# 22 Pricing and revenue management

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**Abstract**

The focus of this chapter is on the strategic role of price in revenue management (RM). In order to successfully use price as a strategic weapon, firms must address two questions: what prices to charge and how to determine which customers or market segments should be offered those prices. In addition, companies must study and understand both customer and competitive reaction to their use of RM pricing. In this chapter, I address these questions through a review of the relevant literature and of current practice.

## Introduction

The focus of this chapter is on the strategic role of price in revenue management (RM). I will first review the revenue management literature and present some of the most commonly used models. Following that, I will discuss how prices are set in practice and provide a review of the relevant literature on how customers react to variable pricing.

## Revenue management

Revenue management (RM) has been practiced in the airline (Smith et al., 1992), hotel (Hanks et al., 1992) and car rental industries (Carroll and Grimes, 1995; Geraghty and Johnson, 1997) for over 20 years, and has more recently attracted attention in other industries, including broadcasting (Secomandi et al., 2002), golf (Kimes, 2000), health care (Born et al., 2004), and restaurants (Kimes et al., 1998). RM is applicable to any business that has a relatively fixed capacity of perishable inventory (i.e. seats, rooms, tee times), that inventories demand (either through reservations or wait lists), has a high fixed cost and low variable costs, and that has varying customer price sensitivity. Industries using RM typically report revenue increases of 2–5 percent (Hanks et al., 1992; Kimes, 2004; Smith et al., 1992).

The ability to effectively implement RM strategies in different industries is subject to the various combinations of duration control and variable pricing that exist within each industry (Kimes and Chase, 1998). Figure 22.1 illustrates the various combinations of price and duration and specifies the type of industries that correspond to each combination. The most effective applications of RM are generally found in industries in which both duration and price can be managed (see Quadrant 2). Consequently, it is not surprising that industries traditionally associated with RM (i.e. hotels, airlines, car-rental firms and cruise lines) are those that are able to apply variable pricing for a product or service that has a specified or predictable duration. On the other hand, some businesses (e.g. movie theaters, performing-arts centers, arenas and convention centers) charge a fixed price for a product of predictable duration (Quadrant 1), while still others (e.g. restaurants and golf courses) charge the same price for all customers purchasing a particular product or service, but face a relatively unpredictable duration of customer use (Quadrant 3). Finally, a few industries, such as health care, charge variable prices (e.g. Medicare versus private pay), but do not know the duration of customer use, even though

| | | PRICING | |
|---|---|---|---|
| | | **Few** | **Many** |
| **DURATION** | **Controlled** | **Quadrant 1**<br>Movies<br>Stadiums/arenas<br>Convention centers<br>Spas | **Quadrant 2**<br>Hotels<br>Airlines<br>Rental cars<br>Cruise lines |
| | **Uncontrolled** | **Quadrant 3**<br>Restaurants<br>Golf courses | **Quadrant 4**<br>Continuing care hospitals |

*Figure 22.1 Typical pricing and duration positioning of selected service industries*

some may try to control that duration (Quadrant 4). The lines dividing the quadrants are broken because in reality no fixed demarcation point exists between quadrants; thus an industry may have attributes from more than one quadrant.

As discussed above, companies using RM can deploy two strategic levers, price and duration control (Kimes and Chase, 1998). Pricing can be used in two ways: to determine the optimal prices and to determine who should pay which price (typically through the development of appropriate rate fences). What makes RM pricing different is the presence of excess (or unconstrained) demand. When unconstrained demand exists, firms can select the customers willing to pay the most. Because of this, companies that are successful with RM generally show a strong positive correlation between their capacity utilization percentage and their average rate per person (Canina and Enz, 2006).

Duration can be controlled by better managing customer arrivals (i.e. overbooking and wait list management) or by better managing duration (i.e. length of usage controls). Most of the early (pre-1995) RM research focused on the duration aspect of RM and more specifically focused on various facets of the arrival management question including (1) the forecasted demand for different price categories, (2) the inventory allocation decision (the amount of inventory – whether seats, rooms or cars – to allocate to different price categories and (3) the overbooking decision. The question of duration control, whether in the context of the multiple flight legs for the airline industry or the multiple-day usage patterns of the car-rental and hotel industries, was not addressed until the early 1990s (Baker and Collier, 1999; Smith et al., 1992; Williamson, 1992). The implementation of this research was slowed because of the need to develop the necessary level of forecast detail (Smith, 2001). For an excellent review of RM research see McGill and van Ryzin (1999) and Boyd and Bilegan (2003).

