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# DEMYSTIFYING PRICE OPTIMIZATION:

## A REVENUE MANAGER'S GUIDE TO PRICE OPTIMIZATION

As analytic approaches to pricing have evolved over the last decade, one of the most common questions I am asked is "How is Price Optimization different from Revenue Management?" Practitioners today think of revenue management not as a science but as a wide set of business practices with a common goal. By this definition, price optimization could be described as one of the methodologies for applying revenue management.

To offer a better understanding of how price optimization evolved from its own discipline into a tool in the revenue management toolbox, I will explore the history and development of revenue management as a science.

### Revenue management science takes to the sky

The application of mathematical models to travel pricing can be traced to the mid-70s. Before that point, the use of analytics in travel sales was limited to approaches surrounding overbooking. In the mid-70s, after deregulation of the U.S. airline industry, a number of airlines introduced discounted fares to fill seats that would otherwise have gone unused on low-demand flights.

Airlines formed yield management groups to control the number of reservations taken on these reduced fares when demand for late booking, full fare passengers was expected to increase and total demand from both discounted and full fares would exceed capacity. Their goal was to maximize revenue on each flight by predicting the sale of full fare reservations and controlling the number of discounted seats. The amount of space to reserve for these future reservations was referred to as protection. As the airline industry evolved this practice, airlines developed increasingly complex fences (restrictions placed on discounted fares) to distinguish these fares from full fares, thereby reducing dilution (reduced revenue caused by a customer purchasing a discounted fare that was not intended for his market segment). Selling systems were enhanced to enforce these restrictions as they were developed and adapted. Examples of such fences include:

- Advance reservation
- Non-refundable
- Minimum length of stay (including the infamous "Saturday night stay" requirement)
- Day of week applicability

As this business process evolved, and more discounted fares were developed, mathematicians began to model the problem to find the mathematically optimal protection levels that would maximize revenue. The mathematics determined the number of each discounted product to sell in order to maximize revenue. The early systems developed for this purpose were known as yield management systems.

After the carriers began to move towards "hub-and-spoke" itineraries, where a significant percentage of passenger itineraries involved a stop at the carrier's hub, yield management systems needed to account for the network effect. This involved managing demand for a specific segment (known as a "leg") of an itinerary when many different kinds of itineraries (all with different values to the airline) also flowed over it and optimizing the availability of different fares on these connecting itineraries.

### But things changed

The original formulations for revenue management science were based on the airline's business practice of the use of fences to separate different customer groups with distinctly different values. Although fares differed across disparate customer groups, a key modeling assumption was that these different values were relatively stable over time. This assump-

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tion meant that even though they used the same inventory unit, each different fare type could be treated as a separate product, which serviced a separate market of customers.

Three important trends have emerged since these original methodologies were developed: Low cost airlines introduced simplified fare structures with fewer fares and significantly reduced fencing. Today, these simplified fare structures dominate most air travel markets – effectively invalidating the assumption of demand independence made in revenue management models.

Revenue management has been introduced into markets where strict fences on rates or fares never existed. Hotels, rental cars, and cruise lines have rate or fare structures that do not contain strict fences – and so the assumption of demand independence is again problematic.

Rates and fares in these simplified structures have become increasingly dynamic. Revenue managers are now frequently managing the price at which rates and fares are sold on a day to day basis.

These trends have taken travel and hospitality practices away from the expectations of the original revenue management scientists who modeled the airline revenue management problem.

With regards to hospitality and gaming, traditional revenue management approaches could support decisions regarding length of stay (when length of stay level forecasting and optimization was supported) – but only for yielding decisions, not pricing decisions. In addition, traditional revenue management can support control of traditional qualified customers – so long as the contractual arrangements allowed the customer to be yielded, and so long as the contract was not dynamic (i.e. the price of the contract is linked to a market rate). Unfortunately dynamic pricing of contracts has a number of benefits, and so such contracts are increasingly common – and the traditional revenue management approach supports neither the decision regarding the market rate, nor decisions regarding this type of linked rate.

## Revenue maximization beyond travel

At the same time that many travel and hospitality companies were struggling to make these revenue management approaches work, other industries were considering how to maximize their own revenue and profitability – and recognizing that the revenue management approach originally taken by the airlines simply would not work for them. Generally, the lack of "fit" was because the industry did not meet one of the required business conditions (limited capacity, perishable product and advanced reservations) that make the application of revenue management appropriate. Imagine, for a moment, trying to apply revenue management techniques if you are a fashion or consumer goods retailer:


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- You don't have a fixed capacity – if you start selling more toothpaste, you can buy more toothpaste to sell.
- All of your customers pay the same price – they come in, see the price tag on the item or shelf, and that's what they all pay.

So, your business fails to meet every one of the essential elements necessary for the application of traditional revenue management. That doesn't mean that a retailer can't use analytical modeling techniques to maximize their revenues. They just needed a different approach.

## Price optimization

In industries like retail, products are made available at a single price to a broad market of customers. In this broad market, each customer has a different ability or willingness to pay and the business has some capability to change the price of the product offered to the market over time. If the price is increased, the product price begins to exceed the willingness-to-pay-level of more customers and demand decreases. If the price is decreased, the product price drops below the willingness-to-pay-level of more customers, and demand increases. This is simple micro-economic theory.

Using a price optimization approach, demand for a product is estimated as a function of price, and the price itself becomes the decision variable (rather than the protection value, as described above) that is used in maximizing revenues or margin. In these businesses, there may be no advance reservations, or separation by segment, so there's no one to "protect" sales for. In addition, inventory is not constrained, so there's nothing to protect. Since the market is segmented by price, the problem becomes "what is the optimal price to charge the overall market in order to maximize return, accounting for the fact that demand will change as the price changes."

