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Note

A note on effective code-share management in practice

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ABSTRACT

Because code-sharing lets airlines market inventory jointly, it is central to alliance strategy. This research note discusses a common code-share revenue management process and quantifies code-sharing based on empirical data provided by Lufthansa German Airlines. We highlight overcoming selfishness, information asymmetry, system heterogeneity and decentralization as main challenges to effective code-share management.

1. Introduction

As alliances can improve profitability and market share, they enjoy increasing popularity in the airline industry (Topaloglu, 2012). Between 2003 and 2010, the number of alliance members grew by 60% (Hu et al., 2013). Most large and mid-sized network carriers are engaged in one of the three big alliances – Star Alliance, Oneworld and SkyTeam (compare Table 1). The case of Lufthansa and StarAlliance as examined later in this contribution underlines this increasing diffusion of code-sharing. Competition among alliances is replacing competition among individual airlines, as each alliance strives for the best customer service and the most extensive network.

The success of alliances is explained by their benefits. Airlines use the alliance's brand awareness to attract more passengers and to access partners' infrastructure - compare Youssef and Hansen (1994) for an exemplary analysis of the case of SwissAir and SAS. Alliances establish standards of safety, technical equipment, and customer service. They promise passengers better connections, higher service quality, more lounges, and frequent flyer miles - see Goh and Uncles (2003) for a critical analysis. However, alliances also challenge airline planning: They increase process complexity, which can negatively impact performance.

This contribution highlights alliance challenges particularly for revenue management. Revenue management describes the art of *selling the right seats to the right customers for the right prices at the right times* (compare Smith et al., 1992). It is a central component of the airline planning process: Given a demand forecast, optimization determines revenue-maximizing inventory controls, which are implemented in the sales process.

Capacity-based network revenue management controls product availability via itinerary–fare class combinations. While intraline itineraries are sold and operated by the a single carrier, code-share itineraries result as multiple carriers cooperate by assigning their designators to each other's flights and marketing them under their own name (Vinod, 2005). This enables airlines to serve new markets and feed additional passengers into the own network (Oum et al., 1996).

As selling code-share itineraries involves multiple airlines, we distinguish marketing and operating carriers. The former issues the ticket; the latter operates the flights. Fig. 1 illustrates a typical airline code-share revenue management process.

To sell a code-share ticket, the involved flights' operating carriers must each provide a seat. In practice, this is realized by exchanging real-time inventory levels. Following Vinod (2005), code-share revenue management is currently realized via either blocked space or free sale agreements. In a blocked space agreement, the marketing carrier receives a fixed share of the partner's capacity to sell as desired. Soft blocks allow for updates over the booking horizon, whereas hard blocks are fixed. In a free sale agreement, every operating carrier controls their own inventory and transfers their flight-class availabilities to the marketing carrier. Based on a mapping that connects the operating and the

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Table 1
Summary of airline alliances.

	Members	Revenue (BUSD)	Passengers (mil.)
Star Alliance[a]	28	179.05	641.10
SkyTeam[b]	20	146	665.4
Oneworld[c]	15	141.4	512.6

[a] http://www.staralliance.com/en/about, March 2016.
[b] http://www.skyteam.com/en/About-us, March 2016.
[c] http://www.oneworld.com/news-information/oneworld-fact-sheets/, March 2016.

marketing carriers' classes, the marketing carrier determines the code-share availability. Accordingly, all code-share itineraries receive the availability assigned to the local itinerary. The challenges of code-share management as pointed out in this note do apply to each type of agreement, as each requires going beyond selfish motives, exchanging information, establishing joint standards, and centralizing acceptance decisions.

Once a code-share booking is accepted, the operating carriers update their inventory and booking references. The marketing carrier collects the fare, issues the ticket, and compensates operating carriers. Revenue sharing schemes govern compensation and revenue distribution.

