AIRLINE REVENUE MANAGEMENT IN A CHANGING BUSINESS ENVIRONMENT

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The paper first gives an overview on principles of traditional RM. The author outlines a RM approach suited to the pricing policy of low-cost airlines, where each flight only has one fare available at any point of time. In this context, effective RM boils down to a flight-by-flight dynamic price optimization. The paper emphasizes that some traditional RM principles remain valid. However, fare mix optimization and more sophisticated inventory control techniques do not apply for leg-based low-cost operations selling a single fare product at any one time during the booking period of a flight.

Keywords: *transport economics, pricing and revenue management, low-cost airlines*

1. INTRODUCTION

Revenue Management (RM) represents a mainstream business practice in daily airline operation. It is concerned with the optimization of total revenue through the use of tools and techniques. Until very recently, the focus from both the airline industry and academia has been on origin and destination (O&D) multi-leg seat inventory control. However, the changing business environment caused by the strong growth of low-fare, low-cost airlines in short-haul markets such as Europe has raised interest among researchers and airlines alike, how to adjust revenue management techniques and systems given a low-fare pricing model with non-differentiated and less restricted fare products.

The paper deals with a brief overview on principles of traditional RM. This is done in Section 2. In Section 3 it describes pricing and booking procedures currently applied by leading European low-cost airlines like Ryanair and Easyjet, where each flight only has one fare available at any point of time. Section 4 outlines a RM approach suited to this pricing approach.

However, RM for low-cost airlines differs from the one for network airlines with regard to fare mix optimization and more sophisticated inventory control techniques like O&D control. The author concludes with directions for further research on RM forecasting and optimization methods for low-cost airlines and supporting systems solutions. These are also relevant for network airlines facing low-fare competition and downward pressure on yields.

More comprehensive reviews dealing with RM can be found in McGill and Van Ryzin (1999) and Talluri and Van Ryzin (2004). The simple pricing structure that Europe's low-cost airlines apply using Easyjet for their research Koenigsberg, Muller and Vilcassim (2004) have described. The impact of these pricing and booking procedures at low-cost airlines on RM has recently attracted increasing interest of airline consultants like Rubicon Group and RM systems provider like Lufthansa Systems. To the author's knowledge, Fletcher (2003) has provided the first paper with an alternative view on RM given a low-fare airline business model.

2. PRINCIPLES OF REVENUE MANAGEMENT (RM)

There are several characteristics of industries that make the application of RM most effective (Klophaus 1998):

- The product is perishable, which means that it is expensive or impossible to store excess inventory;
- Future demand is uncertain;
- The capacity to offer the product is limited and it is expensive or impossible to increase capacity quickly;

- The market can be segmented (i.e., customers are willing to pay different prices for the same product;
- The fixed cost for offering the product is high, while the marginal cost is low.

All of these characteristics hold for the airline industry. So it is no surprise that airlines have been the inventors and first users of revenue management.

Major US carriers first introduced RM after airline deregulation in 1978. American Airlines is acknowledged for the first capacity controlled discounted fares in the airline market. The principle of placing booking limits on discounted fares allowed the major network carriers to protect their high-yield market segments while simultaneously competing with the new low-cost carriers in the low-yield segment. In the meanwhile, RM has become an industry standard. Lufthansa credits RM techniques for an increase in revenue amounting to more than € 700 million per year (Klophaus 1998). Other industries like car rentals, broadcasting, hotels, cruise lines and so forth followed and adopted the RM principles to their needs.

