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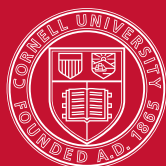


## Making the Most of Priceline's Name-Your-Own-Price Channel

### Cornell Hospitality Report

Vol. 10, No. 13, September 2010

by Chris K. Anderson, Ph.D., and Radium Yan



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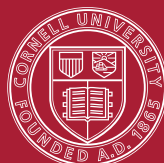
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## EXECUTIVE SUMMARY

**A**s part of their room sales strategy, many hotels make rooms available at reduced rates through such websites as Priceline.com. Priceline's Name-Your-Own-Price application allows consumers to bid on hotel rooms with certain specifications, including that the consumer does not know what hotels have placed rooms in the Priceline system. While this approach fills rooms, it also creates challenges for the hotels regarding how much to charge, because Priceline creates a screen between the hotel and its customers. The hotelier is faced with a decision about what price to charge, because the hotel will sell the room only if it is priced sufficiently below the customer's bid. Using the calculations shown in this report, hoteliers can use Priceline's reports to determine what is the best price to offer through Priceline. Priceline provides reports on bids received, which allows this analysis. A field test of this method on a large convention hotel in 2010 recorded a 24-percent increase in Priceline-associated revenue. A sample of the spreadsheet calculations shows how this optimizing approach works.

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## ABOUT THE AUTHORS



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**Radium Yan** is a Certified Hospitality Revenue Manager by AH&LA (sy439@cornell.edu). She holds a Master of Management in Hospitality degree from Cornell University School of Hotel Administration and a Bachelor's degree in Hospitality Management from Switzerland. She worked six years in the hotel industry in Switzerland and the U.S. with a focus on sales and revenue management. She currently works at InterContinental Hotels Group's America's headquarters, where her responsibilities include asset renovations and financial modeling.

*The findings and opinions expressed in this article are solely those of the authors, and do not represent the position or opinion of InterContinental Hotels Group.*



# Making the Most of Priceline's Name-Your-Own-Price Channel

by Chris K. Anderson and Radium Yan

**O**paque online travel agents, which we call opaque OTAs, have recently become an integral part of many hotel properties' distribution strategy. To clear excess inventory, hotels sell rooms at reduced rates via OTAs, hoping to reach price sensitive customers, while simultaneously selling rooms at "normal" rates to regular brand loyal customers via their traditional channels, including their own websites. In this report we outline a simple model for setting multiple prices and booking limits at Priceline. Our simple-to-use spreadsheet model utilizes the daily bid reports Priceline provides hotels. The spreadsheet accompanies this report, or we can supply it to anyone who is interested.

This paper is an extension of two earlier Cornell Hospitality Reports from the Center for Hospitality Research (CHR). One of those reports, *Setting Room Rates on Priceline*, provides an introduction to the type of data Priceline provides properties and explains how to use the information on Priceline's reports to set a single price that will at the same time fill a room and obtain a reasonably decent rate. The other report, *Setting Prices on Priceline*, shows how the calculations would work for setting multiple prices on Priceline. Needless to say, that involves considerable complex mathematics. For this report, we have done the mathematics for you. We outline a simple-to-implement model—easily set up in a spreadsheet—which approximates the complex model outlined in *Setting Prices on Priceline*. We illustrate our model with data from a large convention hotel. When we tested the model empirically against the property's existing approach, we found that the model provides this hotel a 24-percent increase in revenue received from Priceline (not total revenue) over a two-week test period. It does this by improving the room allocation while not reducing prices on Priceline.

### Priceline's Name-Your-Own-Price Program

Just as a starting point to this discussion, customers looking to acquire services through Priceline's Name-Your-Own-Price (NYOP) mechanism submit bids or offer prices for service without knowing the actual service provider. Using hotels as an example, say that a customer submits a price for an overnight stay arriving November 1 for a 4-star hotel in Midtown Manhattan. Priceline then determines whether that offer can be met. If the offer is declined, the customer can alter the bid by changing an attribute of the hotel, say, changing the 4-star to a 3-star, or changing Midtown to Times Square, or else the customer can change the arrival date. The customer can also wait 24 hours and submit the identical bid on the 4-star in Midtown.