2. The increasing diffusion of code-sharing – the case of Lufthansa and Star Alliance

The number of Lufthansa flights used for or impacted by code-sharing increased tremendously from 2000 to 2010. While operated flights remained relatively constant, the share of exclusively marketed flights dropped from 60% in 2000 to less than 20% in 2010. During the same period, the number of flights marketed by Lufthansa but operated by another airline increased by more than 80%.

Fig. 2 depicts the average number of Lufthansa marketed flights per week from 1994 to 2011. Flights are divided into three categories: (1) operated and marketed by Lufthansa, (2) operated by Lufthansa and marketed by at least one other airline and (3) operated by another airline and marketed by Lufthansa.

Code-sharing increased Lufthansa marketed flights by more than 115% to about 4100 per day in 2011. More than 90% of these were either operated by a code-share partner or marketed by one. This shows that code-sharing impacts large parts of the network; furthermore, it accounts for 7–9% of total bookings. Experts from other airlines report numbers between 6 and 16%. However, the share of code-share bookings is considerably higher on hub-to-hub routes, reaching values between 15 and 25%. It is even higher on

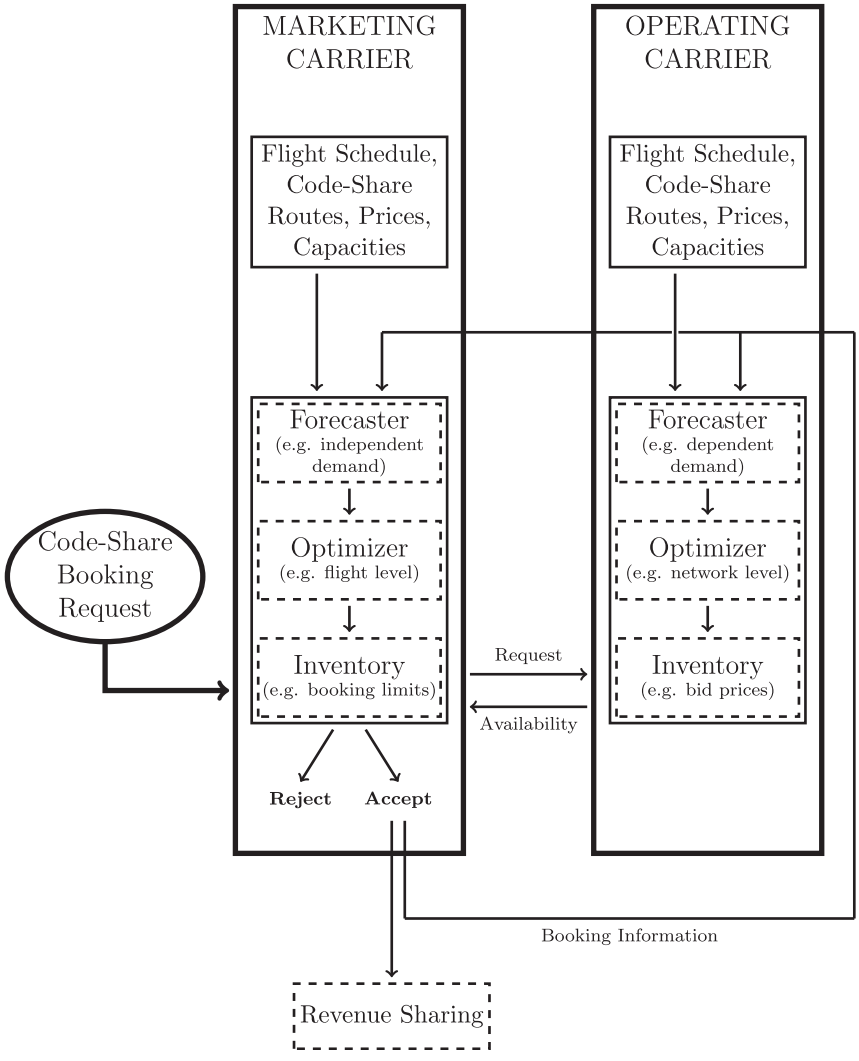

Fig. 1. Code-share revenue management process in practice.