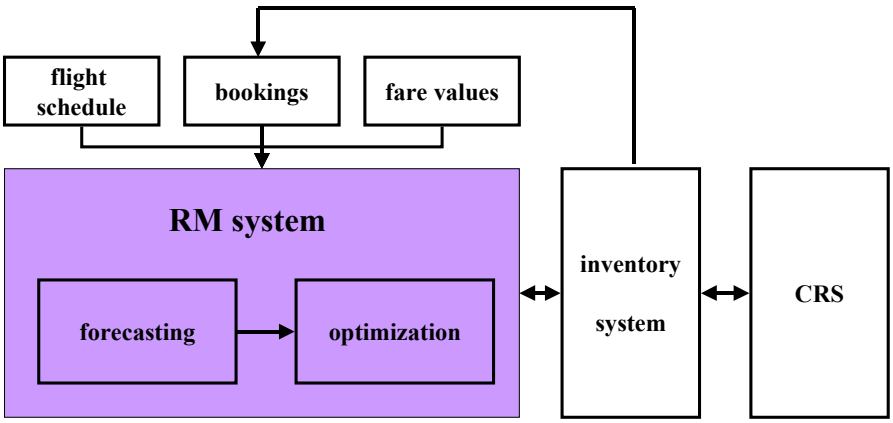

Figure 1. *RM system*

Figure 1 shows the main modules of a RM system. A state-of-the-art system merges two forecasting models to achieve a high degree of quality in this important RM function. These are the seasonal forecast and the bookings-based forecast. The former is ideal for producing a first estimate and for adjusting to seasonal changes, while the latter method performs better in the reservation period closer to departure. Generally, the weighting of the seasonal forecast decreases during the booking period, while the weighting of the bookings-based forecast increases. Hence, both forecasts are used in the optimization. The resulting control parameters are passed to the computer reservation system (CRS) in order to control availability and booking requests.

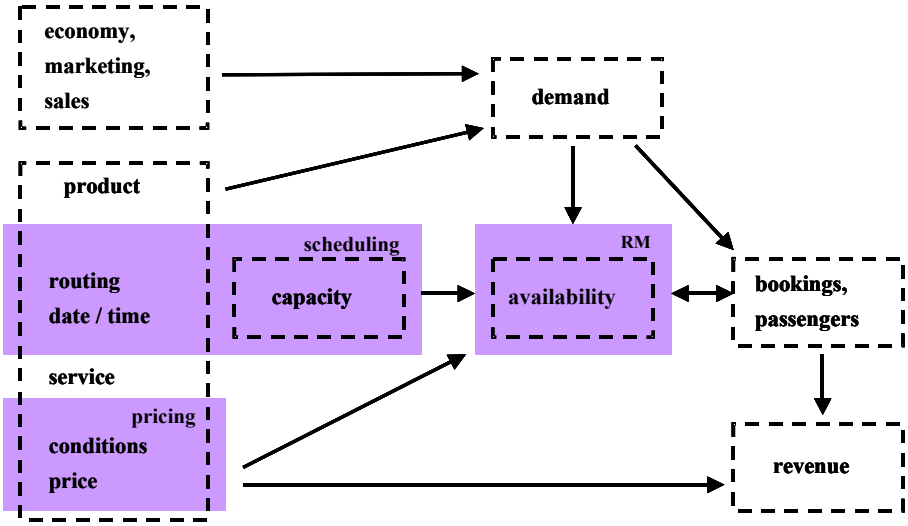

Figure 2. *Interactions of scheduling, pricing and revenue management (Pölt 2002)*

Figure 2 depicts the interactions of scheduling, pricing and RM that determine total airline revenue. The product an airline offers is to a great extent defined by scheduling and pricing. Scheduling specifies the routing, the frequency, the departure time, whether it is a non-stop or a connection. Pricing sets the price and the conditions. Other product features like service, seat pitch, lounges and so on that are defined by product management and frequent flyer programs are not considered here. The quality of the product affects the demand for it. The demand is also influenced by factors like the state of the economy, marketing and sales efforts and so forth. The role of RM is to match the demand with the offered capacity by determining the product availability. This leads to the basic airline seat inventory control problem if a seat should be sold at a current booking request, or if it should be saved for a more profitable customer. For this purpose, RM needs information about the value of the booking request. As information either the fares from pricing can be used or historical average revenues from revenue accounting. The availability together with the demand defines how many bookings the airline has for each product. This translates to revenue. The central message of Figure 2 is that the interactions of scheduling, pricing and RM determine to a large extent the total airline revenue. To maximize revenue the decisions within scheduling, pricing and RM are to be aligned (Pölt 2002).

Common wisdom in airline RM holds that selling more seats than the capacity on a given flight is the only way to compensate for passengers failing to show up at departure, causing loss of revenue due to empty seats. On flights operated by Lufthansa more than 5.5 million passengers did not show up in 2004. This corresponds to 14,000 full Boeing 747. Overbooking allowed Lufthansa to carry more than 640,000 additional passengers. Lufthansa credits the practice of selling a number of tickets for a flight that is greater than the flight capacity for a revenue increase of € 126 million in 2004 (denied boarding costs already deducted) making overbooking not only one of the oldest RM techniques applied by Lufthansa but also one of the most powerful. Like Lufthansa most major American and European airlines overbook their flights above the physical capacity of the aircraft. However, leading low-cost airlines like Ryanair do not overbook their flights and therefore eliminate the possibility of passengers being involuntarily denied boarding as a result of overbooking (Klophaus/Pölt 2005).

