airline industry provides web service, through which tourists may search information on all available flights and book it online whenever they like.

Faced with fierce competition and increasing online booking requirements, hospitality industry also turns to web channel. However, unlike the traditional industries, most hotels are not well-known (Bastakis, Buhalis, & Butler, 2004) so they seek to cooperate with famous third party website like online tour operators such as Expedia (<http://www.expedia.com>), Ctrip (<http://hotels.english.ctrip.com/>), Kuoni (<http://www.kuoni.com/>) etc., or a website has a mass of visitors and their customers who have purchased some services here can give some reviews about the service provider, like dianping.com (<http://www.dianping.com/>) in mainland China.

The cooperation mechanisms between provider and website are diverse (Clemons, Hann, & Hitt, 2002), among which the most famous two are the agent model and the merchant model. For instance, the cooperation between Target (<http://www.target.com>) and Amazon (<http://www.amazon.com>) is the agent one: Target determines the price of its products on Amazon, and pays Amazon a commission fee for each product sold there. However, since the information online can be searched and confirmed conveniently, the merchant model with different retail prices among different online distribution channels (such as the service provider's own website and online travel agencies' website) cannot be adopted for cooperation in the tourism and hospitality industries.

In our agent model between tourism hotels and third party websites, the hotels, as principal players, determine the commission fee for the agent websites; and then the websites determine how much effort will be done for each hotel, including but not limit to the ranking position on the webpage, picture views and video shows, etc., which influences the room sales directly. For this cooperative relationship, this paper tries to answer the following questions:

What is the equilibrium of the cooperation between the tourism hotels and their third party website?

How does a hotel make its decisions considering its own profits and the actions of the other hotels?

Is the cooperation based on agent model inefficient with regard to the total revenue compared with centralized scenario, and why?

Overview of the Cooperation Mechanism and Key Findings

Although in practice the online distribution channel of tourism hotels can be operated in various forms, we employ an agent model through the cooperation with a third party website. Under the cooperation, the hotels provide commission fees to the cooperative website for each hotel room sold through the website. Then the website

determines the effort level for the corresponding hotels, which influences the room sales directly, according to their commissions respect to its maximal profit.

As a result, there are two “sources” of consumers, the traditional tourists and the website consumers, for the hotels under the cooperation. The traditional tourists for a hotel are those who know the hotel and always book hotel rooms from the hotel directly, no matter the cooperation (between the hotel and third party website) exists or not, that is to say, the traditional tourists are loyal to their corresponding hotels. While the website consumers get the hotels’ information from the third party website, choose a favorite hotel among the cooperative hotels of the website, and then make their reservations through the website.

Through a composed game model, we show that there is a first-best solution to gain the maximum profit for the tourism supply chain when the hotels and the third party website are integrated as a single player in the centralized decision scenario. Basing on this centralized model as a benchmark, we analyze the players’ actions in the decentralized scenario, and explain how the hotels make their decisions considering their profits and the actions of the other hotels, and show how the website determines the effort levels for each hotel with respect to its maximal profit and finite effort capacity. The results show that the hotels with high available room capacities and high average room rates have much stronger motivation to organize the cooperative relationship with a third party website in order to make the best use of their room capacity and gain more profits. In addition, the findings tell that the highest commission fees are not generally provided by the most luxury hotels, because the available capacities for the luxury hotels are often small, and they have no motivation to seek high effort level from the website. That’s why the most expensive hotels are not always ranked at the first position on the websites of the online travel agencies. Moreover, the optimal effort levels for the hotels are more sensitive to the available capacities than the commission fees. This suggests that the website prefers to provide online distribution service to hotels with large capacity and low occupancy rate and gives them a marvelous effort level.

The rest of this paper is organized as follows. After reviewing some related literature in the next section, we present the model assumptions afterwards. Then in the following section, we analyze the first-best solution in the centralized scenario and also the second-best case. A numerical study is presented to explain the decision process of the players, and to show how our model can be applied in practice. Finally, in the conclusion section we summarize the managerial implications of our model and present the further research issues.

LITERATURE REVIEW

E-Commerce and Direct Distribution Channel

The rapid development of information technology paves the way of e-commerce, through which suppliers set up their direct distribution

channels besides the traditional ones. Due to the decreasing of selling cost online, manufacturer provides lower retail price for the customers who purchase goods through direct channel in order to improve its market share and revenue. Hence, multi-channel issues attract more and more attention of researchers.

Electronic channel provides consumers convenient experience while searching for products and shopping online. On one hand, the favorable prices and convenience provided by electronic channel are popular among e-customers. On the other hand, the internet shopping center is frequently visited because of its positive images and its emphasis on being for the customer's service. It seems inevitable that electronic channel provides a larger range of products considering the size of the internet (Dennis, Harris, & Sandhu, 2002). Although the direct channel which provided by the internet is helpful to improve market share and revenue for the suppliers and retailers and provides consumers with lower price and better service, there are still many difficulties for suppliers and retailers to operate direct channel. The followings two are the major difficulties.

Firstly, in most cases, there exists conflict among multiple channels because they compete fiercely for customers. And this conflict influences the development of multi-channel. Based on this fact, many papers have studied the conflict among multiple channels and also propose some advice to solve it. (Bernstein, Song, & Zheng, 2008; Cai, Zhang, & Zhang, 2009; Cattani, Gilland, Heese, & Swaminathan, 2006; Dumrongsiri, Fan, Jain, & Moinzadeh, 2008; Geng & Mallik, 2007; Kumar & Ruan, 2006; Seifert, Thonemann, & Sieke, 2006; Tsay & Agrawal, 2004; Yao & Liu, 2005).

Secondly, it is hard for enterprises to independently run their own direct channel because of the lack of visitors, complex corporate and public relations, quick delivery, etc. For example, Toys-R-Us gave up its Internet channel, Toysrus.com, and built an alliance with Amazon.com (Bernstein et al., 2008).

