



Optimal pricing strategy based on market segmentation for service products using online reservation systems: An application to hotel rooms

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ABSTRACT

As an effective policy which brings the service providers high occupancy rate and generates more profit than fixed pricing, the dynamic pricing strategy is extensively used in the online distribution channel. This paper studies the optimal dynamic pricing strategy based on market segmentation for service products in the online distribution channel taking hotel rooms as an example. Firstly, the pricing model is built to maximize the hotel profit through a dynamic process. Then the solution methodologies based on Chebyshev's Sum Inequality and dynamic programming are provided for the linear demand case and non-linear demand case, respectively. The optimal number of segments and optimal boundaries can be obtained. The results suggest that an appropriate policy of market segmentation in using of online reservation systems is benefit for the service suppliers as well as the consumers. Finally, an illustration based on a 300-room hotel is provided for the more realistic non-linear case.

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1. Introduction

In the service industries, numerous service providers are confronted with the dilemma that only a small fraction of products are sold on a given time and given capacity, while the unsold part cannot be kept in inventory for future use when the market demand surpasses the available capacity (Stolarz, 1994). For instance, in the hotel industry, the unbooked rooms in the low demand season cannot be inventoried to the high demand season for sale. As further evidence, the unsold seats of a plane cannot be retained to a future flight. Furthermore, the marginal profit of each sold product (such as a hotel room and an airplane ticket) is very considerable, while the unit variable cost is much lower than the high fixed cost (Ladany, 1996). Therefore, how to achieve the full utilization of the high margin and zero-salvage product capacity becomes a significant issue for the service providers.

Fortunately, the profits can be increased considerably with a proper pricing strategy provided by *Market Segmentation* (Ladany, 1996), which is “one of the most important strategic concepts contributed by the marketing discipline to business firms and

other types of organizations” (Myers, 1996). For example, in the e-tourism era, the online reservation system (ORS) is widely used in the marketing of hospitality industries and makes it possible for e-consumers to reserve hotel rooms at anywhere and anytime with access to the Internet. Consequently, different segments for hotel rooms can be achieved by ORS with a dynamic pricing strategy respecting to the lead time of the reservations.

Furthermore, there are many hotels that adopt this kind of dynamic pricing strategies for their consumers. Abrate et al. (2012) collect the dynamic pricing data “from almost 1000 hotels in eight European capital cities”, which implies that there are so many hotels using dynamic pricing strategy in their revenue management. For instance in practice (all the examples are selected and verified July 2012), Marriott International, Inc. (<https://www.marriott.com>) offers a 25–50% discount to the consumers who book rooms 30 days earlier through the Internet. Similar concession occurs at Hilton Hotels (<http://www.hilton.com>). Compared with a float discount strategy above, Hotel ICON (<http://www.hotel-icon.com/>), which established by School of Hotel and Tourism Management Hong Kong Polytechnic University, will provide a 20% fixed discount to her consumers who book rooms at least 14 days before their arrival date. All these successful dynamic pricing strategies are operating on the hotels' websites through their online reservation systems.

The dynamic pricing strategy segments the market of service products into different parts by the length of the lead time to the end of the horizon. Take hotel rooms as an example, a higher rate

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for business travelers who reserve room on the target day or one or two days earlier; a medium rate for tourists who reserve rooms a longer time before the target day, like a week; and a lower rate for consumers who book rooms more than two weeks earlier before the target day. Due to the price concession, the pricing policy attracts more consumers for the service providers and most products are sold in advance of the end of the horizon. However, once all of the service products are booked before a long time of the horizon finished, the consumers who want to purchase the service near the target day will be declined due to the finite capacity. This may incur an opportunity loss of the profits to the service providers, because the margin is higher if the purchasing time is closer to the end of the horizon.

Consequently, how to determine the optimal dynamic pricing strategy, i.e., the optimal segmentations and the corresponding sale prices are the key issues in revenue management of the service providers in using of online reservation systems in the e-commerce era. Taking the hotel industry as an example, in this paper, we build a pricing model to describe the dynamic pricing process for the service providers. The efficient solution methodologies are outlined for both the linear demand function case and the non-linear case. Finally, the optimal solution of segmentations and the corresponding number of hotel rooms and price in the non-linear case are given by a numerical example with a 300-room hotel.

To the best of our knowledge, this paper may be the first attempt to determine the optimal dynamic pricing strategy in using of ORS in service industries. The remainder of this paper is organized as follows. After reviewing the related literature about dynamic pricing and market segmentation in service industries in Section 2, Section 3 presents the dynamic programming model of the pricing strategy based on market segmentation. In Section 4, we provide the solution methodology for the pricing model. A numerical example for a 300-room hotel is presented in Section 5. And finally, in Section 6 we discuss the management insights of our model and provide some research directions for further study in this field.