There are several ways to calculate and display availabilities in the computer reservation systems. In the beginning, every booking class had its own seat allocation and if the number of bookings had reached this limit, the booking class was sold out. This seat allocation method leads to situations where a high booking class is sold out while a lower booking class is still available. Nesting of booking classes eliminates such illogical situations. In linear nesting there is a linear order of the booking classes and higher nested booking classes have access to the allocations of lower nested booking classes.

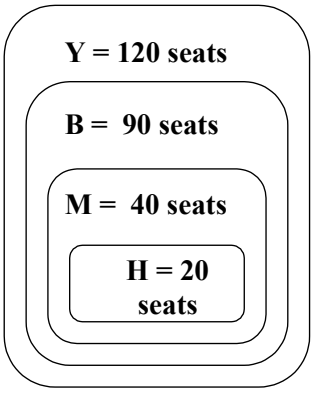

Figure 3. *Nested seat allocation*

In this example, the allocation of highest Y-class contains the allocation of the lower nested B-class. Simulations have shown that with realistic errors in the demand forecasts, linear nesting is the better method and results in revenue gains of 10 per cent and more.

In fare-mix optimization the booking limits are calculated. A popular and robust heuristics to allocate inventory among fare products to maximize profits in the face of uncertain level of demand is expected marginal seat revenue (EMSR) first published in the late eighties.

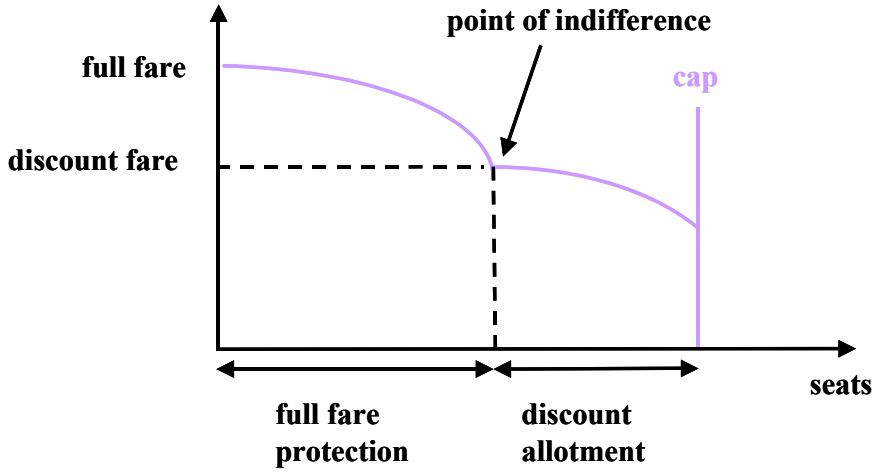

Figure 4. Expected marginal seat revenue (*EMSR)*

For the EMSR heuristic, the probability of each passenger's arrival is calculated from the forecast. The fare level or the average revenue of the booking class leading to the expected marginal seat revenue multiplies the probability. EMSR takes into account the revenue potential of a passenger and the probability of his or her arrival. Figure 4 depicts the basic idea of the EMSR concept. Units of capacity (e.g. seats) are reserved incrementally for customers paying full fare, one at a time, until the expected marginal revenue for the next unit, if protected for a customer in this fare class, is equal to or less than the discount rate.

Leg-based RM methods like EMSR have a disadvantage – they cannot distinguish between one-leg and connecting demand. A connecting passenger gets availability for a booking class if and only if the class is open at both legs. And the optimization of booking class limits is done at both legs independently and separately. Because of the fare structure of airlines two one-leg passengers, one travelling leg 1 and the other travelling leg 2, usually give more revenue than one connecting passenger, while in both cases the same number of seats on the same flights is used. If there is low demand on both legs, the independent optimization of legs does not hurt since every booking request - regardless of one-leg or connecting - should be accepted. If there is low demand at one leg but high demand at the other, connecting passengers should be preferred to one-leg passengers on the bottleneck leg. But, a leg-based RM system cannot distinguish between them. If there is high demand at both legs, two one-leg passengers should be preferred to one connecting passenger of the same booking class. Again, leg-optimization cannot distinguish and accepts within a booking class in a first-come-first-serve order. Another advantage of origin and destination (O&D) inventory control is that it can distinguish different points of sales. For some countries it makes a big difference for the airline at which place the booking was made and in which currency the ticket is paid.

3. PRICING AND BOOKING PROCEDURES AT LOW-COST AIRLINES

The low-cost pricing model radically differs from the pricing approach of network airlines (Fletcher 2003). Traditional pricing includes fences like the fare restriction of a Saturday night or minimum stay to segment travellers according to their willingness to pay different prices for the same product. In addition, each flight is segmented into booking classes, each of which has fare products associated with. The higher fares have fewer restrictions. Further, the fare products may be combined with certain distribution channels to effectively segment the market. The traditional approach to pricing and inventory control is to protect enough seats for higher yielding demand. The resultant seat availabilities are set to get the best mix from a portfolio of fares.