Priceline's method of determining when a bid is accepted is unique and greatly favors the service provider. Following a customer's bid,  $p_c$ , Priceline creates a list of all  $n$  qualifying properties, in this case, all 4-star or better hotels in Midtown Manhattan. Priceline then randomly selects one of these qualifying properties. Note that each property has an equally likely probability of being selected. Priceline then checks the prices that the selected hotel has made available to Priceline. All prices are loaded into the Worldspan global distribution system, and properties are allowed to load multiple rates into Worldspan. If the selected property has loaded a price,  $p$ , that is lower than the consumer's bid then a transaction occurs. That is, the customer is informed that her bid is accepted and

is obliged to complete the transaction. Generally speaking the hotel receives  $p$  (the lower price), the customer pays  $p_c$  (a slightly higher price), and Priceline keeps  $p_c - p$  as its fee for facilitating the transaction. Priceline's business model involves setting minimum margins for the value of  $p_c - p$ . Under most circumstances if the property has more than one room rate less than the customer's bid, the property receives the highest price less than  $p_c$ . For example, if a customer bids \$100 and the selected property has loaded rates of \$100, \$90, and \$70, the customer would pay \$100, the property would receive \$90 and Priceline would keep \$10.

If the property selected in this first round does not have a price loaded that meets Priceline's margin requirement, then Priceline goes back to the remaining properties and again randomly selects a property and checks prices. In this second round each property does not have an equal chance of being selected. Instead a hotel's probability of being selected depends upon its success rate when it has been chosen in the first round. The hotel's chance of being selected increases according to the percentage of time that it has loaded an appropriately low rate when it is randomly selected (i.e., on the initial draw). With regard to the first round only, a property that has an appropriately low rate ( $p < p_c$ ) 50 percent of the time would have twice as great a chance of being randomly selected in the second round as a hotel that has a first-round rate that is low enough just 25-percent of the time. This success rate or batting average is only calculated based on the first round, not on subsequent rounds. This second round procedure is repeated until either a property is found which meets the customer's bid or until all potential properties are exhausted and no sale occurs on that customer bid.

As we said, the Priceline property selection and bid matching mechanism greatly favors the property, for the following reasons. (1) It selects the highest price that yields Priceline a profit. (2) The random nature of property selection does not require the properties to compete on price with each other, but only to compete with the customer. One hotel's price relative to another does not change their probability of being selected (at least in the first round). (3) The opaque nature of Priceline's NYOP model results in sales through Priceline being largely incremental. Although selling rooms through Priceline will reduce your average daily rate (ADR), it will boost your occupancy and increase your revenue per available room (RevPAR). The incremental contribution of Priceline is related to its opaqueness and your relative position to your competitive set. We calculate this *incremental contribution* as *Opaque Rate-P\*Retail*

**EXHIBIT 1**

**Sample Priceline daily bid report**

Attn: Revenue Manager  
Director of Sales  
General Manager

**DAILY DEMAND REPORT**  
ALL CURRENCIES IN \$USD

	Date	Offered RN	Booked RN	Offered Revenue	Booked Revenue	Conversion	Avg Offer Price	Avg Booked Price
OPAQUE	09/03/07	108		\$6,878			\$64	

**MISSED OPPORTUNITIES ON 9/3/07**

Room Nights = 108  
Revenue = \$6,828

Check In Date	Check in Day of Week	Length of Stay	Number of Rooms	Your Priceline Rate*	Offer Price	Declined Revenue	Reason**	Booked by Others
09/03/07	Mon	2	1	\$83	\$52	\$104	Hi	Y
09/05/07	Wed	3	1	\$195	\$45	\$135	Hi	
09/06/07	Thu	1	1	\$179	\$44	\$44	Hi	
09/07/07	Fri	2	1	\$85	\$48	\$96	Hi	Y
09/08/07	Sat	4	1	\$130	\$88	\$352	Hi	
09/09/07	Sun	4	1	\$162	\$88	\$352	Hi	
09/09/07	Sun	4	1	\$162	\$66	\$264	Hi	
09/13/07	Thu	7	1	\$253	\$46	\$322	Hi	
09/14/07	Fri	4	1	\$217	\$84	\$336	Hi	
09/15/07	Sat	4	1	\$300	\$66	\$264	Hi	
09/16/07	Sun	2	1	\$332	\$70	\$140	Hi	

