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Peng Liu Ph.D.
Cornell University, pl333@cornell.edu

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Peng (Peter) Liu

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Cornell University
School of Hotel Administration

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Even with many decades of experience with booking and reservations, managers in the hotel industry still face substantial challenges predicting future room demand. Using a general equilibrium approach, this paper provides a new reservation pricing method. By establishing a price for the reservation that is based on the traveler's best estimate of whether she will actually occupy the room, the hotelier gains information about how likely it is that the room will be sold. The price of the reservation increases as the traveler's certainty of travel increases. At the same time, the room rate decreases according to likelihood that the traveler will actually occupy that room. This approach therefore provides a mechanism by which hotel managers can obtain more accurate information regarding future room demand and potential guests can gain a more favorable rate in exchange for revealing the critical information regarding their trip. With this information, the hotel can focus its revenue management system more sharply and does not have to rely solely on historic ratios to predict room occupancy.

1. Introduction

The service industry has long used reservations as a sales technique, with the idea that once a user has booked a service (e.g., a hotel room, flight ticket) for a particular date, that service has a high certainty of being sold. Current practices pertaining to the reservation method vary among different businesses. Airlines and theaters require advance purchase of tickets, and many of these tickets are non-refundable or charge a significant penalty for modification or cancellation. Most restaurants and car-rental companies charge no penalty for no-show reservations. However, a majority of hotels and motels offer free reservations, subject to a 24-hour cancellation rule.[2]

The importance of reservation systems to the lodging industry is shown first by Westin's development of the *Hoteltype* reservation system in 1947and by the development of the Inter-Hilton Hotel Reservation System in 1948, which allowed guests to telephone for immediate confirmation of availability (albeit two months in advance), (see Ahla.com, 2011; Hilton.com, 2011). Computer-based reservations entered the picture in the late 1950s and 1960s. Sheraton developed an automated electronic reservation system in 1958, and Holidex operated on mainframe computers in the 1960s to allow Holiday Inn guests to reserve a room without a

[1] Please address comments to Peng Liu, 465 Statler Hall, Ithaca NY 14853, pl333@cornell.edu (Tel:) 607-2566818.
[2] A potential customer can book a hotel room any time before the specified date of stay with no charge as long as there is availability. She can cancel the reservation without penalty 24 hours before the specified date. A one day room rate will be charged if the customer cancels the reservation after the deadline has past.

phone call. Choice Hotels is credited as the first chain to offer real-time reservations on its website (Ahla.com, 2011, choicehotels.com, 2011). Thus, we see that a reservation system is a core operating feature of hotel chains and referral systems.

However, even with many decades of experience with booking and reservation, managers in hotel, airline, rental car, and other service industries still face substantial challenges. With regard to cancellations and no shows, Smith 1992 documents that the combination of cancellations and no-shows involve 50 percent of American Airlines reservations and cancellation rates of 30 percent or more are not uncommon today for airlines. Marcus and Anderson 2006 report that the car rental industry has cancellation rates in the range of 20 to 30 percent. As hospitality operators seek to offset this toll by overbooking, their policies, however, are imperfect and often leave travelers and guests unsatisfied. Numerous other studies (e.g., Liberman and Yechiali 1978, Rothstein 1974, 1985, and Bitran and Gilbert 1996, among others) have documented the problems in hospitality demand management resulting from reservation cancellation and overbooking practices. The major reason for such dissatisfaction is related to the difficulty of predicting future demand in the hospitality industry.

Understanding the guest's potential demand dynamics is crucial for service operators. Taking the example of a hotel, to cover the hotel's significant fixed costs, the hotel needs at least a certain portion of rooms occupied by the guests. On the other hand, due to fixed capacity, the hotel cannot necessarily satisfy all booking requests. If the hotel uses its historical cancellation and no-show information to overbook the property, any guests who are subsequently not accommodated will be dissatisfied, to say the least. Therefore, obtaining precise information regarding what percentage of reservations will be honored by the guests is important and valuable to the provider. Current practice of estimating future room demand based on historical booking information has become more and more inefficient due to market competition, complexity of distributional channels, price transparency, and communication convenience. The inefficiency of current demand management tools has been intensified by the recent financial crisis (Kosova and Enz 2012) when budget concerns and travel uncertainty due to business needs have expanded. The hospitality industry calls for new approaches that can do a better job predicting service demand while simultaneously providing enough incentives to attract customers (Kimes 2010, Cross, Higbie and Cross 2009). In this paper, I propose a new reservation method that could provide hoteliers more accurate prediction of future demand. As the distinctive feature, this approach is forward-looking.

The reservation to occupy a hotel room for a particular night is valuable to both the potential guest and the hotel. For the guest, a reservation is the promise of a room on a certain date at a certain price. That said, under current practice, the guest in most cases can cancel that reservation without penalty in accordance with the hotel's policies. In effect, the hotel has granted the guest a future option with regard to a room, but only the guest knows the likelihood that the room will actually be occupied. Reservations are important to hotel operators in many ways. The quantity of reservations gives a hotel operator valuable information about potential demand, so that the operator can plan ahead to achieve the best capacity utilization. With predicted future room demand, the hotel can apply yield management tools to adjust the hotel rate with a goal of achieving higher revenue. Such yield management tools include marketing initiatives, promotion campaigns, and selling to a third party agency such as Priceline or Travelocity.