Related Literatures in Tourism and Hospitality

The problems of multi-channel also commonly exist in service industry, and they have attracted more and more researchers' attention. Pietro (2011) studies the cooperative behavior in the tourism destination communities, gives the tourism destinations a series of suggestions for their cooperative planning, and indicates that the cooperative behavior is a necessary condition for sustainable planning and development. Yoon, Yoon, and Yang (2006) study the impact of e-business on the distribution of airline tickets in Korea, and point out that consumers may be uninterested in the website of individual service firm because of its small scale. Therefore, it suggests that airline corporations should pay more attention to the cooperation with the travel agency or the third party website. As Shon, Chen, and Chang (2003) say, some airlines cooperate with the third party website, and meanwhile build website with other airlines. For instance, the biggest ticketing website,

www.ezfly.com, is founded by the three biggest airlines of Taiwan. For the same reason, it is a good choice for hotels to cooperate with the third party website because their sizes are even smaller than airlines'.

Cooperate with third parties is benefit for the hotels' development (Korel, 2000), and the importance of cooperation has long been recognized by hotel industry. Schulz (1994) points out that hotel and travel agency or other third party companies are coming to recognize the advantages of collaboration over competition. Christof (2006) does a network study as a new policy in tourism marketing. And Ling, Guo & Liang (2009), Ling, Guo & Liang (2011) study the optimal pricing strategy of hotel for travel agency as a long term cooperative partner. Besides the literatures mentioned above, there are some others study on the travel agency. Moreover, the development of e-commerce provides an expansive space for such cooperation. Medina-Muñoz and García-Falcón (2000) identify the decisive factors for successful cooperation between hotels and third party companies as a new distribution channel of the hotel room sell.

The success of the cooperation between hotel and third party companies lies on whether the cooperation is beneficial to both parties. That is to say, on one hand, it increases hotel occupancy rate and improves hotel revenue; on the other hand, the third party company can obtain commission revenues and provide convenient service. Hence, pricing is not only a key strategic lever deployed by hotels to manage revenue (Kimes & Chase, 1998), but also an important tool to build and enhance cooperation. Abbott and Lewry (1999) and Tso and Law (2005) point out that travel agency and other third party companies enjoy low room rate from their cooperative hotel. Even so, few papers focus on the pricing issue of the cooperation between hotels and the third party companies. Although there are many works about the hospitality industry, there are few papers about the multi-channel of the distribution of hospitality service.

As a kind of effective management leverage, pricing strategy is always a hot topic among academic research. In the previous studies of the hospitality industry, Gu (1997) builds a room pricing model for optimizing the profitability of hotels; Lai and Ng (2005) work over the optimal model of hotel pricing in the circumstances of uncertainty; Collins and Parsa (2006) study the effect of pricing on hotel industry revenue. Schwartz (2006) analyzes the relationship between booking and hotel revenue, and proposes a booking project which could increase hotel revenue. Guo and He (2012) study the optimal pricing strategy of hotels for different tourism packages which provided by tour operators. Demand is a key factor that affects the decision maker's choices. As a consequence, it is essential to take the demand into account. Pan (2007) explains how market demand and hotel capacity affect the optimal price of hotel; van der Rest and Harris (2008) prove that discount is the best pricing policy for hotel in the case of high costs and rigid changes in demand.

Sales Effort

Besides the cooperative relationship in distribution which discussed above, many parties also cooperate with others in sales effort. As for effort in supply chain coordination, Taylor (2002) considers the supply chain coordination under the condition that channel rebates with sales effort effects. Suo, Wang, & Jin (2005) propose a contract to coordinate the supply chain considering the effects of effort. Based on sharing sales profits as well as the cost of effort, they model a novel contract which could not only achieve supply chain coordination, but also hold certain advantages. He, Zhao, Zhao, and He (2009) study the coordination of supply chain with sales effort under dependent stochastic demand, and analyzes the effect of sales effort on the supply chain.

As for the corporative effort in a supply chain composed of a manufacturer and a retailer, the manufacturer or the leader of a cooperative system advertises its products on TV or the internet; and at the same time, the retailer or the follower deploys the product in his own store or local area. Huang and Li (2001) and Li, Huang, Zhu, and Chau (2002) give us a particular analysis of cooperative advertising in manufacturer-retailer supply chains. It is worth mentioning that there is another way of cooperative advertising, that is, the retailer does the advertising alone, but the manufacturer affords part of the cost caused by the advertising. The sales effort in this paper is done by the website alone, and the hotel provides commission fee to the website as a way of sharing part of the cost caused by the website's effort. Xie and Wei (2009) study the coordinating advertising and pricing in a supply chain which is comprised of a manufacturer and a retailer. In that article, they analyze the effect of advertising from two aspects: one is the non-cooperative, leader-follower situation, and the other is the cooperative situation. At last, they conclude that the cooperative model achieved better coordination with higher channel profits than the non-cooperative model. However, the effect of sales effort in tourism industry under the condition of e-commerce has not caught the scholars' attention.

MODEL DESCRIPTION

In order to improve their occupancy rate and profit, hotels cooperate with third party websites (for example online travel agencies). In this paper, we propose a framework which is composed of n hotels and a single website, where the hotels are independent from each other and the website provides online distribution service for the hotels. We use subscript w to denote the website and subscript i for hotel i , $i = 1, 2, \dots, n$.

Hotel i with a capacity C_i sells its rooms at a standard room rate p_i . Without affecting the conclusions drawn herein, we further suppose that the C_i rooms are identical and one room accommodates one customer. The fixed cost of hotel i is denoted as F_i and the daily variable

cost of each occupied room is v_i . Furthermore, we set $v_i = 0$, which has no effect on the outcome of our model.