*Rate.* In this calculation, *P* is the probability the guest would have booked your hotel anyway, which is a function of the opaqueness of the channel (number of similar star hotels, amenities, guest ratings) and of how you are priced relative to your competition. As you can see, two factors drive incremental contribution. One is focused on whether the consumer can reverse engineer your offer, that is, whether the consumer can figure out who made the opaque offer. Second, given the price consciousness of this segment, would that customer have purchased from you through normal channels anyway—a situation which might occur if yours is the least expensive 4-star hotel in your area.

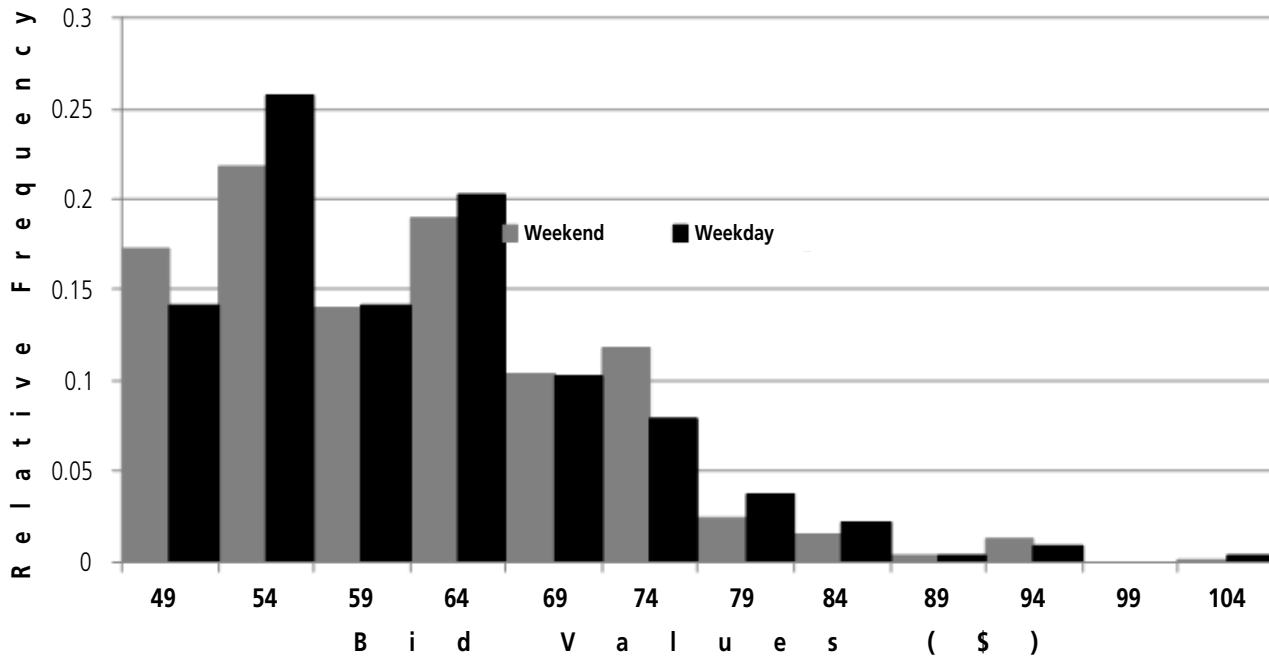
Frankly, we are not concerned with *P*, because we doubt that many price sensitive customers would be purchasing rooms at a particular hotel's regular rates. They're on Priceline to find a "better rate." In the following sections we focus on how to make the best use of Priceline, without worrying about *P*. We want to calculate how to maximize revenue from the rooms you decide to allocate to Priceline.