In contrast to earlier eras, access to the internet and hotels' real-time inventory allows guests to make a reservation and then continue to search for a lower price accommodation. A study by Thompson and Failmezger 2005 found numerous price disparities among various reservation channels, which would abet such search practices. While hotel chains may have made progress on price consistency, the key point here is that reservations usually price both the right and benefit of a reservation as a bundle. In this regard, the value of a reservation is contained in the price of the service product. In contrast to this practice, Quan 2002 and Carvell and Quan 2008 argued that a reservation is, in fact, a valuable option, which should be priced separately from the service.[3] They show that for price-sensitive customers hotel reservations are analogous to financial call option contracts written by the hotel and given to the guests.

However, the above mentioned reservation pricing method does not determine the value of a reservation from the standpoint of the provider's profit function or from the consumer's utility function, which is what the economists call "*a partial equilibrium.*" This paper fills the gap in the literature and prices the reservation option using the "*general equilibrium approach*,"

[3] Quan 2002 argues that *"reservations can provide a form of price insurance which consumers can use to "lock in" a price for the future delivery of the service. When there is future price uncertainty, such a commitment is costly to reservation issuers."* Carvell and Quan (2008) extend the option pricing methodology and value some exotic reservations.

in which I jointly solve the maximization problems of both the provider and the guest. I further compare the differences between the partial equilibrium and general equilibrium approach in section 2. For convenience of presentation, I perform the analysis and give examples in the context of the lodging industry with the transient segment as the target customers. With modifications, however, the pricing methodology and analytical results are applicable to other segments and other service industries as well. Section 3 discusses such applications and provides some managerial implications.

2. The Value of a Hotel Reservation – A General Equilibrium View

To demonstrate the necessity and benefit of the general equilibrium approach to hotel reservations, let us first examine the limitations of the partial equilibrium method. The partial equilibrium studies consider a group of travelers who are indifferent with respect to which hotel they book. They consider a market with numerous commoditized hotels each offering rooms of comparable utility. The reservation in such a model is similar to a financial option. With a room reservation in hand at a known rate, the guest obtains the right to search for cheaper hotels in the same destination. In fact, an important result of the partial equilibrium approach, as Quan 2002 stated, is that "*if all future rates are perfectly predictable, or that there is no unpredictable component to future prices, the reservation option has no value.*" This is contradictory to the industry wisdom: Even though the service rate is fixed or the volatility of the room rate is zero, the value of reservation should still be positive, because providers still find the reservations valuable for services scheduling.[4]

Table 1 distinguishes in detail the general equilibrium approach from partial equilibrium approach to hotel reservations. In contrast to the partial equilibrium perspective, which claims that reservation is pure cost for the provider, a general equilibrium approach views that price of a reservation and price of a hotel room are jointly determined by the market where providers and guests maximize their respective utilities.[5]

[Insert Table 1 around here]

[4] In finance literature, we know that the standard option pricing formula developed for financial assets (e.g., Black and Scholes) is not appropriate for pricing the perishable goods and services. Because one cannot re-sell or sell short the hotel rooms and other service products the same way as to common stocks and other financial assets.

[5] In economics, utility is a representation of preferences over some set of goods and services.

The general equilibrium approach for a hotel reservation mechanism proposed in this article generates a positive reservation price even if the hotel rate does not change. I show that the limited availability of hotel rooms and the uncertainty of whether the traveler will actually need to occupy the room are the key components to valuing the reservation, factors which are especially relevant to transient travelers with some level of budget concerns. This model takes these two factors into account: travelers have a certain level of concern that the resource (i.e., the hotel room) will not be available when they need it, but they also have a certain level of uncertainty that they actually will occupy the reserved room. Under the general equilibrium approach, the reservation option is priced by jointly solving the utility maximization problems of both a potential guest and the provider. Unlike a partial equilibrium approach, which yields a unique solution from the Black-Scholes option pricing model, the general equilibrium approach provides a range of prices that satisfy the following two conditions: (1) to achieve the profit maximization for the service provider (the hotel); and at the same time (2) to provide sufficient incentives for customers to use this method. While the solution is not unique, within a narrow range, the hotel manager can provide a pricing scheme based on her pricing power and market strategies.

2.1 The Theoretical Framework

Assume every guest has a constant but different private value v_i of staying in a hotel on a particular future date T. At the present date t=0, the probability that the guest needs the hotel room at T is p_i. The demand distribution is characterized by a probability density function $f(p; v)$. Each day before date T, potential guests are given a menu of prices for the hotel services. The hotel service price has two components: a non-refundable reservation price, r, to be paid at reservation date t=0 and a hotel room rate, h, to be paid at check-in date T, if and only if she consumes the hotel service at T.[6] Therefore if the guest shows up at T, her total hotel expense is $r+h$; while she will lose r if she changes her mind and does not occupy the hotel room at T. Therefore, the expected revenue the hotel receives from each guest is $r+hp_i$. Since only the guest (not the service provider) knows private value and travel likelihood, I call the combination (v_i, p_i) at date 0 private information. The consumer makes her reservation by selecting the reservation price-room rate pair, (r, h). Any date before date T, the price schedule is subject to change and

[6] Note that both r and h are functions of t and T, suggesting that for a given consumer demand probability p_i, the room rate and reservation fee depend on check-in date as well as when she makes the reservation.

the guest can update her probability of occupying the room, by changing the reservation and paying the corresponding fees. The pricing schemes are determined by the monopoly provider (i.e., the hotel) who aggregates all information from potential guests. To emphasize the importance of reservation pricing, let's focus for now on the case that each client knows her probability of service needs when she makes the reservation. To highlight the importance of demand uncertainty (rather than hotel rate uncertainty), we assume the room rate does not change during the period between the reservation and check-in date.