By contrast, in the pure low-cost pricing model, there is no explicit market segmentation. Price versus demand is a continuum although in practice airlines increase fares in steps e.g. € 29, € 39, € 49 etc. The simple pricing problem is how much should the selling price of each flight be at a particular point in the booking period. If the price is too low, the flight will fill up too early meaning higher yielding later booking demand will be turned away. If the price is too high, the flight risks departing with empty seats that otherwise could have been sold.

The low-cost pricing model can be summarized as follows:

- Each flight only has one price available at any point in time;
- One-way pricing, no Saturday night or minimum restriction;
- During the booking period of a flight, prices most likely go up;
- Flights have only one cabin compartment but several booking classes as 'virtual' compartments;
- Removal of advance purchase restriction (Apex rules);
- Bookings are non-refundable but changeable for a fee;
- Most bookings are made through the Internet leading to an increased price transparency.

In consequence, traditional pricing fences of network airlines to segment market are removed. Low-fare pricing can be considered as a synonym for one-way, restriction-free pricing. The only remaining effective segmentation possible is through time of booking and choice of flight. Once the contingent of seats in a lower booking class is sold, the booking class is closed and the one higher booking class becomes available for sales. The basic RM problem is recast from a portfolio mix problem to a price optimization problem.

4. CONSEQUENCES FOR RM

Although pre-conditions to apply RM still hold for low-cost airlines, some of the traditional RM forecasting and optimization techniques are no longer valid under such a pricing model. It becomes difficult to forecast demand. A basic question with regard to demand forecasting is how to derive price elasticity information where only one price is available at any given time. The classic fare mix optimization is also no longer appropriate. The RM problem is now one of how to calculate the optimum fare to charge at any point before flight departure. Network airlines facing low-cost competition which continue to apply traditional RM control techniques may encounter a spiral down effect, i.e., lower demand for higher fare products leads to greater availability of low-fare products resulting in a further decrease in high-fare demand.

Traditional RM assumes market segmentation and fares, which have rules and regulations. Even without RM, there is a mix of passengers owing to fare rules. RM of unrestricted fares is a different issue. The passenger will always buy the lowest fare in the cabin. On off-peak flights with lower seat load factor, demand will always shift to the lowest available booking class. Traditionally, RM controlled only peak flights, as the fare rules ensured some mix of passengers. Now, off-peak flights also need to be controlled at a detailed level. The dilution risk on off-peak flights must be assessed against the potential for volume growth on off-peak flights (Donelly/James/Binnion 2004). The role of RM has been re-defined; the question becomes when to close the current available booking class – after x number of bookings or y days before departure (Donelly/James/Binnion 2004). Calculating when to close a booking class should reflect the level of price elasticity for that flight.

Low-fare RM has to consider that low fares must be visible in the market (e.g. during promotions). Hence, RM assigns a minimal capacity to these fares even on high demand flights. To optimize average revenue, RM needs to find the best time to increase fares on each flight and to force late booking business travellers into high fares (up-selling) even on low demand flights. Further, no nesting of fare classes is required when only one booking class with one fare is available at any point in time and also no origin and destination (O&D) multi-leg seat inventory control due to the point-to-point traffic pattern at low-cost airlines. Optimization boils down to dynamic price optimization instead of getting the best mix from a portfolio of fares. By looking at low-cost airlines and their relatively low no-show rates, network airlines like Lufthansa are prompted to review underlying principles of their own overbooking policy. First, network airlines should pursue ways to better control seat inventory even when travel agents remain the most important sales channel. Second, fare conditions for lower and medium fares are to be reviewed.

5. CONCLUSIONS

In the new business environment revenue gains for airlines from applying RM remain substantial. In addition, pricing, scheduling and RM are still deeply interconnected and a high forecasting accuracy still translates to revenue increases. However, forecasting methods and some basic RM principles like overbooking and the EMSR heuristic need to adapt to the changing airline marketplace. Other inventory control techniques like nested seat allocations or origin and destination (O&D) multi-leg seat inventory control are no longer relevant within the point-to-point traffic pattern of low-cost airlines offering only one booking class with only one available fare at any point during the booking period of a flight.

The low-fare environment asks for new supporting RM forecasting and optimization methods. These are also relevant for network airlines facing low-fare competition and downward pressure on yields.

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