**Price-dependent Demand**

In this section we illustrate a set of sample bids placed at our test property and show how these bids form the basis of our model to set prices and control inventory. Exhibit 1 shows a sample daily bid report that properties can receive daily from Priceline. The report lists all bids placed by consumers the prior day for all future stay dates. Exhibit 2 summarizes a series of these bid reports into a probability distribution, or relative frequency of the number of bids placed for weekend and weekday arrivals. In this example, 17 percent of bids for weekend arrivals are placed at \$49 or less, and just over 44 percent are placed at that rate for weekday arrivals. About 22 percent of bids placed for weekend arrivals are between \$49 and \$54, and that figure is 26 percent for weekday arrivals. The figure indicates that consumers' bids are similar for both weekend and weekday arrivals. Exhibit 3 summarizes the average number of bids placed for weekend and weekday arrivals as a function of when the bids are placed (days before arrival, or DBA). Unlike the value of the bids, one can see considerable differences in the number of bids placed.

**EXHIBIT 2**

**Distribution of Priceline offer prices**



**EXHIBIT 3**

**Average number of bids placed, by days before arrival**

	Days Before Arrival							
	0	1	2	3	4	5	6	7
<b>Weekend</b>	30.2	35.9	29.1	19.2	14.9	11.9	8.7	7.8
<b>Weekday</b>	7.8	7.0	4.4	3.1	2.1	2.5	2.6	2.3

On average 30.2 bids are placed on the day of arrival for weekends, but that average is only 7.8 for weekday same-day arrivals. The greater interest in weekend arrival dates (the ratio of roughly 4:1) also holds true for up to seven days before arrival.

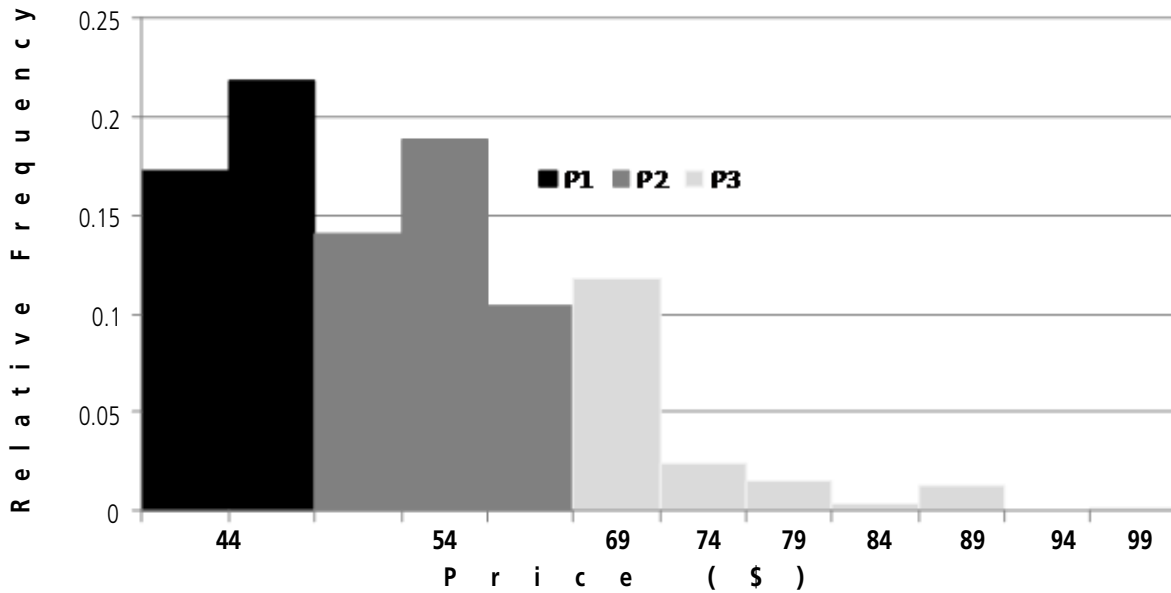
Together Exhibits 2 and 3 can be used to create a demand distribution as a function of prices. As discussed in the recent CHR report<sup>1</sup> and tool<sup>2</sup> that we mentioned above, when you post a price  $p$  a fraction of bids placed by consumers will be higher than this price. The fraction of bids higher than  $p$  represents the probability that given a

