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An Empirical Test of a Full-Service Hotel Room Pricing Model

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Abstract : Gu (1997) proposed a hotel room-pricing model for maximizing before-tax profits that considers both costs and market forces. This study tested the Gu (1997) model using the data of eight full-service hotels in Southern California. A negative relationship between rooms sold and room rates was found for most of the hotels with monthly data. The results show that the model is applicable to monthly rather than daily data, due to the nature of monthly rooms sold and ADR being void of major group or event fluctuations. Hotels with ADRs and rooms sold demonstrating negative relationships may use the model to set up ADR guidelines for profit optimization.

Key Words : Room rate, Rooms sold, Variable cost, Profit optimization

Introduction

Pricing is one of the seven Ps (price, product, place, promotion, people, process, and physical evidence) of the services marketing mix tactics, and the only one that directly generates revenue (Kotler, Bowen, and Makens 2006). Product perishability, capacity constraints, guest variability, and day-to-day demand changes cause room pricing decisions to be difficult and frequent. Furthermore, the service industries try to maximize revenue by satisfying demand from various market segments (Bertsimas and Popescu 2003), thus making pricing a more intricate issue. Finding a room pricing strategy that addresses all of the room pricing variables is complex. Individual hotel property management teams generally make pricing decisions, which frequently fall under the Kotler et al. (2006) marketing objective of current profit maximization.

The early cost-based models focused on recovering the initial investment. The market-based models focus on guest perceptions, but tend to ignore variable costs. One model that attempts to consider both costs and market forces is the model proposed by Gu (1997). The purpose of this study was to test the Gu model using real hotel data and to provide useful room pricing applications. Best-fit models that revealed positive pricing opportunities for some of the hotels were developed based on data applications. Suggestions for future room pricing research were also provided.

Brief Review of Room Pricing Models

The traditional hotel cost-based pricing model is known as the $1 per $1,000 approach (Schmidgall 2002). In other words, for every $1,000 in per room capital investment, the price of a room should be increased by $1. Using this approach, a 300-room hotel costing $30 million to construct, or $100,000 per room, should be priced at $100 per room per night. Another frequently used cost-based room pricing model is known as the Hubbart Formula (Arbel & Woods 1991; Coltman 1987). This is an eight-step process that begins with a desired rate of return and adds costs to net income to determine a room price.

Arbel and Woods (1991) emphatically showed the fallacies of these cost-based approaches. Kotler, et al. (2006) supported the work of Arbel and Woods (1991) by noting that one common pricing mistake is to be too cost oriented. Gu (1977) stated that two market factors, fierce competition and extensive market segmentation, make these two cost-based room pricing approaches less useful. In essence, hotel rooms of various hotel segments (economy, mid-scale, deluxe, upscale, etc.) represent fairly similar products to a traveler wanting a good night's rest away from home. There has been a significant increase in economy and mid-scale hotel products during the last ten years. These economy and mid-scale products have competed with and challenged full-service hotel pricing processes.

A major group of hotel room pricing methods revolves around the yield management concept. The yield management theory is based on being able to impact hotel room demand by raising and lowering the price of hotel rooms (Relihan 1989). Another description of yield management was posited by Orkin (1990), who

said to sell as many rooms as possible at high rates to the price-insensitive traveler, and then, sell as many rooms as possible to the price-sensitive traveler by offering discounted rooms. The main hazard of yield management is that it confuses the frequent guest with varying rates for the same room at different times. Chen and Bei (2005) have found that inconsistent price information confuses consumers and diversifies price perceptions, leading to a yield management hazard.

Another group of hotel room pricing methods focuses on what price the guest is willing to pay. Lewis (1986) encouraged hoteliers to provide fair and stable prices. Lewis and Shoemaker (1997) designed the price-sensitivity approach, which determines an acceptable range between expensive and inexpensive. The difficulty of the price-sensitivity approach is that each market segment must be evaluated separately. Finding appropriate survey participants for each hotel market segment on a regular basis is administratively difficult. The Dellaert and Lindberg (2003) study complicates the price sensitivity approach with their finding that high-income tourists are generally less sensitive to average price changes. In other words, users of the price sensitivity approach may want to monitor closely the income levels of participants in certain market segments.