The Cooperation and Demands

Nowadays, in the cooperative relationship of a hotel and a third party website, the website provides its customers the same price as the hotel’s own website and receives a commission for its sales, from the hotel. Furthermore, the website will determine its effort level for the hotel, including but not limited to the ranking position of the hotel on its webpage, high evaluation, pictures and videos of the hotel, etc., the factors which may increase the demand of the hotel.

Denote the total demand of hotel i ’s rooms as D_i , which is composed of the traditional consumers and the website customers. It is distributed continuously with probability density function (pdf) $f_i(D_i)$ and cumulative distribution function (cdf) $F_i(D_i)$. Among these consumers, there are α_i proportion of them loyal to this hotel and they reserve the hotel rooms through the hotel’s traditional distribution channels (such as by phone, in person or through the hotel’s own website); while the $(1 - \alpha_i)$ part of them will turn to the third party website for a more cost-effective accommodation or multifarious service packages, that is to say, this part of customers may purchase another hotel through the cooperative website. As a result, the traditional demand of hotel i is $\alpha_i D_i$ and the total potential demand for the n hotels through the website is $\sum_{i=1}^n (1 - \alpha_i) D_i$. The detail of the demands is shown in Fig. 1. For convenience, we denote $x_i = \alpha_i D_i$ as the traditional demand of hotel i with pdf $h_i(x_i) = f_i(x_i/\alpha_i)$, cdf $H_i(x_i) = F_i(x_i/\alpha_i)$ and mean value μ_i ; $Y = \sum_{i=1}^n (1 - \alpha_i) D_i$ as the total potential demand for the hotels through the website with pdf $g(Y)$, cdf $G(Y)$ and mean value $\sum_{i=1}^n \mu_i (1 - \alpha_i) / \alpha_i$. $g(Y)$ and $G(Y)$ can be obtained when the

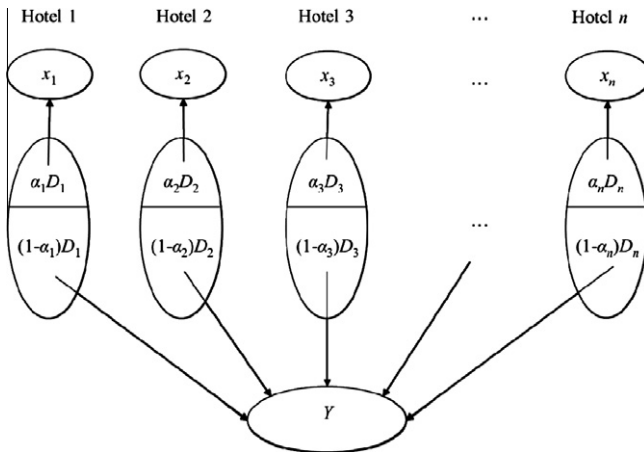


Figure 1. Demands of the Hotels and the Third Party Website

demand distributions of the n hotels are known. For instance, by assuming the distributions of all the n hotels are all normal distribution with different parameters, i.e. $D_i \sim N(a_i, \delta_i^2)$, then the traditional demand of hotel i follows a normal distribution as $x_i \sim N(\alpha_i a_i, \alpha_i^2 \delta_i^2)$ and the demand of the third party website follows $Y \sim N(\sum_{i=1}^n (1 - \alpha_i) a_i, \sum_{i=1}^n (1 - \alpha_i)^2 \delta_i^2)$.

Through the cooperation, hotel i provides the website a commission, ω_i , for each sold room through the third part website. After knowing all the commissions of the n hotels, the website decides the effort level, β_i , for the hotels according to their commission fees. In this paper, we denote the effort level as the proportion of the consumers or the probability of a consumer chooses hotel i and makes reservation. In other words, when the website provides hotel i the effort level β_i , it means there are $\beta_i Y$ website consumers booking hotel i 's rooms from the third party website. And suppose that the total effort capacity of the third party website is 1 with a fixed setup cost W , which is accordance with logical thinking.

The effort of the website for a hotel may be composed of several aspects, for instance, the ranking position of the hotel, high positive evaluations, pictures and video shows, etc. Firstly, as we all known, it is more likely to make sales if the hotel's information is placed near the top of the first webpage; and to the contrary, if the hotel is placed at the bottom of the webpage, it is less likely to make sales because most of the consumers read the hotel's information from the top of a webpage. Secondly, on the virtual marketplace provided by the B2C e-commerce, the evaluation of a product influences the sales heavily (Anderson, 1998; Chevalier & Mayzlin, 2006; Hennig-Thurau, Gwinner, Walsh, & Gremler, 2004). For this reason, the third party website can improve the sales for the hotel that gives the considerable commission through providing high positive evaluation. Thirdly, the picture and video shows of a hotel will improve the consumers' understanding of the hotel, and decrease the worry about the uncertainties about hotel facilities, environment and even security, and so on. As a result, the hotels with detailed pictures and video shows may gain more consumers than others. The last but not the least, service package is another important strategy which influences the room sales on a third part website (Chiam, Soutar, & Yeo, 2009; Delgado-Ballester & Hernández-Espallardo, 2008; Kim, Bojanic, & Warnick, 2009). For instance, in practice, the global biggest online travel agency, Expedia (<http://www.expedia.com>), provides his consumers with travel packages such as "flight + hotel", "hotel + car" and "flight + hotel + car" etc. to meet their needs, and furthermore, he also provides the consumers some discount options on traveling or shopping near the hotel.

With appropriate operations and combinations of the above strategies, the website can decide the optimal effort levels for the hotels respect to its maximal profit under the condition of $\sum_{i=1}^n \beta_i \leq 1$. Moreover, in the game of this cooperation, the hotels compete with each other for an optimal effort level of the website by providing an optimal commission, that is to say, this is a full game among the $(n + 1)$ players.