customer will make a bid that is higher than your price  $p$ . Similarly this fraction times the number of bids placed is the average number of bids placed higher than your price  $p$ . The demand distribution in Exhibit 4 (overleaf) is a simplified version of Exhibit 2—showing only weekend arrival prices. The bars in Exhibit 4 have also been grouped to represent the three prices that the hotel set on Priceline. The darkest area (P1) is the fraction (39%) of bids between \$44 and \$54, the medium gray region (P2) is the fraction (43.5%) greater than \$54 and less than \$69, and the lightest area (P3) is the fraction (17.5%) of bids above \$69. Combining this information with Exhibit 2 for a hotel that is posting prices of \$44, \$54, and \$69 to Priceline on the arrival day (DBA 0)—on average there will be demand of approximately 12 ( $.39 \times 30.2$ ) at

<sup>1</sup> [www.hotelschool.cornell.edu/research/chr/pubs/reports/abstract-14705.html](http://www.hotelschool.cornell.edu/research/chr/pubs/reports/abstract-14705.html)

<sup>2</sup> [www.hotelschool.cornell.edu/research/chr/pubs/tools/tooldetails-14706.html](http://www.hotelschool.cornell.edu/research/chr/pubs/tools/tooldetails-14706.html)

Price-dependent demand, weekends



Price 1, 13 (.435\*30.2) at Price 2, and 5 (.175\*30.2) at Price 3. More formally stated the average demand at price  $P_j$ ,  $E[D_j]$  is:

$$E[D_j] = (1 - F[P_j]) * E[N] \text{ for } P_j$$

where  $P_j$  is your highest price and,

$$E[D_i] = (F[P_i] - F[P_{i-1}]) * E[N] \text{ for } P_i (i=1 \text{ to } j-1).$$

Where  $E[N]$  is the expected number of bids placed between now and arrival (from Exhibit 2) and  $F[p]$  is the fraction of bids placed that are less than  $p$ . Here  $E[D_j]$  is the average demand at the highest price with  $E[D_i]$ ,  $i=1$  to  $j-1$ , the average demand at each of the lower price points—here assuming the hotel is setting multiple price points. Note that  $E[D]$  also includes demand for which the hotel may not have a chance at making any sale at all, because competing hotels may be selected first (at random) and have prices that satisfy the consumer’s bid.

Similarly the variance of demand (uncertainty in demand) as a function of price  $P_j$ ,  $V[D_j]$  can be approximated as:

$$V[D_j] = (1 - F[P_j]) * F[P_j] * E[N] \text{ for } P_j$$

where  $P_j$  is your highest price and,

$$V[D_i] = (F[P_i] - F[P_{i-1}]) * (1 - F[P_i] + F[P_{i-1}]) * E[N] \text{ for } P_i (i=1 \text{ to } j-1).^3$$

<sup>3</sup> As the number bids placed is random, the estimate for demand uncertainty is better estimated as  $V[D_j] = (1 - F[P_j]) * F[P_j] * E[N] + (1 - F[P_j])^2 * E[N]$  for  $P_j$  where  $P_j$  is your highest price and,  $V[D_i] = (F[P_i] - F[P_{i-1}]) * (1 - F[P_i] + F[P_{i-1}]) * E[N] + (F[P_i] - F[P_{i-1}])^2 * E[N]$  for  $P_i (i=1 \text{ to } j-1)$ .

This formula may seem complicated but it can be calculated in a spreadsheet once the formula is input.

