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## Revenue Sharing in Airline Alliances

Xing Hu

Lundquist College of Business, University of Oregon, Eugene, Oregon 97403, xingh@uoregon.edu

René Caldentey, Gustavo Vulcano

Leonard N. Stern School of Business, New York University, New York 10012 {rcaldent@stern.nyu.edu, gvulcano@stern.nyu.edu}

We propose a two-stage game-theoretic approach to study the operations of an airline alliance in which independent carriers, managing different reservation and information systems, can collaboratively market and operate codeshare and interline itineraries. In the first-stage game, airlines negotiate fixed proration rates to share the revenues generated by such itineraries. In the second-stage game, airlines operate independent inventory control systems to maximize their own expected revenues. We derive a revenue-sharing rule that is (i) an admissible outcome of the first-stage negotiation, in the sense that no airline coalition has enough incentives to secede from the grand alliance, and (ii) efficient for the second-stage game, in the sense that the decentralized system can achieve the same revenues as a central planner managing the global alliance network. Our numerical study shows that the proposed proration rates can lead to a significant increase in revenues with respect to other rules commonly used in practice. Finally, because our proposal requires the disclosure of private demand information, we introduce a simple alternative rule that is based on public information. This heuristic performs remarkably well, becoming an interesting candidate to be pursued in practice.

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## 1. Introduction

An *airline alliance* is an agreement between multiple independent partners to collaborate in various activities to streamline costs (e.g., by sharing sales offices, maintenance facilities, ground handling personnel, check-in and boarding staff, etc.) while expanding global reach and market penetration. The presence of alliances in the airline industry has followed an increasing trend since the first large airline alliance was formed in 1989 between Northwest and KLM. By March 2009, the three major alliances combined (Star, Sky Team, and Oneworld) flew nearly 73% of all passengers worldwide. The aggregate number of members evolved from 33 in 2003 to 52 in 2010. As the airline revenue management (RM) practice within the boundaries of a company is acknowledged to generate incremental revenues when switching inventory controls from leg-based to origin-destination (O-D)-based (2%-7% according to Vinod 2005), the formation of alliances scales up this benefit. At the same time, with the advent of airline alliances, the practice of O-D RM has become even more challenging.

One of the fundamental building blocks of an airline alliance is the ability to offer codeshare and interline flights. *Code sharing*, or *codeshare*, is the practice of one airline (the marketing carrier) marketing and selling its own itineraries and services on flights that are actually operated by a different airline (the operating carrier). Interlining permits a carrier to ticket another airline on its own ticket stock, leading to agreements that can be unilateral or bilateral. For example, within Oneworld, a one-stop itinerary from Buenos Aires (EZE) to Chicago (ORD) is operated by two airlines with the first leg Buenos Aires (EZE) to Miami (MIA) operated by LAN Airlines and the second leg MIA to ORD operated by American Airlines (AA). This itinerary is offered under both a codeshare agreement, where LAN is the marketing carrier of the AA flight but both legs are sold as LAN flights, and under an interline agreement, where LAN sells a sequence of two legs: a LAN leg and an AA leg. Thus, an itinerary as a combination of flight legs, may be operated by two or more companies, so that a request for a ticket will be accepted only if all airlines operating the legs agree to do so. The airlines involved generate revenues, and a transfer price is paid by the marketing airline to the operating airline(s) for the consumption of capacity. To illustrate the magnitude of the codeshare/interline practice, its revenues at Oneworld reached US\$2.2 billion in 2010, an increase of 17% year-on-year. For some Oneworld members, these multicarrier revenues