The Expected Numbers of Consumers and Profits

Under the cooperation with the third party website, hotel i has two types of consumers: the traditional tourists who are loyal to the hotel’s traditional distribution channels, and the consumers who get the hotel’s information and purchase rooms through the third party website. In order to simplify the consumer classes in the following discussion, we use t-tourists (traditional tourists) and w-tourists (get information and make reservations from the third party) to present the two classes of consumers.

Under the cooperation with the third party website, the number of t-tourists of hotel i follows a distribution with pdf $h_i(x_i)$ and mean value $\mu_i < C_i$. Due to the demand of t-tourists and the commission paid to the website, the hotel prefers to retain some rooms to meet the t-tourists’ demand and gives a part of the capacity to the w-tourists. In our model, we assume that hotel i retains μ_i rooms for the t-tourists, in other words, hotel i gives an upper bound of the number of the w-tourists, $(C_i - \mu_i)$, to the third party website.

Being offered a commission for each sold room, ω_i , the website determines the effort level, β_i , for hotel i by adjusting the position ranking, media shows and service bundling, etc. As a result, the expected number of the w-tourists for hotel i is,

$$\begin{aligned}
 y_i &= \int_0^{(C_i-\mu_i)/\beta_i} \beta_i Y g(Y) dY + \int_{(C_i-\mu_i)/\beta_i}^{\infty} (C_i - \mu_i) g(Y) dY \\
 &= C_i - \mu_i - \beta_i \int_0^{(C_i-\mu_i)/\beta_i} G(Y) dY.
 \end{aligned}
 \tag{1}$$

Through the cooperation, the hotels will receive more consumers and their occupancy rates increase; nevertheless, they face such a problem: if the total number of consumers (including the t-tourists and the w-tourists) exceeds their capacity, the redundant consumers should be refused from the service. This is a management conflict between customer relationship management and revenue management (Wang, 2012). In order to operate the cooperative relationship successfully for a long term, the hotel will choose the relationship rather than the immediate revenue and provide the w-tourists a priority to check in if the number of the w-tourists is within the capacity. As a result, there are finally $\int_0^{C_i-y_i} x h_i(x) dx$ t-tourists staying in hotel i when the total number of consumers is lower than the hotel’s capacity; and $\int_{C_i-y_i}^{\infty} (C_i - y_i) h_i(x) dx$ ones otherwise. Hence, the expected number of t-tourists for hotel i is

$$\begin{aligned}
 x_i &= \int_0^{C_i-y_i} x h_i(x) dx + \int_{C_i-y_i}^{\infty} (C_i - y_i) h_i(x) dx \\
 &= C_i - y_i - \int_0^{C_i-y_i} H_i(x) dx,
 \end{aligned}
 \tag{2}$$

where y_i is as shown in Eq. (1).

As the expected numbers of different consumers are observed, the expected profits of the hotels and the third party website under the cooperation are realized as follows, respectively,

$$\begin{aligned}\pi_i &= p_i(x_i + y_i) - \omega_i y_i - F_i \\ &= p_i C_i - F_i - p_i \int_0^{C_i - y_i} H_i(x) dx - \omega_i y_i,\end{aligned}\quad (3)$$

$$\pi_w = \sum_{i=1}^n \omega_i y_i - W, \quad (4)$$

where $y_i = c_i - \mu_i - \beta_i \int_0^{(c_i - \mu_i)/\beta_i} G(Y) dY$.

Sequence of Events

The model of this paper aims to exploring the agent cooperation model between tourism hotels (the Principals) and a third party website (the Agent). According to the assumptions we have laid out so far, the sequence of the events is as follows:

Firstly, the hotels offer the website take-it-or-leave-it contracts with the commissions for each room sold through the website and room capacities for w-tourists;

And then, the website accepts or rejects the contracts;

Afterwards, the website who accepts the contracts decides the effort levels for each hotel respect to its maximal total profit subject to the effort capacity;

At the target day, the numbers of both types of consumers are realized;

And finally, with successful room reservations, the customers check in to the hotels and enjoy the service and the website is rewarded according to the contracts by the hotels.

ANALYSIS

The game between the hotels and the third party website follows a Stackelberg one in which the hotels play as the leaders and the third party website as the follower. While the game among the hotels follows a Nash game model and in which each hotel decides the commission price to obtain the optimal effort level from the website. In this section, we will analyze how each player makes the decision to maximize its profit based on other players' actions. We first present the benchmark model in which the website and the hotels are integrated as a single decision maker (centralized scenario), and then the decentralized scenario in which the players make their private decisions is shown.

The Centralized Scenario: Integrated Action of the System

In the centralized scenario, all the players make decisions as an integrated system to maximize the profit of the system. We set this as the benchmark case and the situation often offers the best solution because the integrated player makes all the decisions respecting to the total profit. Then the problem is,

$$\begin{aligned} \max_{\beta_i} \Pi &= \pi_w + \sum_{i=1}^n \pi_i \\ &= \sum_{i=1}^n \left(p_i C_i - F_i - p_i \int_0^{C_i - y_i} H_i(x) dx \right) - W, \end{aligned} \tag{5}$$

$$s.t. \ y_i = C_i - \mu_i - \beta_i \int_0^{(C_i - \mu_i) / \beta_i} G(Y) dY \quad \forall i \tag{6}$$

$$\sum_{i=1}^n \beta_i \leq 1, \tag{7}$$

$$\beta_i \geq 0 \quad \forall i.$$

To maximize the total profit of the integrated supply chain, the decision maker needs to allocate the effort to each hotel properly. Hence, this model can be considered as an optimization problem about resource allocation in which the resource is constrained by Eq. (7). To derive the optimal solution, let θ be the Lagrangian multiplier associated with Eq. (7), i.e., the resource constraint. Because the second order derivative of Eq. (5) with respect to β_i is negative, the objective function is concave in the effort level. We use superscript FB to denote the first-best solution which is obtained from the centralized scenario and the superscript SB for the second-best solution obtained from the decentralized scenario. From the first-order condition, we can obtain the first-best solution of the cooperation as follows.