The guest maximizes her expected utility over consumer surplus by reporting a consumption probability q_{it} at any time before check-in date T, subject to her constraints.

$$\max_{q_{it}} \; E\sum_{t=0}^{T}\left\{p_{it}v_{it} - \left[r_t\left(q_{it}\right) + p_{it}h_t\left(q_{it}\right)\right]\right\} \tag{1}$$

$$\textit{subject to } r_t\left(q_{it}\right) + p_{it}h_t\left(q_{it}\right) \le p_{it}v_{it} \textit{ for } \forall t \in \left[0,T\right] \tag{2}$$

The guest's consumer surplus is the difference between the expected utility of consuming the hotel service using the guest's true probability (p_{it}), $p_{it}v_{it}$ and the expected total expense she selected at the reservation based on her reported travel probability (q_{it}), $\left[r_t\left(q_{it}\right) + p_{it}h_t\left(q_{it}\right)\right]$, provided that the expected consumer surplus is non-negative. The reported likelihood of business need is equivalent to choosing an *r-h* pair offered by the hotel, which is a function of q_{it}.

The provider's problem is illustrated as follows: The hotel maximizes the sum of expected potential guests' revenue subject to its capacity constraint *C*. For the purpose of this example, assume there is a monopoly hotel provider in this market.[7] With modifications, my model can be generalized to the setting with other market structures.

$$\max_{r,h} E\int\int\left\{\sum_{t=0}^{T}\left[r_t\left(q_{it}\right) + p_{it}h_t\left(q_{it}\right)\right] + \pi\left(I_{q_{it}=p_{it}}\right)\right\} f\left(p,v\right)\, dpdv \tag{3}$$

$$\textit{subject to } \iint f\left(p,v\right) dpdv \le C \tag{4}$$

where *f(p,v)* is demand distribution from potential guests and $\pi\left(I_{q_{it}=p_{it}}\right)$ is the benefit of improved operational management. $I_{q_{it}=p_{it}}$ is an indicator function, which equals one if the hotel obtains the consumer's private travel probability via this reservation method. In other words, the

[7] Unique location and specific service quality always give the hotel a monopoly power. One could also assume that all other hotels are fully booked and this is the only property with availability.

information benefit $\pi(I)$ is positive if and only if the customer reports the true travel probability, i.e., $q_{it}=p_{it}$. The benefit can be regarded as the implicit value of obtaining the true information about guests' check-in probability from their reservations.[8] With accurate future demand information, the hotel can better manage room inventory and adjust (potentially increase) the room rate to reflect current demand. The dynamic nature of room rate (similar to airlines) will reinforce the necessity of using this reservation method, because the benefit of doing so has increased. Additionally, the hotel can adjust marketing and promotion intensities according to the revealed demand information. The above proposed method will be more attractive than the typical overbooking practice using historical booking and cancellation information. Therefore, this method will provide the most price integrity and lead to better customer satisfaction.

2.2 An Illustration of the General Equilibrium Results

A general equilibrium is solved by jointly maximizing the functions (1) and (3) above. Instead of formally deriving the equilibrium solution, I describe the common features of the results. In addition, a numerical example is provided to offer the implications. Let's look at a concrete example of a consumer's travel plan, Amy. Table 2 lays out Amy's business decision and hotel reservation timeline.

[Insert Table 2 around here]

Assume that, on January 1, 2013, Amy is planning a business trip to the New York City and will stay one night on June 1, 2013. However, the trip (thus the need for a hotel room) depends on whether her business proposal is selected by her client, who will not decide until April 1, 2013. According to past bidding experience, the likelihood that the guest's proposal is selected is only about 10 percent. Once the proposal is chosen, though, Amy will need to make the trip and stay in the chosen hotel on June 1, 2013. Amy is concerned that there will be no available rooms (or the price will be too high) if she waits until April 1, 2013, to book the room, when the likelihood of travel is more certain.

Table 3 provides a pricing scheme (*r*-*h* pairs) that satisfies the general equilibrium equations (1) – (4) and provides an incentive for Amy to book on January 1, 2013, for her

[8] Since each hotel may have a different value function, the information benefit varies. Therefore, the benefit function in equation (3) is generally specified.

potential hotel need on June 1, 2013. Even though the travel probability is small (10 percent) in January, there is a benefit to lock in a hotel rate early to secure a room and then update the likelihood later, on April 1, 2013, when the travel need becomes certain. In the example, the room rate with a free reservation is $200 for the specified date, and the lowest non-refundable rate is $50 for the same room. If only the two choices in the shaded columns in Table 3 are available (which is current practice by most hotels), Amy is not offered any discount for booking the room early, and she will probably do one of the following. Amy can either wait until she is relatively certain of her trip to make a non-refundable reservation (probably on April 1, or even closer to the check-in date), because Amy has only a 10-percent estimated probability. Or alternatively, if Amy is concerned about room availability on June 1, 2013 (e.g., peak season in that market), she can initiate a regular reservation, which allows her pay nothing up front to secure a room at $200. Amy can cancel the reservation if her business proposal is turned down. However, as long as she can cancel it before May 31, 2013, there is no charge. Therefore, Amy has no incentive to cancel it early, even though she will know the travel need on April 1. Either way, the traditional reservation option fails to provide the hotel manager accurate information about Amy's likelihood of arrival. Let's now add the availability of reservation plans as demonstrated in the unshaded columns in Table 3 by which Amy can book early at a reduced rate and pay $1 for the reservation based on 10-percent probability. If Amy finds out that she does not need the hotel room, she loses only $1. However, if she takes the trip and stays in the hotel, she pays the lower room tariff of $180. Therefore, her total cost is $181 (disregarding any issues surrounding the time value of money). The reservation approach also allows Amy to update her probability later and in the case of increased travel probability, and enjoy a total cost as low as $51.