RM research has been conducted since the late 1950s (Beckmann, 1958), but did not become widespread until the 1990s. Early research (e.g. Littlewood, 1972) focused on the seat inventory allocation problem in the airline industry. Belobaba (1987, 1989), in his work on the expected marginal seat revenue (EMSR) model, further developed Littlewood's earlier research.

The EMSR model considers both fare categories ($f_i$) and the expected demand for each fare category ($d_i$). Demand is assumed to be normally distributed and customers booking lower fare classes are assumed to book earlier than those booking higher fare classes. The EMSR model is as follows:

$$\text{EMSR}_i(d_i) = f_i * P_i(d_i)$$

where $f_i$ is the average fare level of the fare class $_i$; and $P_i(d_i)$ is the probability of selling $d$ or more inventory units at a given price.

The model is solved iteratively to set booking limits for each fare class, and the booking limit for the full fare is assumed to be equal to the remaining capacity. Note that the fare classes are considered as a given. Belobaba (1992) later modified the EMSR to better account for the relationship between fare classes. This revision, termed the EMSRb, is one of the most commonly used seat allocation heuristics used in the airline industry.

Linear programming methods have also been used as a basis for RM models. The objective is generally to maximize revenue given capacity and demand constraints over time. Again, rate classes arc taken as a given. The basic linear programming formulation is as follows:

$$\text{Max} \sum_{j=1}^{m} \sum_{i=1}^{n} \sum_{t=1}^{p} Rij * Aijt$$

$$\text{Subject to} \sum_{j=1}^{m} \sum_{i=1}^{n} Aijt \leq Ct \quad \text{for all } t$$

$$Aijt \leq Dijt$$

$$Aijt \geq 0$$

where

$i$ = rate class
$j$ = length of stay
$t$ = time period
$A_{ijt}$ = the number of inventory units to sell for each rate class $i$, length of stay $j$, time period $t$ combination,
$R_{ij}$ = the revenue from rate class $i$ and length of stay $j$ combination,
$C_t$ = the capacity at time period $t$
$D_{ijt}$ = the forecasted demand for each rate class $i$ length of stay $j$, time period $t$ combination.

The linear programming formulation is generally approached in one of two ways: (1) as an allocation method in which the decision variables arc the number of inventory units to allocate to each rate class; or (2) as a shadow price approach in which the shadow prices associated with the capacity constraints arc used to determine which (if any) of the rate classes should be available (Baker and Collier, 1999; Simpson, 1989; Talluri and van Ryzin, 1998; Williamson, 1992). The shadow price approach (also referred to as the network bid price approach) can be used to develop duration controls and allow a firm

to move from Quadrant 4 (multiple prices and little duration control) to Quadrant 3 (multiple prices and increased duration control).

Dynamic programming models have also been proposed and allow for better inclusion of the multiple decisions needed over a set time horizon than linear programming-based models (Badinelli, 2000; Bitran and Mondschein, 1995; Lee and Hersh, 1993). Although theoretically appealing, the dynamic programming approach has been stymied because of the size of the problem and the intensive computation required.

Interestingly, very little of the research published before 1995 included price as a variable. Price was considered to be an exogenous variable that was provided by a third party and there appears to have been little consideration for the fact that price might drive demand or that the prices provided may not be optimal. Given that any RM decision is a function of both price and duration, it is essential that RM models include information on the relationship between price and demand, and consider the potential impact of that relationship on revenue maximization.

Most research on integrating the pricing and allocation decision began in the mid-1990s and both deterministic and stochastic models for both the single- and multiple-product problems have been proposed. For an excellent review of pricing research in an RM context, see Bitran and Caldcntey (2003) or Elmaghraby and Kcskinocak (2003).

Ladany and Arbel (1991), in their article on RM in the cruise line industry, were some of the first to consider the role of price in RM. Weathcrford (1997) developed a simultaneous pricing/inventory allocation decision model, but the complexity of his formulation led to the need for simulation to develop reasonable solutions.