Gu (1997) Model Derivation

The Gu (1997) model was derived in the environment of the growing need to consider market forces and the recognized inadequacy of the cost-based approaches to do so. The first assumption of the model is a negative relationship between rooms sold, an indicator of room demand, and room rates. In other words, as room rates rise, rooms sold decrease, and vice versa. Evidently, this assumption is based on the law of demand, which holds that the consumer is willing and able to buy more of a good or service the lower the price (Maurice and Smithson 1985). The second assumption is that fixed and variable costs can be identified. Mixed costs can be separated into fixed and variable components using a regression approach as proposed by Schmidgall (2002). The final assumption is that undistributed operating costs can be properly allocated to the rooms department (Gu 1997).

The first step in the Gu model development is a demand function depicting the first assumption represented by the equation below:

$$D = \alpha - \beta r \quad (1)$$

In the equation, D represents the daily demand for rooms, and r is the room rate. Alpha is the potential demand for rooms when rooms are free. Beta is a measure of the price sensitivity of the demand. In other words, as room price or rate, r, increases by $1, the rooms demanded, D, would decline by β .

The next step adds costs to the equation. The pre-tax rooms department profit, π , is the product of rooms sold or demanded, D, and room rate, r, less all the related rooms operation costs, C, represented by the equation: $\pi = Dr - C$. Continuing with the second assumption, C can be separated into variable costs per room sold, v, and daily fixed costs, F. Combining the first two model development steps, and substituting v and F for C, yields the quadratic equation:

$$\pi = -\alpha v - F + (\alpha + \beta v) r - \beta r^2 \quad (2)$$

This quadratic equation is a parabola that indicates a maximum pre-tax room profit. By taking the first derivative of π with respect to r, the r that maximizes π can be identified. This first derivative equation is:

$$\pi' = (\alpha + \beta v) - 2\beta r \quad (3)$$

At the top of the parabola, which represents the maximum pre-tax room profit, the slope or the line tangent to the curve is zero. By setting the first derivative, π or Equation 3 to zero, the rate that maximizes pre-tax room profits, r* can be identified. The Gu (1997) model for identifying the optimal rate, r*, that will maximize pre-tax room profits, is summarized below:

$$r^* = (\alpha + \beta v)/2\alpha \beta \quad (4)$$

where: r^* = optimal room price

α = potential demand for rooms when the room rate is 0

α = a measure of the price sensitivity of demand

v = variable costs per room sold

As shown in Equation 4, fixed cost is not included and hence is not a relevant factor in determining the optimal rate. According to Gu (1997), by nature, fixed cost is a sunk cost in the room pricing process. In the equation, if variable cost per room is held constant, the optimal room price will decrease as the customer's price sensitivity, , increases. When price sensitivity is lower, the optimal room price should be higher.

Data and Methodology

One of the primary reasons for the Gu (1997) model not to have been tested up to this point is the difficulty in obtaining hotel specific occupancy and ADR data. In this study, the data collected is a convenience area sample from Southern California. Many general managers were very cooperative in allowing the collection of their occupancy, ADR, and expense information.

All of the data are from eight full-service hotels ranging from 300 rooms to over 1,000 rooms.The markets these hotels serve are primarily convention, leisure, and transient business.The hotel locations range from near the beach, to near an airport, to near a convention center. They are all national brand affiliated hotels that practice yield management.

The study included both monthly and daily data to test which time periods would best indicate the negative relationship between room rate and rooms sold. Two months of daily data, or approximately 60 observations, from seven full-service hotels were collected. The fourth quarter of 2001 was specifically excluded in collecting data so as to avoid the worst of the September 11 impact. The time periods tested are noted in Table 1. The data was taken from the daily revenue reports and month-end financial statements of each hotel. Five hotels, which provided monthly occupancy and ADR data, were used to test the long-term relationship of room price and rooms sold. Occupancy and ADR data from these hotels were collected for a consecutive 60-month period from the month-end statements of income. Seven of the eight hotels also provided daily data.