Proposition 1. When the hotels and the website are integrated as a system in the centralized scenario, the optimal effort level for hotel i is unique and shown as follows,

$$\begin{aligned} \beta_i^{FB}(\theta) &= \arg \left\{ H_i(\mu_i + \beta_i \int_0^{(C_i - \mu_i) / \beta_i} G(Y) dY) \int_0^{(C_i - \mu_i) / \beta_i} (G((C_i - \mu_i) / \beta_i) \right. \\ &\quad \left. - G(Y)) dY = \theta / p_i \right\}, \end{aligned} \tag{8}$$

$$\sum_{i=1}^n \beta_i^{FB}(\theta) = 1. \tag{9}$$

Although Eq. (8) cannot yield the closed form optimal solutions, it is easy to find that $\partial\beta_i^{FB}/\partial p_i > 0$, $\partial\beta_i^{FB}/\partial C_i > 0$ and $\partial\beta_i^{FB}/\partial\mu_i < 0$. It implies that, if the parameters of the other hotels are fixed, the optimal effort level for hotel i is increasing with its average room rate and room capacity, however, decreasing with the expected number of t-tourists. The managerial insight behind the conclusion is that the hotels with high room rate and sufficient spare rooms will receive high-level effort from the website in the centralized decision scenario, while the hotels with low room rate and insufficient spare rooms assigned to the w-tourists will receive less attention from the website.

Private Actions: The Website’s Problem

Unlike the centralized scenario, the $n + 1$ players in the decentralized scenario make decisions to maximize their own expected profits separately in the cooperative frame. The equilibrium response of the third party website is first analyzed in this subsection, and then the Nash equilibrium of the n hotels is presented in the following Subsection.

Given the commission ω_i , $i = 1, 2, \dots, n$, the website decides the optimal effort allocation to every hotel to maximize its expected profit subject to the effort capacity. Consequently, the model of the website’s decision making is,

$$\max_{\beta_i} \pi_w = \sum_{i=1}^n \omega_i y_i - W, \tag{10}$$

$$s.t. y_i = C_i - \mu_i - \beta_i \int_0^{(C_i - \mu_i)/\beta_i} G(Y) dY \quad \forall i, \tag{11}$$

$$\sum_{i=1}^n \beta_i \leq 1. \tag{12}$$

$$\beta_i \geq 0 \quad \forall i.$$

Since the second order derivative of the objective function with respect to β_i is negative, Eq. (10) is a concave function of β_i and there is a unique optimal solution for β_i to maximize the profit. The first-order condition yields the optimal response of the third party website to the hotels with the given commissions.

Proposition 2. With given commissions provided by the hotels, there is a unique optimal effort allocation for the website to maximize its profit. Specifically, the effort level for hotel i is given as,

$$\beta_i^*(\theta) = \arg \left\{ \int_0^{(C_i - \mu_i)/\beta_i} (G((C_i - \mu_i)/\beta_i) - G(Y) dY) = \theta/\omega_i \right\}, \tag{13}$$

$$\sum_{i=1}^n \beta_i^*(\theta) = 1. \tag{14}$$

The following corollary concludes the insights implied by this proposition.

Corollary 1. There are $\partial\beta_i^*/\partial\omega_i > 0$; and $\partial\beta_i^*/\partial(C_i - \mu_i) > 0$.

This corollary explains how the website’s optimal responses to the hotels’ contract terms. Take hotel i as an example and suppose the parameters of the other hotels are fixed, if hotel i increases the commission ω_i , the website will get more margin from selling rooms for hotel i , which motivates the website to exert more effort for hotel i to attract the consumers’ attention. Meanwhile, if the available capacity for the w-tourists of hotel i increases, the marginal effort cost will decrease. As a result, the website will transfer some effort from the other hotels to hotel i to gain more profits.

Private Actions: The Hotel’s Problem

Knowing that the third party website will respond to its commission by choosing the effort level β_i according to Eqs. (13 and 14), hotel i determines its optimal commission for the website by solving

$$\begin{aligned} \max_{\omega_i} \pi_i &= p_i C_i - F_i - p_i \int_0^{C_i - y_i} H_i(x) dx - \omega_i y_i, & (15) \\ \text{s.t.} \quad & \int_0^{(C_i - \mu_i)/\beta_i} (G((C_i - \mu_i)/\beta_i) - G(Y)) dY = \theta/\omega_i \quad \forall i, \\ & y_i = C_i - \mu_i - \beta_i \int_0^{(C_i - \mu_i)/\beta_i} G(Y) dY \quad \forall i, \\ & \sum_{i=1}^n \beta_i(\theta) = 1 \end{aligned}$$

Observing the objective function, we can find that the problem of hotel i is not independent from the other hotels; the problem is a Nash game in which all the hotels are involved.

Supposing that the actions of the other hotels are determined, hotel i decides its commission from the first-order condition of its profit function. Furthermore, since the second order derivative is negative, the optimal decision of hotel i is unique.

It is more convenient to obtain the equilibrium solution by converting the hotels’ problem into a function of β_i as follows rather than a function of ω_i .

$$\max_{\beta_i} \pi_i = p_i C_i - F_i - p_i \int_0^{C_i - y_i} H_i(x) dx - \omega_i y_i, \tag{16}$$

where $\omega_i = \theta / \int_0^{(C_i - \mu_i) / \beta_i} (G((C_i - \mu_i) / \beta_i) - G(Y)) dY$, $y_i = C_i - \mu_i - \beta_i \int_0^{(C_i - \mu_i) / \beta_i} G(Y) dY$, $\sum_{i=1}^n \beta_i(\theta) = 1$.