Gallego and van Ryzin (1994) studied the optimal pricing decision in situations with stochastic and price-sensitive demand where a firm is trying to maximize revenue. Gallego (1996) developed a simple deterministic model to analyze pricing and market segmentation decisions and presented optimality conditions.

Gallego and van Ryzin (1997) and Zhao and Zheng (2001) studied the problem of dynamically pricing products over a given time so that a firm can maximize revenue. Other studies have looked at similar problems in the retail context (e.g. Bitran et al., 1998; Hcching et al., 2002).

Beyond developing an optimal set of prices, a firm must decide on the number of prices (or price buckets) that should be offered (Bitran and Caldentey, 2003; Quain et al., 1999); the maximum number of price changes to make over the selling horizon (Bitran and Caldentey, 2003); the strategy for integrating markdowns, markups and promotions (Bitran and Caldentey, 2003; Bitran et al., 1998; Heching et al., 2002) and the potential impact of price on bundled products (Morwitz et al., 1998; Xia and Monroe, 2004).

The change in research orientation parallels the changes in RM practice. During the 1980s and 1990s, the primary way that RM professionals used price was to ask the marketing department to provide prices and then used their RM system to determine how to best allocate demand to those prices. During the past ten years, RM practice has moved from an operations focus to much more of a marketing orientation in which revenue managers try to develop products/services for particular market segments and price them accordingly. Not surprisingly, this change has also resulted in the movement of the RM function from operations-related departments to sales and marketing departments.

**How prices are set in practice**

Although some of the pricing research previously described has been adopted by firms in the airline, hotel, car-rental and retail industries, the majority of pricing practices are still non-mathematically based. In practice, most RM prices are set either with competitive pricing or through negotiation. This results in a large number of prices that generally have to be placed into rate categories (or buckets) so that they can be controlled by the RM system.

*Competitive pricing*

Competitive pricing has become even more important with the growth in the online travel market (Green, 2006). Customers can easily compare prices among competitors by going to any of the large Internet travel sites such as Expedia.com, Travclocity.com or Orbitz.com and specify the date(s) of travel, the location (or origin–destination of the flight) and a particular quality level (hotel type, car type, class of service). They can also compare the price for a particular company across distribution channels (including the company's own website).

Travel firms have mixed feelings about these third-party intermediaries: they like them because of the increased visibility and sales of their products, but do not like the associated cost (often 20–30 percent). In addition, when a company uses multiple distribution channels, they must maintain the same price in each channel because of the potential impact on customer satisfaction. A number of travel firms have instituted lowest rate guarantees in an attempt to reassure customers that the company always offers the best rate available (Rohlfs and Kimes, 2007).

Firms generally obtain competitive information from four sources: (1) phone calls to competitors ('shopping'); (2) global distribution systems (GDS); (3) third-party data providers; and (4) various electronic distribution channels (e.g. Expedia and Travelocity). This information is useful for adjusting overall price levels, but docs not really provide detailed competitive pricing information by market segment.

- *Shopping* Many hotels and car-rental companies call their competitors on a daily basis to inquire about rates and availability. Generally, these calls arc made as if they were made by a potential customer, but in many cases, the source of the call is known. This information is then used to evaluate the current pricing policies.
- *Global distribution systems (GDS)* Many airline pricing analysts rely on the fares listed in the various GDSs (Sabre, Amadcus, Worldspan and Galileo) to determine what the competition is charging for different origin–destination pairs and use this information to make adjustments in their prices.
- *Third-party data providers* A variety of third-party systems such as Electrobug (www.Electrobug.com), RateGain (www.rategain.com) and TravelClick (www.travelclick.com) search competitive websites on at least a daily basis and provide clients with information on what their competition is charging in various markets. This information is then used to evaluate current pricing policies.
- *Electronic distribution systems* Many of the online travel distribution systems (e.g. Expedia (www.expedia.com) and Travelocity (www.travelocity.com)) provide their suppliers with competitive pricing information. Again, as with the other sources of data, this can be used to evaluate current pricing policies.

*Negotiation*

Prices for a considerable portion of airline, hotel, car-rental and cruise line industry inventory are set through negotiation. Group and tour operator prices are generally negotiated as arc the rates offered to large corporate accounts. The prices are based on demand, the forecasted number of inventory units that will be used, when usage is likely to occur, the ancillary revenue associated with the business, and the long-term value of the business to the firm.