Table 1 : Personal Corellation Coefficients between Rooms Sold and ADR

Description	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Test Period Daily Monthly	 NA 96-00	 A&S 01 96-00	 J&F 02 NA	 J&F 02 NA	 J&A 01 96-00	 J&F 02 96-00	 M&A 01 NA	 M&J 01 96-00
Pearson Daily Monthly	 NA -0.44**	 0.56** -0.27*	 -0.01 NA	 0.32* NA	 0.27* -0.32*	 0.34** 0.20	 0.49** NA	 0.42** -0.57**

Time Periods: Monthly data of five hotels cover January 1996 to December 2000; daily data cover August & September 2001 (Hotel 2); January & February 2002 (Hotels 3, 4 & 6), July & August 2001 (Hotel 5); March & April 2001 (Hotel 7); May & June 2001 (Hotel 8).

** Significant at the .01 level. * Significant at the .05 level.

Variable cost information for the corresponding periods of the rooms sold and ADR was also collected. The cost information was from the month-end statements of income. For the hotels from which two months of daily data were collected, the two months of revenue and costs were summed in order to calculate variable costs. In the case of the hotels with sixty months of monthly data, all sixty months of revenue and costs were summed for the basis of variable cost calculations.

An allocation of undistributed operating expenses was calculated. The allocation was based on the percent of rooms' revenue to total revenue. Allocation bases such as square footage and number of employees were not available. The allocated undistributed operating expenses were then regressed against actual rooms sold to calculate a fixed portion as suggested by Schmidgall (2002). The remaining undistributed operating variable costs were then added to the rooms' variable costs. Rooms department labor and other expenses were also regressed against actual rooms sold to calculate a fixed portion. The rooms labor and other expenses minus the fixed portion were considered rooms variable costs. The sum of the rooms' variable costs and the undistributed allocated variable costs was then divided by actual rooms sold to obtain a total variable cost per room sold.

For hotel operations, rooms sold seasonality is likely to occur due to weekday and weekend demand variation within a week, or busy-month and slow-month demand variation within a year. To control for the impact of seasonality on demand for rooms, seasonal adjustments were made to daily and monthly rooms sold to account for seasonal variation in occupancy using the centered moving average method proposed by Anderson, Sweeney, and Williams (2001). Weekday seasonal indexes of rooms sold were derived for each of the seven hotels that provided daily data, and monthly seasonal indexes were calculated for the five hotels furnishing the monthly data. Then, the actual rooms sold of each hotel were divided by its relevant seasonal indexes to arrive at the deseasonalized rooms sold.

A critical assumption of Gu's (1997) model is that the demand for rooms is negatively correlated with the ADR as specified by the demand function, D α = - r. Therefore, the correlation between desasonalized rooms sold and ADR of each hotel was first examined. The Pearson correlation between the two variables for each hotel was calculated and tested (see Table 1). A significant and negative correlation between rooms sold and ADR is a necessary condition to indicate that proper market forces are in place to test the Gu model. For hotels displaying significantly negative correlation between rooms sold and ADR, regression was run with rooms sold as the dependant variable and ADR as the independent variable to estimate the and parameters as specified in Equation 1. Finally, combining the estimated total variable cost per rooms sold with estimated α and β the optimal ADR was determined based on Equation 4.

In the regression to estimate α and β parameters, tests were conducted to make sure that necessary regression assumptions were met. The Jarque-Bera statistic was calculated and tested to check the normality of the dependent variable or rooms sold. A low P value associated with the statistic would lead to the rejection of the null hypothesis that there is a normal distribution. Since our regression model involves time-series data, the Breusch-Godfrey test, which is a Lagrange multiplier (LM) approach, was used to examine serial autocorrelation of the regression error terms. The null hypothesis of the test is that there is no autocorrelation, or the error terms are independent of each other. A significant test statistic with a low P value would show that autocorrelation exists. The final regression assumption test was for non-constancy of variance, or heteroscedasticity, of the dependent variable, or rooms sold. The test used was the White test. The null hypothesis of the White test is that the variance of the dependent variable remains constant when the value of the independent variable changes. A significant test statistic would reject the null hypothesis and indicate heteroscedasticity (Eviews 1994-1999).