From the discussion has been presented so far, we have the following proposition.

Proposition 3. The optimal solution of the transformed function (16) is shown as follows,

$$\beta_i^{SB}(\theta) = \arg_{\beta_i} \left\{ \frac{H_i(C_i - y_i) \beta_i^3 \left(\int_0^{(C_i - \mu_i) / \beta_i} (G((C_i - \mu_i) / \beta_i) - G(Y)) dY \right)^3}{\beta_i^3 \left(\int_0^{(C_i - \mu_i) / \beta_i} (G((C_i - \mu_i) / \beta_i) - G(Y)) dY \right)^2 + y_i (C_i - \mu_i)^2 g((C_i - \mu_i) / \beta_i)} = \frac{\theta}{\beta_i} \right\},$$

and

$$\sum_{i=1}^n \beta_i^{SB}(\theta) = 1, \text{ where } y_i = C_i - \mu_i - \beta_i \int_0^{(C_i - \mu_i) / \beta_i} G(Y) dY.$$

This proposition shows the Nash equilibrium of the game among the n hotels. Specifically, the corresponding optimal commission which is provided to the website by hotel i can be obtained from $\omega_i^{SB} = \theta / \int_0^{(C_i - \mu_i) / \beta_i^{SB}} (G((C_i - \mu_i) / \beta_i^{SB}) - G(Y)) dY$.

The existence and uniqueness of the equilibrium solution have been proved so far. Unfortunately, the closed form solutions, β_i^{SB} and ω_i^{SB} cannot be derived from Proposition 3. In order to gain additional insights, as well as circumvent this difficulty, we provide a numerical analysis in the following section.

NUMERICAL STUDIES

In this section, we consider a numerical analysis which comprises one third party website and two hotels. The room demand of each hotel follows a Poisson distribution. The numerical example serves to illustrate our findings in previous sections and to show how related conclusions shed insights into strategic planning and cooperative contract negotiations in tourism supply chains in practice.

For convenience and without affecting the findings, the Poisson distribution of room demand for each hotel can be normalized to a

Table 1. Parameters for the Hotels and Website

Player	C_i	p_i	μ_i	F_i	Λ	W
Hotel 1	150	100	40	2500		
Hotel 2	200	150	60	6000		
Website					233	0

Note: C_i : room capacity of hotel i ; p_i : average room rate of hotel i ; μ_i : mean value of t -tourists of hotel i ; F_i : the fixed cost of hotel i ; Λ : the mean value of the potential consumers of the third party website; W : we assume the fixed operational cost of the website zero with no effect on the findings.

Table 2. Optimal Contract Terms and Profits in Different Situations

Type of Situations	ω_1	ω_2	β_1	β_2	π_1	π_2	π_w	Π
First-Best	—	—	42.41%	57.59%	—	—	—	33921.3
Second-Best	14.82	16.36	43.48%	56.52%	10019.7	20267.9	3605.1	33892.7

Note: ω_i : the commission provided to the website from hotel i ; β_i : the effort level for hotel i ; π_i : the profit of hotel i ; π_w : the profit of the website; Π : total profit of the whole supply chain including the hotels and the website.

normal distribution with identical mean value and variance (Kim, Cohen, & Netessine, 2007; Zipkin, 2000). Suppose that there are 30 percent of the consumers ($\alpha_i = 30\%$, for all $i = 1, 2, \dots, n$ without effects to the result) are loyal to the corresponding hotel, then 70 percent of the total consumers turn to the third party for a hotel reservation. As a result, according to the model description presented previously, the parameters of the hotels and the third party website are shown as Table 1.

Based on the above parameters, the optimal commission that each hotel provides to the third party website and the website's optimal effort levels can be calculated by the simulation implemented in Wolfram Mathematica® 8.0.1.0. The first-best and second-best solutions under centralized and decentralized scenarios of the model are shown in Table 2.

The results of Table 2 tell that there is no significant difference (about 1%) between the optimal effort levels which allocated to the hotels by the website under the centralized and decentralized scenarios. In the centralized scenario, it is an optimization problem for the integrated player to determine the optimal effort levels for the hotels and they can be obtained considering the average room prices and the numbers of available rooms of the hotels. While in the decentralized one, the website faces a similar problem and the only difference is that the average room rates are replaced by the commission fees provided by the hotels. As a result, the hotels play a Nash game by giving appropriate commissions to the website to get the desired effort levels, and the optimal commission fees are shown in the table.

Furthermore, the decentralized cooperation contract of this paper performs at an almost perfect level. From the results shown in Table 2, we can find that although there is double marginalization in the decentralized supply chain system, the marginalization effect of the cooperation contract is extraordinary small (0.08% of the integrated profit in the centralized scenario) according to the total profits.

Sensitivity Analysis

In this subsection, we analyze the influence of the parameters on the decisions and profits of the hotels as well as the third party website. Based on the value set in Table 1, Fig. 2 shows the influence of the