[Insert Table 3 around here]

This pricing scheme is optimal for both parties. Guests are rewarded for reporting their true travel probabilities by choosing the *r*-*h* pairs, and the hotel gains the benefit of the guests' revealing their private information (regarding travel plans). In general, as demonstrated in Figure 1, the reservation price is an increasing function of demand probability. The greater the certainty that a guest will stay in the hotel, the higher the price she should pay for (the option of) a reservation, as this way the total cost of the combined reservation and hotel room rate is smaller. The room rate, on the other hand, is a decreasing function of demand probability. The higher the price paid by a guest for the reservation, the lower should be her room rate. Therefore, the combined cost is a decreasing function of demand probability.

[Insert Figure 1 around here]

2.3 The Economic Significance

The reservation strategy offered in this study can be also regarded as another way to segment customers based on their need and willingness to pay. The approach that I offer here is supported by the economics concept of price differentiation or price discrimination, which refers to the practice of charging different guests different prices for the same goods or services to maximize revenues. Let's compare the pricing scheme proposed in this study with the classic textbook illustration of price discrimination. Figures 2 compares the potential revenues generated from three methods. The horizontal axis is the hotel room rate, while the vertical axis is number of rooms demanded. Panels a and b demonstrate how using traditional rate fences can improve hotel revenue (see also Carroll 2011 and Hanks, Cross, and Noland 2002). When a hotel offers a single room rate (e.g., $100) for all transient travelers,[9] it only captures revenue of $5,000 (50 rooms x $100 per room), as shown in the shaded area of Figure 2-a. The white space in that graph represents unrealized revenues from those potential customers that are willing to pay more than $100 (uncollected willingness-to-pay) or are willing to pay less than $100 (and so don't book, leaving some rooms unfilled).

[Insert Figure 2-a and 2-b around here]

Figure 2-b illustrates the practice of using fences to distinguish potential customers. The hotel room rates can be classified (from the lowest to the highest) as discount rate, leisure tourist rate, corporate rate, business rate, and retail or premium rate. For simplicity, I assume the five rate fence categories separate the market equally with each demanding 20 rooms. When a hotel offers several room rates, the realized revenue in the Figure 2-b increases to $10,000 (20 x ($50+$75+$100+$125+$150)), which is double the captured revenue using a single rate. Intuitively, the white space representing forgone revenue is smaller in this graph.

The economics of demand and supply requires that hotels should utilize different rates to maximize profit or at least to cover the property's large fixed cost. Even though the rate fence strategy has received wide acceptance, hoteliers still face a challenge regarding how to

[9] The single room rate can vary according to bed type, service package, season or the day of the week, etc.

appropriately segment customers while improving price integrity. While rational ways of segmenting consumers such as fences and packages are conceptually easy to understand, implementing such pricing schemes crucially relies on the ability to identify a consumer's willingness to pay. Revenue managers use past behavior for this purpose, and must use historical data to infer consumers' current business needs. The approach presented in this article provides a way to identify consumers' needs by rewarding travelers who reveal their business needs and probability of travel. By submitting an *r-h* pair at the hotel reservation, the potential guest reveals her likelihood of travel at the time of booking. The rate selected naturally segments the market and displays customers' willingness to pay. Therefore, rates can be continuous or as fine as the operator wants to set them, while concurrently maintaining pricing integrity. Figure 2-c illustrates the revenue improvement by subdividing the market even further than typical current fences. The horizontal axis is the total room rate expense, which is determined by both the reservation price *r* and room rate at check-in *h*. The vertical axis going down is the probability of the hotel need that potential travelers need to select. The vertical axis going up shows the number of rooms demanded. For the convenience of presentation, I again assume the market is segmented equally by the probability that travel will occur. The realized revenue under this pricing approach will increase to $15,516 (12*($50+$60+$72+$85+$98+$112+$128+$145+ $162+$181+$200)), which is more than triple the captured revenue using a single rate. Intuitively, the white space in that graph is even smaller than in the first two.

[Insert Figure 2-c around here]

3. Managerial Implications

Although hotels and other service firms rarely charge guests expressly for the privilege of placing a reservation, they have already moved toward a system that accounts for guests' willingness to pay and likelihood of occupying the room. For example, rate fences, nonrefundable reservations, and other practices such as requiring a deposit for group businesses reflect a market awareness of such option value of a reservation. How do those industry practices relate to the pricing method proposed above? How might consumers react to the proposed pricing structure? In reality, is it likely that the business traveler will pay that much heed to the hotel rate anyway? Furthermore, how would one implement such a reservation scheme for hotels with complex distribution channels? When implementing the pricing strategy, what are the implications of the proposed approach for the architecture of revenue management system and under market competitions? These questions are answered in this section.