**Determining who gets which price**

If a company decides to charge multiple prices for essentially the same product, it must differentiate those prices so that customers feel as if they are purchasing different products. For example, consider a hotel that charges three rates ($75, $100 and $125). Customers paying the $125 rate may receive additional services such as 'free breakfast', more desirable rooms and late check-out while those paying the discounted $75 rate may be required to make their reservations well in advance and receive less desirable rooms. The conditions associated with different rate categories (or prices) arc referred to as rate fences. Essentially, a rate fence is the reason why people pay different prices.

Rate fences take five basic forms: physical, controlled availability, customer characteristics, transaction characteristics and product line (Dolan and Simon, 1996; Kimes and Wirtz, 2003). Traditionally, rate fences were not always apparent to customers seeking to make a reservation. For example, a car-rental firm could offer lower rates to government employees or to senior citizens, but most customers might not be aware of these lower rates. Internet prices make rate fences much more transparent to customers and, if not well managed, may lead to questions as to why particular groups are given lower rates that may not be available to other customers.

**Understanding customer reaction to revenue management pricing**

Although better pricing decisions can lead to increased revenue, firms must also consider the impact of pricing on customer satisfaction. Customer satisfaction with pricing is affected by the perceived fairness of those prices (Bolton et al., 2003; Kahneman et al., 1986a, 1986b; Xia et al., 2004), notions of procedural and distributive justice (Smith et al., 1999; Sparks and McColl-Kennedy, 2001; Tax et al., 1998), familiarity with the pricing practice (Kahneman et al., 1986a, 1986b; Wirtz and Kimes, 2007), the relative advantage received from the pricing practice (Xia et al., 2004; Wirtz and Kimes, 2007) and the framing of the prices (Kimes and Wirtz, 2003; Wirtz and Kimes, 2007).

*Perceived fairness*

If customers believe that a company is behaving in an unfair fashion, that they are unlikely to patronize that firm in the future (Kahneman et al., 1986a, 1986b). For example, consider customer reaction to high prices after a natural disaster or high hotel room rates during an important sporting event such as the Olympics or World Cup (Campbell, 1999).

Perceived fairness is strongly affected by the reference price and the reference transaction (Kahneman et al., 1986a, 1986b; Thaler, 1985). When companies use RM, they may alter the reference price and reference transaction and, if they do not carefully plan how to present their pricing practices to customers, may run the risk of customer dissatisfaction.

The principle of dual entitlement (Kahneman et al., 1986a) states that customers believe that they are entitled to a reasonable price and that companies are entitled to a reasonable profit. When this relationship becomes unbalanced in favor of the company, perceptions of unfairness may occur. Based on their research on the principle of dual entitlement, Kahncman et al. (1986a, 1986b) found that: (1) price increases arc seen as acceptable when costs increase; (2) price increases arc seen as unacceptable if costs have not increased; and (3) maintaining a price increase is acceptable even if costs go back to their original, lower levels.

There are three ways to offer multiple prices without upsetting customers: raise the reference price, obscure the reference price, and attach restrictions or benefits with different prices (Kahncman et al., 1986a, 1986b):

- *Raise the reference price* If the reference price (for airlines, this would be the full fare; for hotels, this would be rack rate) is raised, other prices will be seen as relatively low compared to the reference price. For example, airlines frequently use this practice when they offer 'super-saver' fares representing a substantial discount off of the full fare. Since less than 5 percent of airline passengers actually pay full fare, the discount seems a lot better than it actually is.
- *Obscure the reference price* Firms with excess inventory that they would like to sell at a lower price arc often concerned that an extremely low price might send the wrong signal to current and potential guests. If an airline can package a lower-priced airfare with other products (such as a hotel room or rental car), it can obscure the reference price since customers will not know how much the flight actually costs. Tour operators and, more recently, Expedia.com and Travelocity.com, have been very successful at offering packages and allowing travel firms to distribute their inventory while obscuring the actual price of the product.