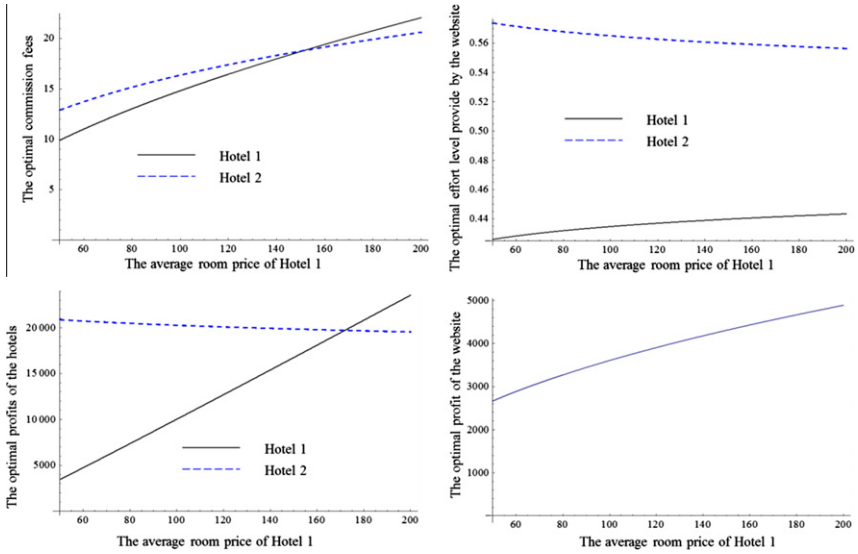


Figure 2. The Effect of the Average Room Rate of Hotel 1 on the Results

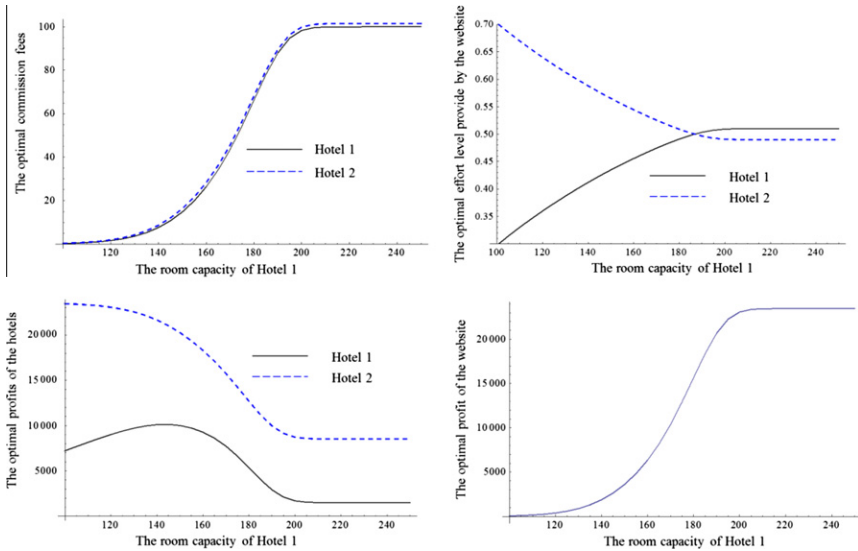


Figure 3. The Effect of the Room Capacity of Hotel 1 on the Results

average room price; meanwhile, Fig. 3 shows how the room capacities of the hotels affect the decisions and profits of the players; and finally, the sensitivity result about the number of the traditional tourists is presented in Fig. 4. Considering that the hotels play the same role in the

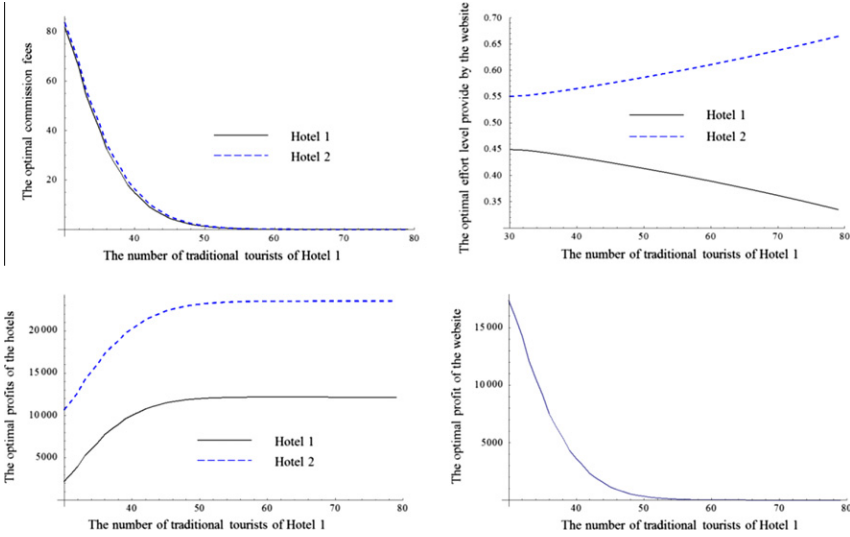


Figure 4. The Effect of the Number of the Traditional Tourists of Hotel 1 on the Results

Nash model and they have the similar influences on the optimal decisions, we present sensitivity analysis of the parameters of Hotel 1 and discuss the influences on the decisions about the two hotels and the third party website.

Fig. 2 tells that the optimal commission fees for the third party website provided by the hotels are both increasing in the average room rate of Hotel 1. Furthermore, the decision of Hotel 1 is more sensitive than that of Hotel 2, the hotel with constant parameter values. Hotel 1 has much initiative to seek high effort level from the website as a result of the fact that there are more profit margins from selling rooms with increasing average room rate. Facing the increasing commission fees from the both hotels, the website will adjust its effort allocation between the two hotels. Driven by the profit maximization, the website will provide an increasing effort level for Hotel 1 because of its more remarkable increased commission than Hotel 2. Accordingly, the website will gain increasing profit form the collaboration when the average room rate of the hotel(s) is increasing. Through the measure of providing higher and higher commission fee, Hotel 1 gets increasing effort level as well as more and more w-tourists from the third party website and certainly richer and richer profit with its average room rate increasing. While due to the increasing commission fee provided to and decreasing effort level obtained from the third party website, Hotel 2 gets decreasing profit caused by the increasing of the average room rate of its competitor.