Allocating Rooms and Setting Prices

The hotel industry’s rate adjusting tactics are based on the revenue management approaches pioneered by the airlines. The earliest revenue management approach by the airlines was focused on the allocation of seats to discounted fare classes on individual flight legs.<sup>4</sup> We can adapt this discount fare allocation model to the determination of optimal prices and room allocations at Priceline. As background, airlines originally sought to maximize revenue by allocating plane capacity to the various fare classes in the following manner. Since discount-seeking customers would book earlier than full-fare business flyers, the airline needed to determine how many seats to retain for those later booking, higher yielding customers. Let’s say that there are just two fares—full fare and discounted fare. The approach is to reserve capacity (seats) for the full fare class (i.e., set a “protection level” for the full fare class equal to the  $(1 - r/R)$  fractile of the demand distribution for full fares, where  $r$  represents the revenue from a discount fare and  $R$  the revenue from a full fare. One intuitive rationale behind this is as follows: seats should be added to those reserved for full fare customers until the expected marginal seat revenue from such an allocation no longer exceeds the revenue from a discount customer. So the

<sup>4</sup> K. Littlewood, “Forecasting and Control of Passenger Bookings,” *AGI-FORS Symposium Proceedings*, 1972, p. 12.

airlines would choose the protection level for full fares as the largest integer  $n$  that satisfies this formula:

$$R \cdot P[D \geq n] \geq r$$

In this formula,  $P[D \geq n]$  is the probability that demand for full fare seats is at least as big as  $n$ . That factor expresses the probability you will sell all the seats you protect to full-fare customers. This simplified formula can be extended to multiple fare classes, in a method devised by Belobaba.<sup>5</sup> The approach is as follows: work out a protection level for the highest fare class from the second highest class as above; then amalgamate these two highest fares into a single class. Again, set a protection level (as above) between the new, amalgamated high-fare class and the next highest and make the same calculation. Then merge these rates into a single class, and continue the process sequentially with each rate class until one has obtained (nested) protection levels for all fare classes above the least expensive. This approach is illustrated below using three fares.

Suppose there are three fares. Full fare is \$300, saver fare is \$200, and supersaver is \$100. Assume historic demand for full fares is normally distributed (a bell curve) with a mean of 15 and a standard deviation of 5, while saver fares are normal with a mean of 25 and a standard deviation of 10. Using the protection level factor that we gave above, the level for full fares is the  $(1 - 200/300)$  fractile of the demand distribution for full fares. That is, 12.85. To calculate the protection level for the saver fare class, amalgamate full and saver into one class. The demand distribution for this amalgamated class is a normal random variable with a mean of  $15 + 25$  and a variance of  $25 + 100$ . The average fare in this amalgamated class is the demand weighted average of the \$300 and \$200 fare classes, i.e.,

$$(300 \cdot 15 + 200 \cdot 25) / (15 + 25) = 238$$

So the protection level for this amalgamated class is the  $(1 - 100/238)$  fractile of a normal distribution with a mean of 40 and variance 125, or 42.23. So, 12 seats would be reserved for full fares and 42 seats should be reserved for full and saver fares combined.

The above method of allocating seats to fare classes is static, but we know that demand levels are constantly changing. To account for that issue, Belobaba suggests applying this calculation in a dynamic fashion.<sup>6</sup> For a given number of periods before departure of a flight, our hypothetical airline will have demand information for each fare class. When the

<sup>5</sup> P.P. Belobaba "Application of a Probabilistic Decision Model to Airline Seat Inventory Control," *Operations Research*, Vol. 37, No. 2 (1989), pp. 183–197.

<sup>6</sup> *Ibid.*

Applying the Priceline optimization formulas netted a 24-percent revenue increase from Priceline for one hotel.

**EXHIBIT 5****Sample prices and allocations**

<b>Price</b>	<b>Booking Limit</b>
87	14
85	14
83	14
81	14
79	14
77	14
75	14
73	14
71	14
69	13
67	13
65	12
63	11
61	10
59	8
57	7
55	5
53	3
51	1
49	0

flight opens for booking, a set of protection levels is obtained using historical demand distributions from that point to departure. One period later, the airline recomputes the protection levels taking into account how many seats have been sold and the demand patterns from this new point onwards. This is called the “expected marginal seat revenue” or EMSR approach.

