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Transfer price optimization for option-based airline alliance revenue management

M. Graf, A. Kimms*

Chair of Logistics and Operations Research, Mercator School of Management, University of Duisburg–Essen, Lotharstr. 65, 47048 Duisburg, Germany

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ABSTRACT

Recently, an option-based capacity control process for the case of airline alliance revenue management with two partner airlines providing flight tickets on a single flight leg has been proposed. This previous work describes the determination of the booking limits as control variables for the capacity control by means of real options as well as simulation models which consider the option-based process to evaluate the booking process of the partner airlines within the strategic alliance. The booking limits are improved with simulation-based optimization in an iterative process. However, the transfer prices are assumed to be given. In this paper, the optimal transfer prices will be determined by a negotiation process. The results of the option-based capacity control process combined with transfer price optimization will be compared with the results of a first-come-first-served approach, ex post optimal solutions, a blocked seat allotment procedure and a random approach.

1. Introduction

Due to deregulation of fares in the airline industry in the late 1970s, major airlines were confronted with the competition of low-cost carriers entering the markets. As stated by Shumsky (2006), low-cost competitors force major traditional carriers to process an increasing amount of their traffic in airline alliances. By forming strategic alliances, the airlines can generate additional revenues, for example, due to extended flight networks, coordinated flight schedules, and higher load factors. Further incentives for airlines to join strategic alliances are listed in Oum and Park (1997). According to O'Neal et al. (2007), the partner airlines within an alliance combine their flights through code sharing. Code-sharing agreements allow partner airlines within the alliance to offer a flight operated by one of the partners as a product of another partner airline.

To maximize their profit generated from a limited seat capacity, the airlines decide which fares to charge and how many seats to reserve for each customer segment with support of revenue management instruments. Talluri and van Ryzin (2004) give a detailed description of revenue management instruments. Kimms and Klein (2005) list several specific and general definitions of revenue management and describe the revenue management instruments as well as the requirements for implementing revenue management instruments. In this paper, we focus on capacity control in revenue management applications in the airline industry. However, there are several other sectors in which the use of revenue management instruments make significant contributions to the performance. Kimms and Klein (2005) and McGill and van Ryzin (1999) present an overview of revenue management research in non-airline service sectors.

Airlines use revenue management capacity control to coordinate the seat capacity of an aircraft. Talluri and van Ryzin (2004) outline current publications covering capacity control methods for a single airline not part of an alliance which in fact is already a highly complex problem. However, new decision problems concerning the capacity allocation occur if airlines build strategic alliances: Capacity control not only has to sort out how many seats should be allocated to the different booking classes of the airlines, but also how the seats will be divided among the alliance partners. Boyd (1998) specified two common decision control mechanisms used in practice: in a free sale, the airline operating the considered flight provides access to the seats in the aircraft to the non-operating alliance partners. The alliance partner airlines are allowed to access the seats, for example, in a first-come-first-served order. In a blocked seat allotment procedure, each airline will individually control the seats they have been assigned before the booking process. The drawbacks of capacity control methods so far applied for strategic alliances are: In a free sale setting, no capacity will be reserved for higher yielding booking classes while in a blocked seat allotment procedure, each airline will individually control the seats they have been assigned to which leads to static allotments.

* Corresponding author. Tel.: +49 203 379 3492; fax: +49 203 379 5451.
E-mail addresses: michaela.graf@uni-due.de (M. Graf), alf.kimms@uni-due.de (A. Kimms).
URL: http://www.msm.uni-due.de/log/ (A. Kimms).

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Although there are some publications regarding alliance revenue management (compare Boyd, 1998; Brueckner, 2003; Brueckner and Whalen, 2000; Vinod, 2005; Wright et al., 2010), to the best of our knowledge, there is no literature that describes option-based capacity control models or methods with transfer price optimization for strategic alliances.

We presented an option-based decision control for two partners within an alliance in a previous publication (see Graf and Kimms, 2011). This option-based decision control overcomes the mentioned disadvantages of the common decision control mechanisms so far used in practice by calculating booking limits for the alliance partners to reserve seat capacity for higher yielding booking classes and by allowing the alliance partners to switch their assigned capacity during the booking processes. The main contribution of our work to revenue management literature is an option-based capacity control procedure with transfer price optimization to divide the capacity among partners of a strategic alliance.

In Graf and Kimms (2011), two procedures with the underlying option-based decision control were presented. The transfer prices used in these procedures were assumed to be given parameters. The surveys outlined in Graf and Kimms (2011) revealed that the results of the introduced methods depend on the choice of the transfer prices. The optimal transfer prices can be determined by systematically searching through the entire solution space. Since this approach is very run-time-intensive, methods to efficiently incorporate optimal transfer prices as an extension to the procedures described in Graf and Kimms (2011) will be introduced in this paper.