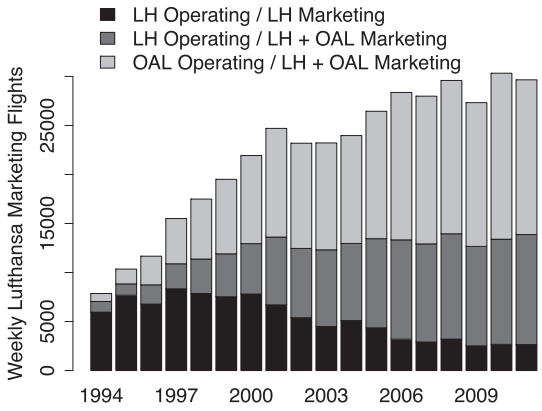

Fig. 2. Development of Lufthansa marketing flights.

individual flights.

The share of code-share bookings is also high in areas governed by pricing agreements, such as transatlantic routes. Here, airlines coordinate sales activities and act indifferently between selling their own and their partners' inventory. This is referred to as "metal-neutrality". Moreover, roughly 10% of all Lufthansa passengers on hub-to-hub routes continue their journey beyond the partner hub on a complementary code-share flight. 1.6% of all the airline's intercontinental bookings occur on code-share flights to destinations outside its own network.

Finally, analyzing summer flight schedules from 2000 to 2010 also shows how the three big alliances evolved strategically. On the one hand, the number of city pairs served by two or more alliance members decreased (Star Alliance from 22% to 17%; SkyTeam from 20% to 12%; Oneworld from 14% to 11%), while only hub-to-hub routes are consistently served by multiple carriers. On the other hand, the use of complementary code-sharing to destinations outside an airline's own network tripled. This suggests that alliance members focus on extending their networks and that they strive to reduce overlaps.

As the importance of code-sharing is growing constantly, the gap between the economic significance of code-shares and the quality systems controlling them increases. Even though theoretical research offers a wealth of methods for code-share control, these are rarely implemented in practice. The following section highlights the challenges airlines have to overcome to change this.

3. Challenges to implementing code-share revenue management

Integrating code-sharing in the revenue management process is essential (Vinod, 2005). However, such coordination is difficult to implement in practice. The main obstacles to overcome are selfishness, information asymmetries, heterogeneity, and decentralization.

3.1. Selfishness

Selfishness refers to the egoistic nature of alliance members, who act as separate profit centers. Consequently, they focus on individual performance and potentially act opportunistically, exploiting the alliance. As a typical example, common revenue management approaches do not account for code-sharing, but maximizes the carrier's individual revenue.

In the context of revenue management, code-share partners are tempted to cheat on each other in three ways: Particularly for blocked space agreements, carriers can restrict the available inventory to prohibit the partner from selling code-share tickets or shift low-value passengers to the partner's flights. Furthermore, a carrier can underbid the partner on code-share routes and thereby reduce joint yield.

To overcome selfishness, alliances need to stimulate cooperation. Without the willingness to cooperate, any alliance is likely to fail. Cooperative behavior can be encouraged by appropriate incentives rewarding joint decisions and letting each partner experience the benefits. Particularly in the airline industry, high competitive pressure and low margins make incentive and allocation schemes an effective steering mechanism.

Revenue sharing schemes and the valuation of code-share itineraries in the optimization are two powerful levers. For instance, ideas on how to valuate code-share itineraries in a way that avoids opportunistic behavior can be drawn from cooperative game theory (Hu et al., 2013). However, implementing sophisticated control and compensation schemes also requires increasing information exchange.

3.2. Information asymmetry

Information asymmetry arises when one partner possesses more information than the others. Sharing information is essential to improve the internal decisions and to coordinate the alliance. If carriers' systems' capabilities differ, they may not be able to collect, store, and use the same data. This particularly affects free sale agreements, as classes have to be mapped and availabilities have to be communicated between partners.