3.1 Relationship Between Current Industry Practice and the Proposed Method

A typical reservation offer from a New York hotel is shown in Figure 3. The webpage snapshot displays a hotel room search for a Sheraton Hotel in New York. The search for room availability of a check-in date of 10/1/2011 and for a specific bed type (1 queen bed) results in four matches with different room features (including a service package with parking and breakfast) and different cancellation policies. Clearly, these four hits show different products with different rates.

[Insert Figure 3 around Here]

The top two products – products 1 and 2, which are identical except for the cancellation policy, typify two products commonly used in the hospitality and service industry. Product 2 (with a room rate of $359.00) contains the traditional reservation terms. If the guest cancels before 6:00 PM local time on the night before arrival (that is, 09/30/2011), there is no penalty. If the guest cancels after 6:00 PM local time on 09/30/2011, however, the guest forfeits the cost of a one-night stay. Product 1 (with a room rate of $323.10), representing one example of a recent trend in hotel rate discounting, is an advance-purchase product similar to what has long been used by the airline industry. Although it is only about 10-percent cheaper than product 2, product 1 requires a nonrefundable, full prepayment at booking. Thus, this product does not allow for changes or cancellation. If the guest cancels the reservation, the forfeiture amount will be 100 percent of the amount paid.

The two reservation products described above can be regarded as the two extreme cases in the reservation pricing approach proposed in this paper. At one extreme, when the probability of the room being rented is almost zero the *r-h* pair values show that the reservation is free and the guests pay for hotel room only (perhaps a higher walk-in rate, if they do not end up canceling). At the other extreme, when the probability that the room will be sold equals one, the *r-h* pair shows this as a situation where guests make an advance purchase and pay the full amount at the time of the reservation (perhaps paying nothing or a much lower room rate in consideration that their reservation cannot be refunded). If hotels price products between those two extremes they can allow more flexibility for guests and a wider variety of room rates. By extending the common practices of the above two cases, the hotels are able to capture more potential guests, especially those whose likelihood of using the service is small. More importantly, by aggregating the potential room demand for a give date, the hoteliers can focus its revenue management system more sharply and do not have to rely solely on historic ratios for room occupancy.

3.2 Customer Perception and Implementation under Multi-distribution Channels

More than ever before, hotel customers embrace innovations. Smartphone apps and online search and booking make reservations fast and convenient. The concept of paying a fee to gain value in conjunction with a reservation is no longer as alien as it was ten years ago. Due to this method's financial incentives (significant room rate discount by various travel probabilities) and modification flexibilities, consumers should welcome this paper's proposed reservation method as well. Nowadays, consumers have become used to dynamic changes in prices and yield management innovations, primarily in the airline industry. A recent example of an option-like reservation is FareLock introduced by Continental Airlines in 2010. (United Airlines has continued this practice following its merger with Continental.) For a non-refundable fee, FareLock service guarantees the itinerary and fare for 72 hours or 7 days depending on how much the consumer pays for the reservation option. I would expect that consumers would not resist such an innovation if it is introduced into hotel industry.

The reservation approach introduced in section 2 demonstrates how the method works in a controlled scenario in the transient segment. Hotel markets are competitive and complex, filled with third-party distributors and online travel agents (OTAs). Hotels have been actively involved in multi-channel distribution using a combination of traditional and electronic channels such as Expedia, Travelocity, Priceline, Orbitz, and Hotwire (Thompson and Failmezger 2005, Kimes and Kies 2012). PhoCusWright reports that the room revenue booked online has been increasing steadily since 1998, and reached 30 percent in 2010 (Carroll 2011). The industry has long recognized the complexity and inter-relationships among multi-distribution channels and other hotel segments. It has attracted a lot of attention in the academic literature as well. Anderson 2011, 2009, Kimes and Kies 2012, Enz, Canina and Noone 2012 are good sources of this type of research.

The proposed reservation pricing approach works well in competitive markets. Essentially the two corner prices (non-refundable room rate and free reservation rate) are determined by the market's competitive forces. The hotel operator using the reservation pricing method can charge the same price as its competitors for the two corner scenarios. Additionally, the hotel can offer more prices in between, which will attract more consumers thus potentially increase its market share. An important advantage of the proposed pricing method is that the hotel operator can set its own prices in a sliding scale according its pricing power and marketing strategy while preserving its competitive position against existing rivals.

The reservation pricing strategy also works well with OTAs and other third-party intermediaries. In fact, I would argue it would be easier for OTAs and third parties to adapt this new pricing tool, because OTAs have a clear business model and often lead service innovations. Recall that in the model, three basic input parameters are necessary to implement the proposed reservation method: number of rooms (capacity), non-refundable rate (price 1), and free reservation rate (price 2). For a third-party agent, the capacity can be the total number of rooms under management, while price 1 can be determined as the cost of acquiring the inventory or carrying cost, and price 2 will be the cost plus some desirable profit margin depending on each agent.

4. Conclusion

Widely used in the hospitality and other service industries, a reservation as an option secures the availability of the service and grants the purchaser the right to search lower-price alternatives. However, by issuing the reservation option, the service provider obtains valuable information about the consumers' demand, which in turn helps to improve the provider's revenue management. The price of a reservation under the general equilibrium framework developed in this paper is determined jointly by maximizing the utilities of the potential user and the service provider. Using hotel reservations as an example, I show that if a reservation is priced separately, the guest can pay for the right to gain a lower room rate, while the hotel gains an indication of the guest's knowledge regarding whether the room will actually be occupied.