This paper is organized as follows: In Section 2 we present the option-based capacity control procedure enhanced by a negotiation process to determine optimal transfer prices. Furthermore, we illustrate the determination of the booking limits and the simulation of the booking process of the alliance partners including real options and transfer prices. To be self-contained, Sections 2.1 and 2.2 briefly repeat what is described in Graf and Kimms (2011) in greater detail already. In Section 3 the negotiation process to optimize the transfer prices will be discussed. Section 4 contains the computational study outlining the adopted test bed and comparing the results of the introduced option-based control with transfer price optimization to the results of the first-come-first-served approach, the ex post optimal solution, the blocked seat allotment approach, and the random approach. The implementation of the first-come-first-served approach, the ex post optimal solution, the blocked seat allotment approach and the random approach will be explained in Section 4. We summarize our study in Section 5 which concludes the paper with some comments on further research possibilities.

2. Capacity control with real options and transfer price optimization

In the following, real options to divide the capacity in an aircraft among the members of the alliance are considered. As stated by Amram and Kulatilaka (1999), an option is the right, but not the obligation to take an action in the future. Compare Amram and Kulatilaka (1999) as well for a detailed discussion concerning the classification of options and for a survey of literature describing other industries utilizing real options.

The underlying idea of real options in our context is the following: the non-operating airline can buy an option to possess the right of buying the underlying asset at a fixed price in the future by paying the option price up front. To exercise the option and actually buy the asset during the booking process, the non-operating airline has to pay a defined strike price. The asset corresponds to a seat in the aircraft of the operating airline in our application. The goal of the option-based mechanism is to maximize the combined revenue of the alliance partners.

We make the following assumptions in order to explain the new procedures: an alliance with two airlines is considered. The operating airlines provides seats in an aircraft that is operated on a single flight leg. This airline will be called operating carrier (OC). The other airline can access the seats of the operating carrier by buying options for the seats. We have chosen the term ticketing carrier (TC) to classify this airline based on the remarks of Brueckner (2003). Other papers refer to the non-operating airline as marketing carrier (see Shumsky, 2006). In our application, the ticketing carrier does not operate a flight that is a direct substitute to the one operated by the operating carrier. In practice, however, it is not uncommon for both airlines to act as operating and ticketing carriers depending on which flight leg is being considered.

The option price and strike price can be subsumed under the generic term ‘transfer price’. There are many publications dealing with transfer prices in the field of accounting (compare, for example, Bierman, 1959; Cook, 1955; Dean, 1955; Eccles, 1985; Kaplan and Atkinson, 1998; Stone, 1956; Tang, 1993; Verlage, 1975). An early publication which discusses transfer-price policies as instruments for intracompany pricing in the field of accounting was introduced by Hirshleifer (1956). He defines a transfer price to be the price of a good or service that is exchanged between separate autonomous operating divisions within a corporation. According to Tang (1993), a transfer price describes the cost of the division which buys just as the revenue the selling division achieves. Establishing a connection between strategic alliances and this definition, an alliance will be regarded as a corporation with separate autonomous operating divisions representing the stand-alone partner airlines integrated in the alliance. The option price represents a payment that the ticketing carrier conveys to the operating carrier in exchange for a service, the reservation of seat capacity in the operating carrier's aircraft by means of real options. By paying the strike price to the operating carrier, the ticketing carrier obtains the right to sell a ticket for a seat in the operating carrier's aircraft. The operating carrier can pay back the option price to the ticketing carrier in exchange for an option that the ticketing carrier bought from the operating carrier beforehand. So, as described in our application area, the option price and the strike price are payments that are only authorized among the partners of the alliance. The end customer, which is the airline passenger in our application area, will not pay or even notice these payments.

In the field of accounting Bierman (1959) suggests to use negotiated transfer prices or a combination of market-based and negotiated transfer prices. There are other authors recommending negotiations to determine transfer prices that maximize the revenue of the firm (compare Chalos and Haka, 1990; Dean, 1955; Haake and Martini, 2008; Kaplan and Atkinson, 1998). Since, in our application area, the market prices charged by the partner airlines for a ticket in the different booking classes give some evidence about the determination of the transfer prices, we decided to choose a method for determining the optimal transfer prices that is a combination of market-based transfer prices and negotiated transfer prices. This combined mechanism will be described in Section 3.

The interaction between the operating carrier and the ticketing carrier can be divided in the interaction before, during, and after the booking process. The airlines start a negotiation process after the simulation of the booking process concerning the option price and the strike price. The negotiation process will be described in detail in Section 3.

Fig. 1 shows the interaction between the operating carrier and the ticketing carrier.

Before the booking process starts for a particular flight operated by the operating carrier, the operating carrier calculates the booking limits for the operating carrier's booking classes according