Findings

Table 1 provides the Pearson correlation coefficients between rooms sold and ADR of the eight hotels and their significant levels of two-tailed t tests. Four of the five hotels that provided the monthly data show a significantly negative correlation between monthly ADR and rooms sold. The daily data from Hotel 3 also demonstrates a negative relationship between ADR and rooms sold, but the correlation is not statistically significant. The other correlation tests for hotels providing daily data were all positive and significant at the 0.01 or 0.05 level.

One hotel (Hotel 6) had a positive but insignificant correlation between monthly ADR and rooms sold. It appears that this hotel is part of a brand that successfully utilizes vertical market segmentation within the brand, regional reservation and sales processes, yield management, and frequent guest recognition programs that effectively circumvent normal demand functionality.

Since Hotels 1, 2, 5, and 8 were the ones that had a significantly negative correlation between monthly rooms sold and ADR as assumed by the Gu (1997) model, regression was run for each hotel with rooms sold as the dependent variable and ADR as the independent variable to identify the α and β parameters as specified in Equation 1. The estimated demand models for Hotels 1, 2, 5, and 8 with their respective α s and β s are displayed in Table 2. For other hotels, as no significant and negative relationship was found between rooms sold and ADR. regression was not run to estimate the demand function of $D = \alpha - \beta r$.

Table 2 : Estimated Demand Models for Four Hotels

	Hotel 1	Hotel 2	Hotel 5	Hotel 8
Alpha (α)	15,085.60**	11,417.70**	8,555.03**	14,203.55**
Beta (β)	-47.99**	-29.80*	-20.86**	-41.67**
F-Statistic	16.68**	5.23*	7.72**	39.40**
Adjusted R Square	0.21	0.07	0.10	0.39
Jarque-Bera	0.73	0.87	0.39	0.85
Breusch-Godfrey	0.07	0.07	0.25	0.33
White	0.38	0.47	0.67	0.49

** Significant at the 0.01 level. * Significant at the 0.05 level

The values indicated for Jarque-Bera, Breusch-Godfrey and White tests are P values.

As shown in Table 2, the estimated demand equations for Hotels 1, 2, 5, and 8 are as follows:

Hotel 1	$D = 15{,}085.60 - 47.99r$
Hotel 2	$D = 11{,}417.70 - 29.80r$
Hotel 5	$D = 8{,}555.03 - 20.86r$
Hotel 8	$D = 14{,}203.55 - 41.67r$

The models are significant at the 0.01 or 0.05 levels with an adjusted R squared value ranging from 0.07 to 0.39. The alpha and beta coefficients are all significant at the 0.01 or 0.05 levels. The Jarque-Bera statistics have P values ranging from 0.39 to 0.87, suggesting that the null hypothesis of normality cannot be rejected. The Breusch-Godfrey statistics range from 0.07 to 0.33, suggesting that the null hypothesis of no autocorrelation can be accepted at the 0.05 level. The White test's P values range from 0.38 to 0.67, suggesting that heteroscedasticity is not present in the regression.

The estimated variable costs per room for Hotels 1, 2, 5 and 8 are \$33.93, \$37.42, \$43.48 and \$31.88, respectively. Based on Equation 4, the optimal prices for the four hotels are calculated as follows:

Hotel 1	\$174.15 = [15,085.60 + (47.99 X 33.93)] / (2 X 47.99)
Hotel 2	\$210.27 = [11,417.70 + (29.80 X 37.42)] / (2 X 29.80)
Hotel 5	\$226.79 = [8,555.03 + (20.86 X 43.48)] / (2 X 20.86)
Hotel 8	\$186.38 = [14,203.55 + (41.67 X 31.88)] / (2 X 41.67)

At the end of the year 2000, the annual ADRs for these hotels was around \$100. The hotel ADRs had been steadily rising over the past five years, but could rise even more according to the Gu (1997) model.

The annual ADR of the hotels examined appeared to be significantly lower than the calculated optimal rate based on the Gu (1997) model. This could be due to national discount participation requirements. Hotels often set the rack rate to be in compliance with national discount programs, which require a percent discount off the rack rate. For example, the AARP rate may be a 50% discount (AARP website, December 2005). The rack rate, then, becomes a baseline for setting all other rates, as opposed to being used frequently for guests. Our results indicate that the Gu (1997) model optimal rate could be best used to establish the rack rate.