A key distinguishing feature of the general equilibrium reservation pricing approach is that it considers the uncertainty of whether the traveler will actually need to occupy the room. Two common reservation patterns currently used in the lodging industry represent the two extreme cases of reservation pricing approach proposed in this paper. The reservation that may be freely canceled carries a reservation charge of zero, while the non-refundable purchase effectively represents a fully prepaid reservation. By the same token, the guest has effectively indicated a 100-percent probability that the room will be occupied. The reservation pricing method proposed in the study expands the spectrum from the two extreme cases and aggregates the guests' private information regarding lodging demand.

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Table 1: Comparison of general equilibrium and partial equilibrium approach to hotel reservation

	General Equilibrium Approach (This Study)	**Partial Equilibrium Approach** (Quan 2002, Carvel and Quan 2010)
Pricing Method	The value of reservation is priced separately from hotel room rate as a *real* option	The value of reservation is priced separately from hotel room rate as a *financial* option
Room Rate	Jointly determined with reservation price	Exogenously given
Value to the Hotelier	Obtain valuable information about true probability of consumer needs. Hotelier can change room rate according to real time inventory and adjust marketing and promotion strategies	Reservation options are issued at the provider's cost. The value is computed based on the customer's right to search for lower hotel rates
Value to the Guests	Financially rewarded for revealing true probability of hotel demand and flexible in revising the probability	Lock in a price and obtain a right to search for cheaper room rates
Benefit to Guests with Small Demand Probability	Encouraging guests with small demand probability	No difference in terms of guest demand probabilities
Impact of Room Rate Volatility	The reservation value is still positive even if the room rate does not change	No value if room rate does not change (zero volatility)
Uniqueness of Reservation Value	Non-unique value Reservation value is priced in a narrow range under the general equilibrium. The hotelier determines the reservation fee structure based on the provider's pricing power and marketing strategy	Unique value which is determined by Black-Scholes option pricing model

Table 2: Time table of hypothetical consumer – Amy's business need and hotel reservation plan

Time Line	**t = 0**	**t = 1**	**t = T**
Example	**January 1, 2013**	**April 1, 2013**	**June 1, 2013**
Business Scenario or Travel Need	Submit a business proposal. The need for a hotel room is uncertain.	A decision regarding the proposal is made. The need for a hotel room is clear or the likelihood of travel evolves.	A trip is made and the guest checks in the hotel, if travel is necessary.
Reservation Schedule	Make a reservation with a non-refundable ***r*** according to probability of business needs	Revise the reservation with updated probability	Pay room rate ***h*** at the check-in

Table 3: A numerical example of reservation pricing scheme

Probability of Business Needs	Close to 0	10%	20%	30%	40%	50%	60%	70%	80%	90%	Almost 100%
Reservation Price (Pay at t=0)	$0	$1	$2	$5	$8	$12	$18	$25	$32	$40	$50
Hotel Room Rate (Pay at t=1)	$200	$180	$160	$140	$120	$100	$80	$60	$40	$20	$0
Total Cost if Guest Checks-In (Ignore Interest and Payment Timing)	$200	$181	$162	$145	$128	$112	$98	$85	$72	$60	$50
Analogy to Current Practices of Hotel Reservation	Free Reservation: 24-hr Cancellation Rule										Advanced Purchase: Fully prepay, no change allowed