Additionally, from this figure, we can also find that although Hotel 1 provides more commission fee to the third party website than Hotel 2 when its average room price is higher than 150, it is still given a lower

effort level from the w-tourists provider than the other hotel. It reveals that: (1) the hotel with higher room capacity does not always provide the higher commission fee; (2) the hotel that provides higher commission fee will not always be offered the higher effort level. This is because that, in this example, on one hand, Hotel 1 has more profit margins and has motivation to pay a higher commission; on the other hand, the website would like to provide higher effort level for Hotel 2 which has a bigger capacity for w-tourists. This finding tells that the optimal commission fee of a hotel is determined by its average room rate and available capacity for w-tourists and the optimal effort level from the website is determined by the commission fee and the available capacity for the w-tourists.

Fig. 3 illustrates the effect of the hotel room capacity on the results. On one hand, Hotel 1 has strong incentive to increase the commission fee to attract more w-tourists because of its increasing capacity, and the website increases the effort level for Hotel 1 because there are more available rooms for the w-tourists at Hotel 1. As a result, both Hotel 1 and the third party website benefit from the increasing capacity of Hotel 1 and gain more profits when the capacity of Hotel 1 is small. On the other hand, at the same time, Hotel 2 with higher average room rate increases the commission fee correspondingly struggling to maintain its w-tourist demand through the Nash game with Hotel 1. As a result, the mutual stimulation between the two hotels drive the commission fees higher and higher and even reach the average room rate of Hotel 1 (when the capacity is larger than 200 in this example), which makes Hotel 1 gets zero profit from the cooperation at the Nash equilibrium. Consequently, when the capacity of Hotel 1 is too big (bigger than 150 but smaller than 200 in this example), the optimal profit of the hotels will decrease with the capacity of Hotel 1 and the website will gain more advantages from the mutual stimulation caused of the Nash game between the two competitive hotels until the commission fee of Hotel 1 reaches its room rate. And then the decisions and the profits of the players do not change with the increasing of the capacity of Hotel 1 (when the capacity is bigger than 200 in this example).

The finding suggests that the hotels should do some sales effort to attract tourists when their occupancy rates are low; and the website will gain significant income through the cooperation with hotels with high room capacity and low occupancy rate.

The effect of the number of the t-tourists of Hotel 1 is shown in Fig. 4. Similar to the increasing of the room capacity of Hotel 1, the number of t-tourists influences the available capacity for the w-tourists directly. Hence, along with the increasing of the number of the t-tourists, the hotels provide lower commissions to the website and the website decreases the effort level of Hotel 1 and transfers it to Hotel 2 whose available capacity for the w-tourists is larger. Accordingly, the hotels benefit from the increasing number of t-tourists of Hotel 1 and the website get decreasing profit due the decreasing commission fees.

CONCLUSION

This paper studies the cooperation contract between tourism hotels and third party websites. The website receives commission fees from the hotels for selling room reservations online, and determines the level of sales effort (such as ranking position of hotels' information on its webpage, customer evaluations, picture and video show, etc.) to maximize its profit with a finite effort capacity. We give the first-best solution in the centralized scenario when the hotels and website are integrated as a single player, as well as the second-best solutions showing each player's equilibrium actions in the decentralized scenario.

Intuitively, the hotels' optimal commissions would increase with the room capacity of the hotels. However, through the analysis and numerical studies of this paper, we find that the optimal commission fee is not only depends on the room capacity of the hotels, but also the average room rate and the expected number of t-tourists. And this finding gives the hotel managers a suggestion that they should decide the commission for the cooperative website considering both the average room price and the available capacity for the w-tourists (i.e. the desired demand of the w-tourists).

For the website effort, the properties have been shown in Proposition 2 and Corollary 1. The website decides the effort levels considering the commission fees and the available capacities provided by the cooperative hotels. And the findings show that the website prefers to cooperate with hotels with high capacity and low occupancy rate and provides them high effort levels even a low commission is paid (as shown in Fig. 3).

Meanwhile, from the numerical studies, we can find that the cooperation contract in this paper can provide a high operational performance in the decentralized scenario. Although there is double marginalization effect in the decentralized situation, the operational performance maintains high (the performance suffers only 0.08% loss comparing with the centralized case) which implies that channel coordination is not a necessary mechanism in the cooperation.

Finally, the model of this paper is limited by some necessary restrictions in scope, and can be extended to a number of interesting further studies. Firstly, we assume that all the hotel rooms are coessential and the tourists' choice is induced by the website through the website effort. If the demand of the w-tourists for a hotel depends on both the website's effort and the hotel's attributes (such as location place, traffic convenience), then how will the pricing policy of the hotel and the responses of the website be decided? This extension may need an additional assumption on the demand function with respect to the hotel properties. Secondly, this model can be extended to the scenario that the information of the players is unobservable to each other. And then an asymmetric information game will be presented. Thirdly, cancellations and no-shows are very common in the hospitality industry, and accordingly, an overbooking strategy can be adopted to fix this problem, and this would certainly be worth working on. Finally, a dynamic pricing policy depends on the reservation date and room inventory for

a hotel would yield some interesting insights for the service operators, although this may be a great challenge. **A**

Acknowledgements—The authors thank Editor Professor D. Dittman and the three anonymous referees for their encouraging comments and suggestions. The quality of this article was improved substantially as a result of these suggestions. And we would like to thank professor Lan Sun in Department of Foreign Language at University of Science and Technology of China for the language support of this paper.

This work was supported by the National Natural Science Foundation of China (No. 71271197) and the Foundation for Innovative Research Groups of the National Natural Science Foundation of China (No. 71121061). And the first author would like to thank the support of the Special Funding for Countermeasure Study on the Development of Popular Science of the China Association for Science and Technology under Project No. 2012KPYJD07-5.

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Submitted 12 October 2011. Resubmitted 13 March 2012. Resubmitted 27 June 2012. Resubmitted 10 August 2012. Final version 3 November 2012. Accepted 12 November 2012. Refereed anonymously. Coordinating Editor: David Dittman.

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