  In addition, some online travel distribution channels such as Priceline (www.priceline.com) and Hotwire (www.hotwire.com) allow travel firms to easily dispose of their distressed inventory while obscuring the identity of the firm. Companies using these 'opaque' sites (so called because the identity of the company selling the inventors' is obscured) can specify the number of inventory units available and the minimum acceptable price. Customers then place bids for an inventory unit in a particular city or for a particular flight, but do not know the identity of the companies providing inventory. If a bid is higher than the minimum acceptable price, it is accepted and the customer is then given the company name. In addition, all of these reservations are non-refundable: if a bid is accepted, the customer's credit card is immediately charged.
- *Benefits and restrictions* If companies include certain benefits (such as a larger car or free Internet access) with higher rates and attach restrictions (such as time of booking or change penalties) to lower rates, they can effectively differentiate not only the price, but also the inventory unit.
- *Procedural and distributive justice* Customers also evaluate the fairness of a policy (procedural justice) and the fairness of the outcome of that pricing policy (distributive justice) (Smith el al., 1999; Sparks and McCoil-Kennedy, 2001; Tax et al., 1998). It is possible that a customer could consider a policy to be fair (procedural justice), but the outcome resulting from its implementation to be unfair

(distributive justice), and vice versa. For example, customers may feel that a car-rental company's Internet pricing policies are fair but that it is unfair that some people pay more than others.

*Familiarity*

Perceived fairness is affected by community norms (Monroe, 1976), and perceived fairness of a pricing practice is judged relative to these community norms (i.e. a reference price provides a basis for fairness judgments because it is normal, not necessarily because it is just (Kahneman et al., 1986a, 1986b). This means that reference prices arc not static but continually adapt to market conditions (Wirtz and Kimes, 2007).

In an RM context, there is evidence to suggest that customers are shifting their fairness perceptions to community norms. For example, Kimes (1994) showed that RM pricing practices were considered more acceptable for airlines than for hotels in 1994. Interestingly, in a follow-up study eight years later, Kimes and Noone (2002) found that there were no longer significant differences between the acceptability of these same practices in both industries. US golfers and diners are also more accepting of RM practices and find them relatively fair (Kimes and Wirtz, 2002, 2003). As a market becomes more familiar with RM practices, the unfairness perceptions of those practices may decline over time (Wirtz and Kimes, 2007).

*Relative advantage*

Xia et al. (2004) suggest that perceived price differences can lead to perceptions of advantaged inequality (i.e. the consumer pays less than the reference price or another consumer) or disadvantaged inequality (i.e. the consumer pays more). Every RM pricing practice can be seen from two perspectives: that of the person paying the higher price (e.g. a non-student who pays a full price and cannot take advantage of a special student rate); and that of the person who can take advantage of a lower price through the same fencing mechanism (e.g. a student who pays the discounted student rate).

When there is a wide variation in the prices charged (as is the case with airlines, car-rental companies and hotels), customers are likely to compare the prices they pay with the prices paid by other customers (Bolton et al., 2003; Chen et al., 1998; Martins and Monroe 1994), and customers who receive a lower price may be seen as receiving an unfair advantage (Adams, 1963). Wirtz and Kimes (2007) found that customers who are familiar with RM pricing practice do not consider relative advantage when assessing the perceived fairness of that practice.

*Framing*

Price differences can cither be presented as a premium or as a discount to regular prices. For example, a restaurant may decide to charge higher prices for weekend dinners. They can either present the higher price as a premium over regular menu prices, or they can position the regular menu price as a discount from the higher weekend prices.

Prospect theory holds that price differences framed as a customer gain (i.e. discounts) as fairer than those framed as a customer loss (i.e. premiums or surcharges), even if the situations arc economically equivalent (Chen et al., 1998; Kahneman and Tversky, 1979; Thaler, 1985). RM research has shown that customers view prices presented as a discount as fairer than those presented as a surcharge (Kimes and Wirtz, 2002, 2003; Wirtz and Kimes, 2007).

## Summary and conclusion

In this chapter, I have reviewed the literature on RM allocation and pricing models, discussed how RM prices arc set in practice and reviewed the literature on customer reaction to prices. As RM practice becomes more sophisticated and as the Internet becomes the customer booking engine of choice, we can expect price to become an even more important component of an RM strategy. The technical pricing models discussed arc likely to become much more widely adopted, and models that incorporate competitive reactions to price changes arc likely to be developed. Still, as pricing becomes an even more important part of an RM strategy, companies must carefully monitor customer reaction to these policies since a reduction in customer satisfaction may result in lower long-term profitability.

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