We can use this standard EMSR model for hotel bookings in concert with our price dependent demand to determine prices and optimal room allocations by assuming that price dependent demand follows a normal distribution with mean  $E[D_j]$  and variance  $V[D_j]$ . A property selling inventory at Priceline needs to determine the prices to post as well as the rooms to allocate to each price. While Priceline only allows properties to use three rate classes at Priceline, it’s possible to use many more price levels by selling different room types. By offering different prices and room types, some properties often post as many as 25 different prices. Having said that, we omit the details of the allocation here in an effort to keep technical content to a minimum. We’ll send you the fully functional model upon request via email.

### A Field Test

We tested the model at a large convention hotel. Similar to many city-core convention properties, this property saw a drop off in group demand during the Great Recession. Soft group demand results in lower occupancy, of course, but convention properties cannot simply lower rates to fill empty rooms because they still are fulfilling contracts that they negotiated with groups. Guests from these contracts are arriving daily, and the hotel still has considerable transient business demand. With so many rooms open, Priceline’s NYOP model allows this property to offer prices that are attractive to price sensitive shoppers while maintaining official rates in regular posted price channels. Indeed, Exhibits 2, 3, and 4, on the previous pages, are from bids posted to this test property. The data represent bids placed for arrivals between January 14, 2010, and February 18, 2010. We used these data to build the price dependent demand distributions. We then set prices and room allocations for February 21, 2010, through March 14, 2010. Exhibit 5 shows a set of sample prices and allocations determined via the model. As you see, we set 20 prices and allocated up to 14 rooms. We set the lowest price at \$49 and went up by \$2 price increments. The modeling framework allows the hotel to set either the minimum or maximum price and price steps (here \$2) and then determines booking limits at these prices. For this example the hotel is looking to release 14 rooms to Priceline. The model makes all 14 rooms available at prices of \$71 and \$87, makes just 12 rooms available at \$65, and no rooms at \$49. The way this works is that once the hotel has

sold 12 rooms, the \$65 rate is closed and the lowest price is never available.

We then tested these optimal prices and allocations with bids placed for arrivals between our test dates. Per Priceline's routine, we only used bids that were available to the property, that is, those bids not accepted by the competition. We randomly selected bids (without replacement) and checked to see whether the model made a sale (that is, the model made rooms available at prices low enough to meet bid). We then compared the revenues from the model during the test period to the actual revenues that the property received from Priceline (using its current Priceline approach). We do not want to disclose specifics about the property's current approach to setting prices on Priceline, except to say that its approach has focused more on prices and price increments and less on allocating rooms across the price points. Exhibit 6 summarizes the results during the test period. The model increased the volume of rooms sold via Priceline's NYOP program by 19 percent, while increasing the average price from \$55 to \$57, for a 24-percent increase in total revenue.

Our model was a direct extension of the property's own price points. It is important to note that we never set prices below those originally used by the property nor did we set more prices than they typically use. Instead, we set these prices in a targeted fashion combined with the appropriate allocations of rooms across these prices.

### Summary

Priceline's NYOP mechanism provides an opportunity for hotels to sell rooms to brand-agnostic consumers. Despite the hotel industry's continuing effort to build its brands, certain travelers are focused primarily on price, general loca-

## EXHIBIT 6

### Sample prices and allocations

	Rooms	Revenue	Average Price
Existing Approach	881	\$48,546	\$55
Model	1,046	\$60,052	\$57

tion, and amenities, and these travelers are not necessarily looking for a specific brand or exact location. While the use of Priceline's NYOP model can generate significant incremental demand—increasing properties' RevPAR (potentially at the expense of ADR), we have illustrated that there are significant opportunities to truly capitalize on this channel by using the data Priceline provides in a tactical and analytical manner.

In closing, we would like to acknowledge the support of the property, which wishes not to be named, during the development of the model. The application of this model results from the efforts of coauthor Radium Yan, during her time at the test property during her winter externship as part of the one-year MMH program at the School of Hotel Administration. Similarly we acknowledge the support of Priceline for provision of data and insight into the workings of their allocation methods. A sample of the spreadsheet model is available on the CHR site, and further details or access to the model please contact the senior author directly at [cka9@cornell.edu](mailto:cka9@cornell.edu). ■

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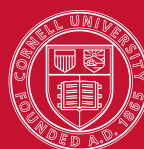
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