2. Literature review

Two distinct streams of related literature should be considered, pricing strategy in service industries (especially the tourism and hospitality industry) and market segmentation.

2.1. Dynamic pricing strategy

Pricing strategy is a critical topic among academic research. As the pioneer theoretical contribution in the hospitality industry, Gu (1997) suggests that the hotels should use a quadratic room pricing model rather than the \$1 per \$1000 approach and the Hubbart Formula, which are the two traditional well-known cost approaches. Along with his work, more and more researchers work on the pricing problem about hotel rooms. For instance, Lai and Ng (2005) study the optimal pricing model in the circumstances of uncertainty. Pan (2007) analyzes the influence of market demand and hotel capacity on the optimal pricing strategy. As an efficient marketing policy, van der Rest and Harris (2008) prove that discount is the best pricing policy for hotels in some cases like the demand has rigid changes. Ling et al. (2012) propose an optimal pricing model for the hotels with long-term stay service. Guo and He (2012) study the pricing decisions when hotel room plays as a part of travel package.

In the cooperation relationship with other organizations, the online pricing issue about hotel rooms has been paid enough attentions in recent years. Ling et al. (2011) provide an optimal pricing strategy for small or medium sized hotels in the cooperation with third-party websites or online travel agencies based on

a Stackelberg game model. Afterwards, Guo et al. (2013) study the cooperation contract between hotels and third party website from the pricing perspective through a network consists of multi hotels and single website. All the above studies identify that pricing is one of the most important strategy of hotel management.

Hotels face the problem that rooms have high fixed cost and low variable cost, and what's more, the unsold rooms remain zero salvage value. Therefore, in order to gain maximal revenue, hotels have strong incentive to sell all the rooms out by the target day. As a pioneer work on dynamic pricing, Gallego and van Ryzin (1994) provide an optimal dynamic pricing model for the problem of selling a given stock of items by a deadline. They formulate this problem using intensity control and obtain structural monotonicity results for the optimal price as a function of the stock level and length of the horizon, and finally, they give useful insights to the retailers selling fashion and seasonal goods as well as the managers of the travel and leisure industry, especially the hotels and airlines. Burger and Fuchs (2005) also point out that dynamic pricing would be a future business model of airlines, which has the same product feature with hotels. Following Gallego and van Ryzin's work, numerous papers about dynamic pricing under different scenarios were published, for instance, multiple products (Bertsimas and de Boer, 2005; Gallego and Ryzin, 1997), multi-generation products (Kuo and Huang, 2012), stochastic demand (Zhao and Zheng, 2000), inventory control (Adida and Perakis, 2010; Bertsimas and de Boer, 2005; Chen and Simchi-Levi, 2004), revenue management (Gallego and Ryzin, 1997; MacDonald and Rasmussen, 2010; Tsai and Hung, 2009), and even strategic consumers (Bansal and Maglaras, 2009; Dasu and Tong, 2010; Kuo et al., 2011; Levin et al., 2009, 2010; Levina et al., 2009; Nasiry and Popescu, 2011). In their models, the price is formulated as a function of the inventory level and length of the horizon, that is to say, the optimal price will be changed every minute or even every second. However, in practice of the online reservation systems of hotels, we notice that the room price for a target day is not changed every day; it often keeps stable for some days. This is a result of two factors which are overlooked in the models of the above literatures, (1) the demand rate of hotel rooms is different along with the time closing to the target date, and (2) hotels must undertake an operational cost of the dynamic pricing policy. And in practice, these two factors are important elements which influence the pricing decisions in many industries, especially the service industries. In order to fill this gap, we introduce a new dynamic pricing model considering the operational cost and dynamic demand for service products sold on the Internet through online reservation systems.

2.2. B2C E-commerce and market segmentation

As an efficient policy, market segmentation is adopted widely in the pricing (and revenue) management both in practice and in academic research. Thus, there are more and more researchers work on this issue, in particular with the rapid development of the business-to-consumer e-commerce. Yelkur and DaCosta (2001) study the differential pricing for hotel services sold on the Internet, and find that hotels are able to take advantage of differential pricing for various segments, thanks for the fact of that the market for hotels can be divided into narrow consumer segments. Taking airline as an example, Toh and Raven (2003) outline the essentials of perishable asset revenue management, and find that market segmentation based on price discrimination is a good choice for the managers of perishable products. Guo et al. (2009) prove this viewpoint through providing a mathematical model of market segmentation application in the airline industry, they build a dynamic model for the electronic airplane ticket through sorting them into multi-class according to different demands of passengers in different seasons.

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