Figure 1: Fee Structure

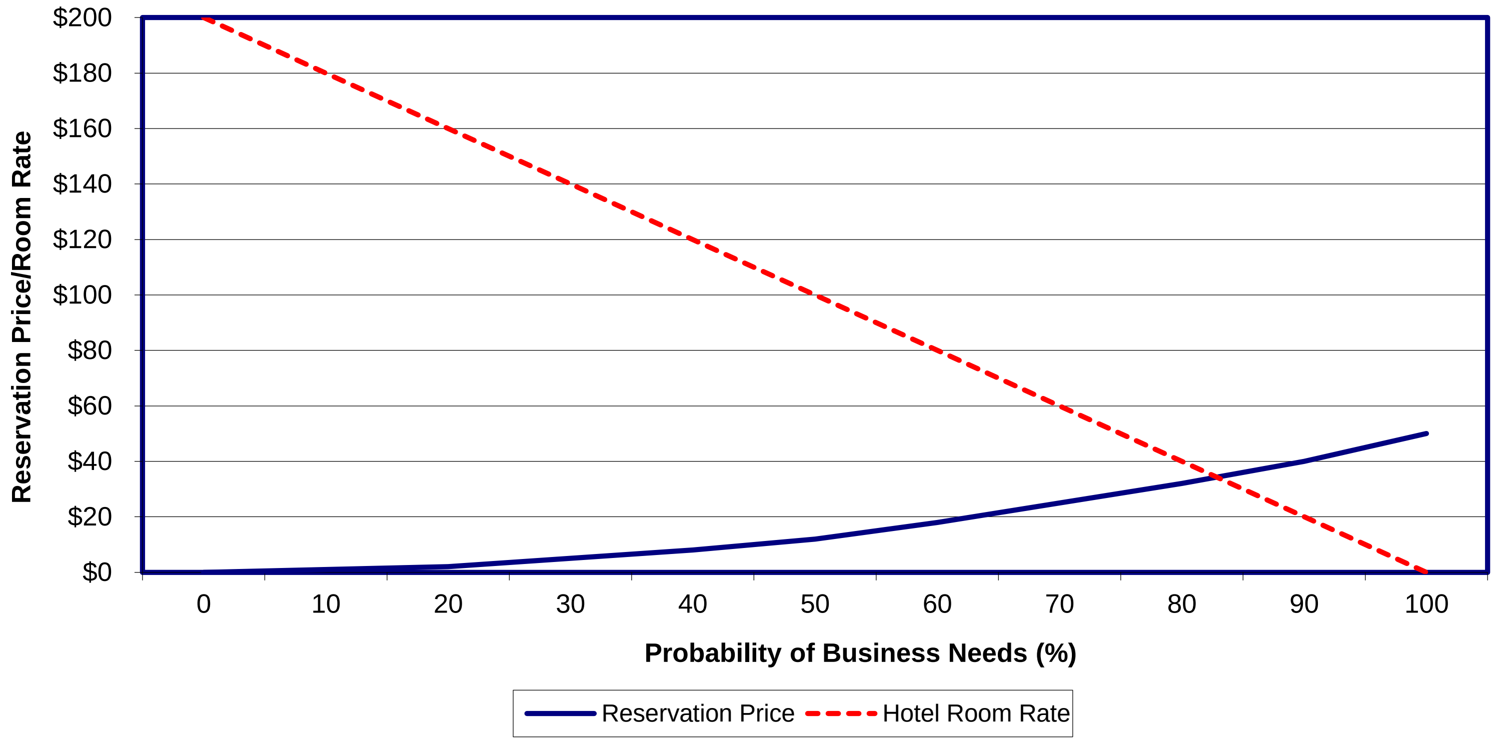

Figure 2-a Revenue expectations from single rate

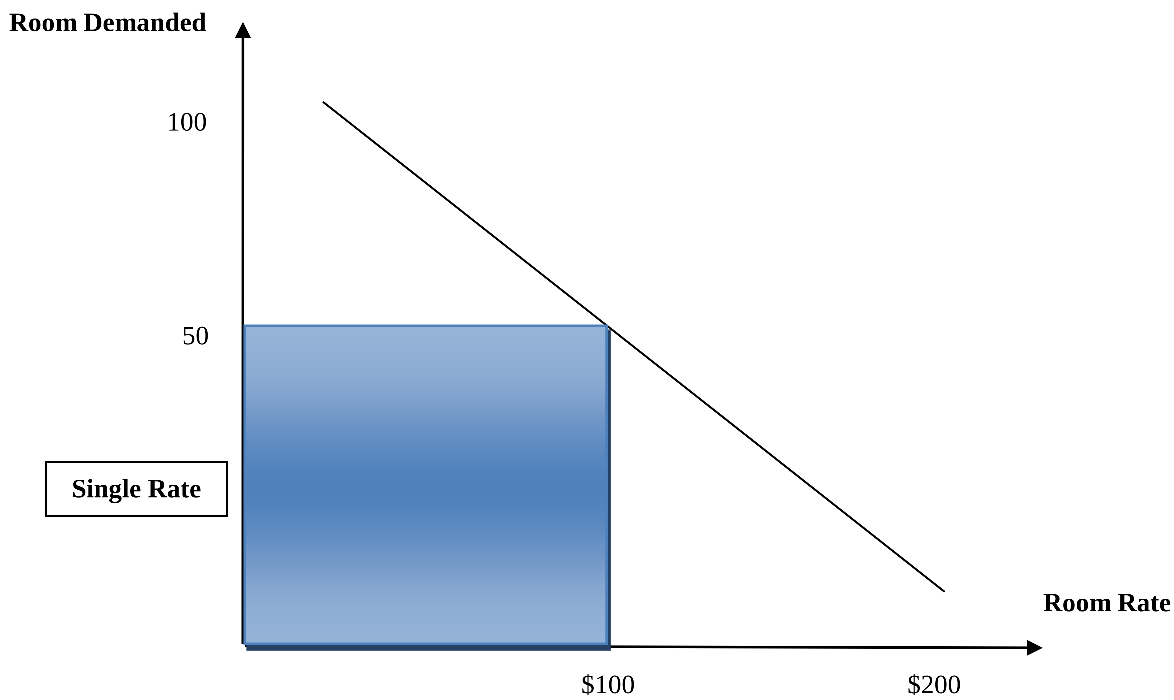

Figure 2-b Revenue expectations from rate fences