A comparison was made between the Gu (1997) model calculated rates and the most recent year hotel average rates. The ADRs of the final year examined for Hotels 1 and 8 were about 55 percent of the Gu (1997) model optimal rates. For Hotels 2 & 5 for the same final year examined, the ADRs were about 43 percent of the Gu (1997) model optimal rates. The R-square values for Hotels 1 and 8 were higher than for Hotels 2 and 5, which may indicate that Hotels 2 and 5 have more market segment pricing challenges than Hotels 1 and 8. Hotels that must target many market segments to achieve an acceptable occupancy frequently use an approach described by Nykiel (2003) of offering a price range within each market segment. The greater the number of market segments, each with its price ranges, the greater the likelihood of price discounts. Also, Chen and Bei (2005) found that a greater price dispersion has a greater influence on the lower internal reference price (IRP) boundary than on the upper IRP boundary. The Gu (1997), Nykiel (2003), and Chen and Bei (2005) studies tend to support a policy of offering fewer discounts as a means of achieving a higher ADR.

Discussion

The law of demand postulates that if the price of a room increases, the demand for a room decreases, and vice versa. Under this theory, the beta coefficient in the regression equation should be negative. Perhaps the most important finding of this study is that daily data has significant limitations in application of Gu (1997) model. It was originally thought that one advantage of the Gu (1997) model was that it could easily be updated with recent occupied rooms & ADR data. However, this study discovered that several problems can arise with daily data.

First, the capacity issue should have caused a problem with daily data for the Gu (1997) model application. With a finite number of rooms to sell in a given geographic area during a certain day of the week, or during a particular convention, the number of rooms sold does not decrease as the price rises. Most hotels use the yield management concept to some degree, which suggests that prices should be increased as demand for rooms increases when capacity is tight. Hence, capacity issues over short periods of time may distort the theoretical negative correlation between rooms demanded and ADR, thus rendering the daily data ineffective in the Gu (1997) model application.

A significant group or convention may highly impact the ADR and occupied rooms for a few days at a given hotel or group of hotels. Monthly ADR data, however, is apparently shielded from the short-term effects of a particular group or convention because a few busy days during a month could possibly be neutralized by a few slow days, thus making the monthly ADR and occupancy relationship consistent with the economic theory. Taking a longer-term look at hotel price and demand, one may find the logical negative relationship between rooms sold and ADR to be present.

Second, other factors may have distorted or masked the normal relationship between room price and rooms sold. Ferguson (1987) and Lee and McKenzie (1998) argue that costs and market forces are not the only factors that affect pricing. There are also psychological, area capacity, and customer interaction issues at work. Lee and McKenzie (1998) suggest that the standard economic theory of high fixed cost and low marginal cost for hotel pricing is tempered by a customer effect. In other words, competition is not expected to drive down rates until excess capacity is eliminated. This customer effect is essentially that the value one consumer receives is influenced by other consumers. Two hotels of similar physical product in the same market illustrate this customer effect. One hotel has the reputation of being noisy, the other one of being quiet. Following the Lee and McKenzie theory, the quiet hotel may charge higher rates to attract guests willing to pay for a quiet environment.

Consumer purchase decisions often violate the negative price demand relationship. One economic theory that helps explain consumer's deviation from the law of demand is Prospect Theory, which has two components: 1) people are more risk-averse when dealing with gains than when dealing with losses: and, 2) people assign more weight to highly probable outcomes than to low-probability outcomes (Ferguson 1987). The application to hotels is that room pricing can take advantage of "psychology economics" by manipulating information and optimizing presentation of room prices. Such tactics could diminish the normal functionality of price and demand interactions.

Finally, the price/demand relationship for the daily data from Hotels 2 through 8 may have been further distorted by the monthly seasonality impact on daily rate and rooms sold for which the study was unable to control. The two-month daily data of the seven hotels allowed us to derive only the week-day seasonal indexes for the seven days of Monday through Sunday to control for the daily pattern of rooms sold within a week. It was impossible for us to derive 12 monthly seasonal indexes based on two-month data sets. Therefore, for Hotels 2 through 8, daily ADR variations due to monthly seasonality was not accounted for, although their weekly variation was neutralized by the deseasonalization using their seven daily indexes.