In code-share revenue management as illustrated by Fig. 1, information asymmetry arises at three points: (1) Information about intraline itineraries, such as the local fares and the expected demand, is private to the operating carrier. (2) Airlines only monitor their own flight's booking levels. (3) Only the marketing carrier can access all details of a booking request for code-share flights such as the complete routing and the sales channel. The operating carriers simply observe a local booking and neither know the actual fare nor the booking restrictions that the passenger accepted.

Gerlach et al. (2013) note that the required frequency of information sharing varies with the decision problem. While infrequent exchange may suffice to coordinate route planning and flight scheduling, instantaneous information sharing is essential for effective revenue management.

3.3. Heterogeneity

Heterogeneity results as airlines implement unique business processes and develop customized information systems. Different market segments may require different products or sales approaches, and legal requirements differ across markets and countries. Consequentially, information systems and data structures are often distinct. Overall, this creates an extensive and company-specific information systems landscape.

Specifically for revenue management, we see three main implications of heterogeneity. Firstly, different forecast and optimization methods require different input data and provide different result types. Secondly, most carriers have distinct price and product structures. Thirdly, airlines often use different inventory control mechanisms, e.g. bid prices as opposed to booking class limits.

To overcome heterogeneity, partners can either standardize their systems or develop interfaces that convert shared information. Either transition may be realized system by system over a longer period of time due to the large number of dependencies and the required investments. However, both variant come at a cost: The former may not optimally support carriers' individual business processes. The latter increases the cost and complexity of

information systems, e.g. in terms of data consistency and maintenance.

3.4. Decentralization

Decentralization refers to the technical, organizational, and geographical fragmentation of code-share partners. Airlines are scattered around the world and legislation hampers foreign takeovers. Boyd (1998) notes that the easiest solution would be centrally optimizing the entire inventory. However, legal, technical, and organizational constraints make this near-impossible.

From a more theoretical perspective, Kim (1991) mentions four hazards of centralization: Computational complexity, operational timeliness, vulnerability to instability, and inefficiency when the central system cannot account for specific attributes of the individual systems.

Thus, centralized planning requires the highest commitment from the partners. For merged companies, centralization is a logical step and resolves the inefficiencies of decentralization. Nevertheless, potential problems may arise from the size and complexity of the resulting systems and need to be carefully analyzed in advance. Furthermore, other factors such as the willingness to collaborate at the grassroots level remain. Here, the value of expertise built while supporting codeshare management without centralized systems can turn into an impediment, as experts may be unwilling to let go of well-learned work-arounds.

4. Conclusion

We expect that the high competitive pressure and low margins in the industry will further incentivize carriers to form alliances. Already, alliance partners frequently request partial immunity or merge. Consequently, we believe that the need to integrate planning and to optimize the joint performance in spite of legal, technical, and organizational constraints will increase. At the same time, airlines must weight the possible benefits especially of small partnerships against the required effort.

Beyond existing research in airline revenue management, inspiration may come from other industries, where similar developments have been studied. For example, Agarwal and Ergun (2010) and Houghtalen et al. (2011) discuss coordinating liner shipping and cargo alliances. Their analyses focus on the network design and capacity allocation problem; they use cooperative game theory to model the interaction of alliance members. The stream of supply chain research discusses how independent partners manage their inventory under various supply chain contracts. The use of revenue sharing contracts in supply chain coordination is presented for instance in Cachon and Lariviere (2005) and Palsule-Desai (2013).

Airline management needs to increase its attention for codesharing as proactively responding to this development will provide future competitive advantages. Research can support this development by addressing the challenges raised in this paper. On the one hand, existing ideas from other streams of research may be transferred to the specific code-share revenue management problem, for example the intensified application of game theory. On the other hand, there is a large potential for new approaches that provide effective code-share control while accounting for practical constraints. The resulting insights need to be transformed into concrete actions for airlines and will help to foster the long-term success of alliances.

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