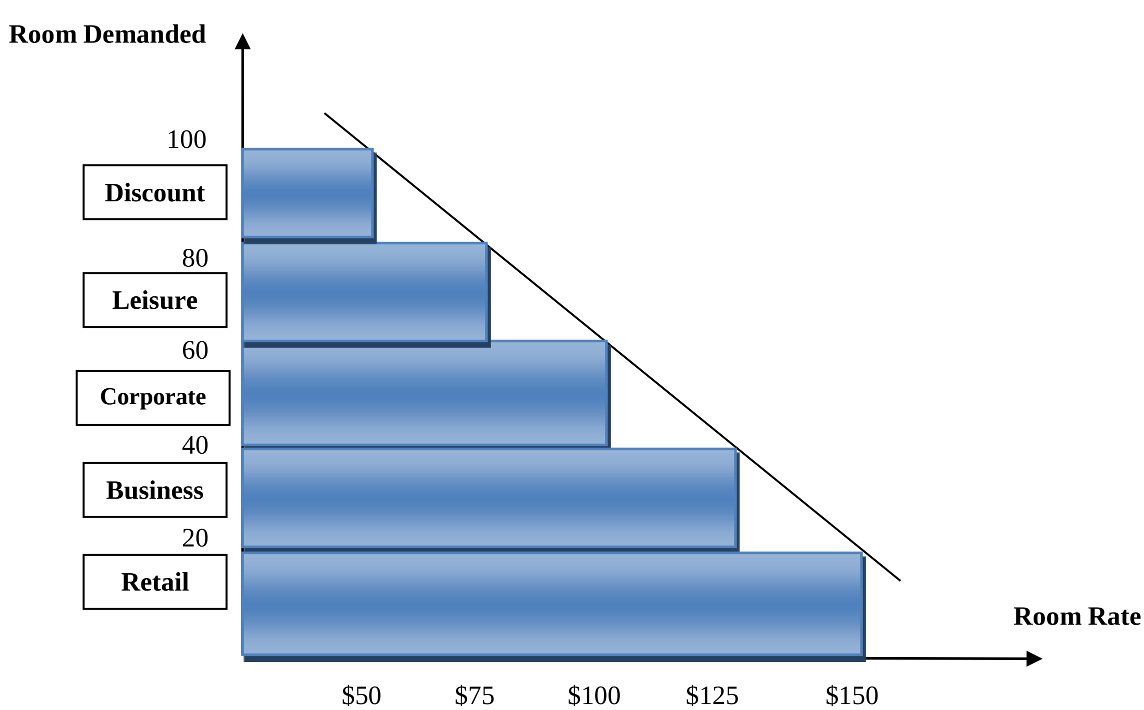

Figure 2-c Revenue expectations from general equilibrium approach

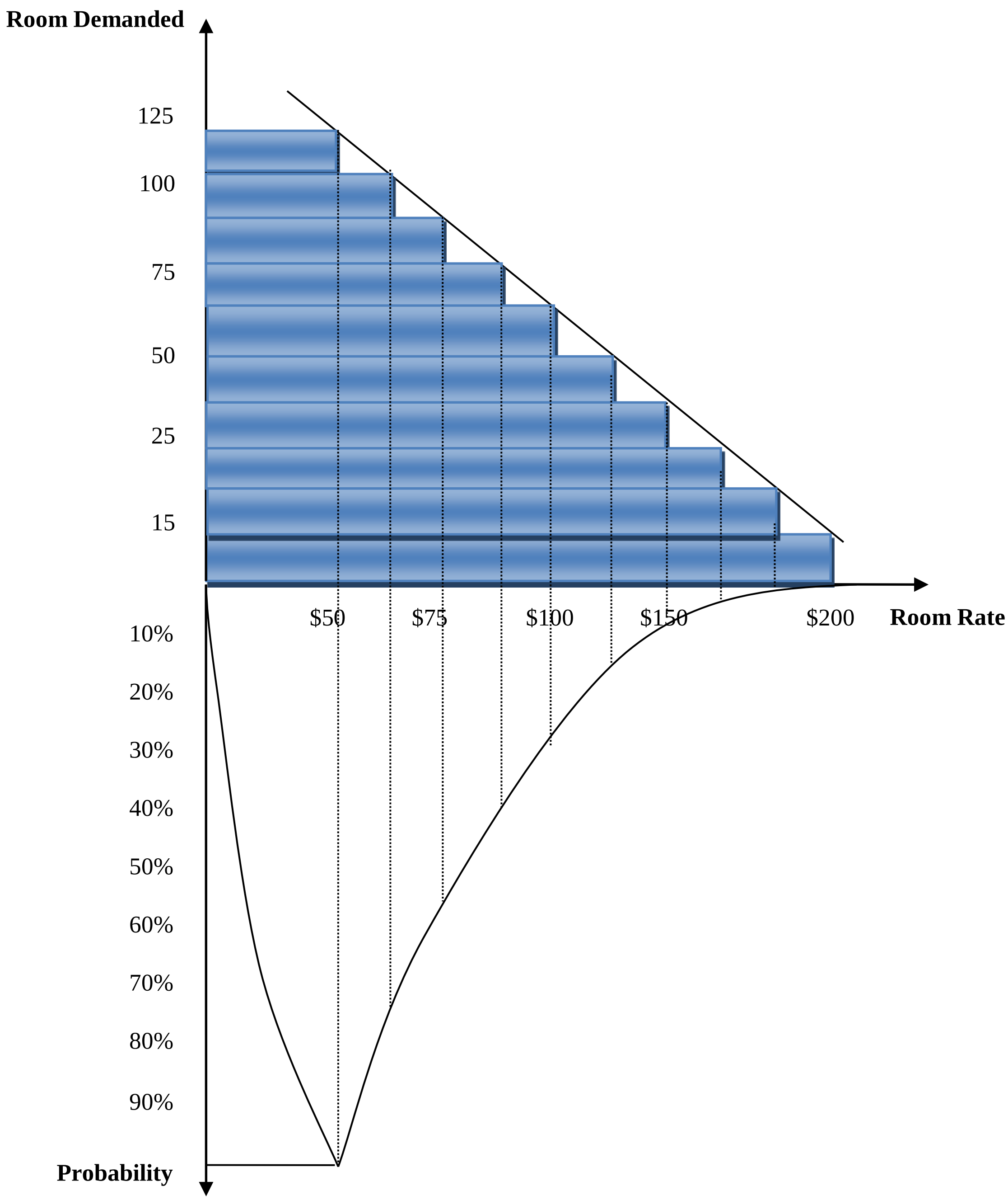

Figure 3 An example of current hotel room rate and reservation practice