Decision support solutions that use price optimization need to estimate demand and its sensitivity to price (a.k.a. price elasticity) for a wide variety of products, often from a wide variety of channels or stores. Calculating price sensitivity on a large scale, automated basis introduces new technical challenges that these solutions have had to overcome – much research has been invested in this area over the last decade.

## The future of revenue management

Several trends have taken hold following the initial development of revenue management methods, which have undermined traditional revenue management science because they invalidate important assumptions built into the models.

Today, rather than selling a series of clearly fenced fares, many travel companies offer fare families. Fare families are distinguished from each other using a set of purchase restrictions (e.g., refundable) or benefits (e.g., frequent flyer points earned or standby benefits). In effect, each fare family represents a different product, and the price for each fare family can be varied on a day to day and flight by flight basis. Fare families represent a two-fold problem for the traditional revenue management approach:

There is no independence of demand for fares within a fare family – all of these fares have the same set of rules and restrictions, and so the assumption of independence fails completely for different fares within a fare family. The differential in restrictions and benefits between fare families is known to be relative-

ly weak so when price differentials between fare families are too large on a given flight, a customer will "jump" from choosing one fare family to choosing a different fare family. Accommodating this complex type of behavior requires a demand modeling approach that considers demand for each flight as a function of both the availability and pricing of each fare family on the flight.

Consider also the roadside hotel – this business meets the primary conditions of revenue management (fixed capacity, perishable product, and advance reservations), but very likely does not have clearly fenced segments. Rather, the hotelier chooses one of several possible rates to charge on any given date for any customer that wants a room. Once again, there is no independence of demand between these rates – they all have the same set of characteristics, so the hotel guest will always select the least expensive one.

These types of "price-able" products represent a significant portion of today's travel and hospitality market. For this type of product, a price optimization approach, where the selection of an optimal price is the primary output of the model, and price elasticity is directly modeled, is a better "fit" for the business problem.

In the airline industry new approaches to accounting for these market changes has taken two forms:

- Continued investigation into estimating up-sell (within fare families) and cross-sell (between fare families), to inform revenue management models. This methodology continues to represent the current "state of the art" for revenue management modeling for airlines.
- Investigation into the use of choice models as a more robust approach which accounts for fare family rule and benefit differences and how these are valued versus price differentials between the fare families. While theoretically attractive, these investigations have been limited in terms of actual applications.

In hospitality (including hotels and cruise lines), while price-able products make up a significant portion of the market, not all products are price-able. Many customers purchase rates and fares that are controlled not through price, but via availability (many promotions are managed this way, for example), and some segments can be both priced and managed via availability.

These changes cause of much of the confusion surrounding revenue management and price optimization approaches – today's travel and hospitality marketplace has aspects of both revenue management and price optimization problems. Hybrid analytic approaches combining aspects of both revenue management and price optimization are therefore the best solution for today's marketplace, and they allow continuing market changes.

## Integrated analytics approach

Hybrid modeling approaches allow for optimization of both price-able and yield-able rates and fares. Hybrid forecasting models can forecast demand for both price-elastic, price-able fares, as well as those that cannot be priced. Hybrid models calculate both optimal price (for price-able fares) and optimal protection levels, for those fares or rates that must be managed via availability.

The major advantage of the hybrid approach is that it models the problem as it exists and does not require significant business shifts or related technology changes in order to maximize revenues. Optimizing yieldable and price-able products together enables companies to develop pricing and inventory approaches that suit the needs of their market, but that are still supported by high-performance analytical modeling. With this approach, flexibility in supporting new sales and marketing approaches in the future is also enhanced.

Hybrid approaches have impacts in both forecasting and optimization. Forecasting changes must be made to enable forecasts which incorporate price elasticity. Optimization changes must be made to enable optimization to support both traditional revenue management protection decisions, as well as price decisions. This makes optimization significantly more complex than traditional revenue management models – but with the benefit that the models capture the full range of decisions available.

This is the future of revenue management and price optimization: flexible, integrated models that allow for the proper modeling of businesses as they exist. No more round pegs in square holes. No more shoehorning our businesses into processes that support analytics, or attempting to utilize analytics that don't really fit our businesses. Let the analytics come to the business.

Kimes, S.E. (1989). Yield Management: A Tool for Capacity-Constrained Service Firms. Journal of Operations Management, 8 (4), 348-363.

*Alex Dietz is the Principal Industry Consultant for the SAS Hospitality and Travel Practice. Dietz is a 25-year veteran of pricing and revenue management solutions development and consulting in hospitality, travel, and retail. Before joining the Hospitality and Travel Practice, he worked as the Product Manager for SAS Markdown Optimization – a price optimization solution used by leading fashion retailers – a position he held with SAS for five years. Prior to joining SAS, he was Vice President of Revenue Management and Marketing for Raleigh-Durham based Midway Airlines from 1998 to 2002, reporting directly to CEO Robert Ferguson. Dietz began his career with American Airlines, where he managed the development of American's industry-leading yield management systems. Following his time with American, he joined SABRE where he acted as product manager for SABRE's airline revenue management solution and also led SABRE's pricing and revenue management global consulting practice. In his various roles as consultant and solution developer, Alex has worked with leading airline, hospitality and retail customers around the globe. Dietz earned his MBA and BS (Industrial Engineering / Operations Research) degrees from Syracuse University.*

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