The adjusted R-squared values for the significant models ranged from 0.07 to 0.39. This indicates that ADR alone explains a small to moderate portion of the variance in rooms sold for Hotels 1, 2, 5, and 8. This low explanation of variance may also indicate other psychological, capacity, or customer interaction influences. Evidently, additional factors need to be added to the demand regression equation if the purpose is to increase the explanatory power of the regression model.

Conclusions

The simple cost-based approaches of the past no longer work in today's complex and competitive market. Ignoring the importance of costs, however, may also be dangerous. Setting prices without variable cost information could lead to cash depletion. The yield management approach of raising and lowering prices, and tightening and loosening room inventory frequently can confuse and alienate customers. Psychological factors distort the normal functionality of price and demand interaction. The Gu (1997) model incorporates both market and cost approaches in room pricing and establishes a baseline for incorporating non-economic factors.

In this study, Hotels 1, 2, 5, and 8, meet all of the statistical significance tests and the Gu (1997) model criteria. The research and testing indicate opportunities for increasing prices at these four hotels. The price increases would yield substantial pre-tax profit increases, as the hotels studied have variable costs below $48. For hotels with their ADRs and rooms sold demonstrating negative relationships, the Gu (1997) model may therefore be used to provide optimal ADR guidelines to maximize pre-tax profits. In particular, this study suggests that hotels may raise the rack rate so that discounted rates may also rise. An increase in discounted rates would raise the total hotel ADR.

Hotels 2 through 8, or those tested with daily data, confirm that other factors influence the interactions of price and demand. Fixed capacity, or a fixed number of available rooms, is one such factor. During a particular event or day of week, the number of rooms sold may increase as prices increase. This is the basis of the yield management approach.

Psychological factors also impact prices. Repeat guest programs, frequent guest rewards, and unique hotel characteristics influence customer decisions. All the eight hotels tested use psychological factors to some extent through their national brand affiliation and location.

This study indicates that using monthly data tends to smooth out the influence of capacity and psychological factors. Another possible approach is to isolate pricing of specific market segments. This is one advantage of the Lewis & Shoemaker (1997) price sensitivity approach.

Hence, a pricing combination approach is optimal. It can start with the Gu (1997) model. Then, the Lewis and Shoemaker (1997) price sensitivity range may initially help identify the highest customer acceptable price. Then, a non-alienating yield management approach would avoid offering too many discounts during high demand periods.

Another reason for starting with the Gu (1997) model using monthly data is that it is critical for hotel executives to calculate variable costs, so that no prices are extended below the variable cost level. Also, it may not be practical or possible to frequently test customer price sensitivity on a day-to-day basis. The Gu model may be used to provide a long-term guidance for room pricing that may help maximize hotel profits.

Additional research opportunities abound in room pricing. Suggested areas of research focus would be: 1) testing the Gu (1997) model for optimal pricing by market segment; 2) finding additional predicting factors for the regression equation and the Gu (1997) model; and, 3) comparing the various pricing approaches or combination of approaches for the optimal pricing solution.

The Gu (1997) model is successful in combining market and cost components, but relies on monthly data versus daily data, due to the nature of monthly rooms sold and ADR being void of major group or event fluctuations. Examining and testing pricing data by market segment may yield additional insights and relationships on ADR and rooms sold.

The price and demand relationship is apparently tempered by such factors as location, capacity, and consumer psychology. Identifying which of these factors influence ultimate pricing decisions would greatly improve the Gu (1997) model. Also, comparing the optimal price computed using the Gu (1997) model with the price obtained using other pricing models would be enlightening.

One final note is that the Gu (1997) model supports the current hotel pricing practice of setting high rack rates that are then discounted for volume and leisure guests. The Gu (1997) model indicates the optimal rate that maximizes pre-tax profits. The process of calculating variable costs and fitting the regression model provides the sophisticated framework for profitably discounting the optimal rate to volume and leisure guests.

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