**Overbooking with Endogenous Demand**

Overbooking is commonly used in the travel and hospitality sectors as a means to ensure available supply isn’t left idle. Airline companies in particular often oversell flights because they anticipate passenger cancellations and no-shows.

Although overbooking is perfectly legal in many countries and can benefit firms, via increased revenues, as well as customers, through lower prices, it is not without its downsides. The recent incident of United Airlines mistreating a bumped passenger is a reminder of the unfavorable consequences of overbooking. Being aware of such risks, some consumers may prefer to switch to alternative transportation options – such as trains, buses or airlines that do not overbook – if available. In turn, the potential of being bumped can decrease demand ex ante, leaving both firms and consumers worse off.

While the overbooking problem has been studied intensively, traditional analytical models in the operations management (OM) literature assume an exogenous demand that is not affected by the airline’s booking policy. The earliest mathematical analysis is a static single-fare-class model, given by Beckmann (1958), in which an airline minimizes lost revenue by reducing unused capacity or the cost of overselling. Rothstein (1971) proposes a dynamic programming model to determine the optimal overbooking policy. The policy specifies the number of remaining reservations available as a function of the time to flight and the number of reservations already made at that time. The problem becomes more complex with the consideration of multiple fare classes, and Chatwin (1996) examines a multi-period multi-fare class airline overbooking problem and proposes a continuous state-space dynamic programming model to optimize booking-limit policy in each period.
In contrast to the OM literature there are recent papers, originating in the economics literature, that explicitly consider the effect of overbooking on demand, though core elements of their models are stylized enough to limit their practical value. For example, in both Fu et al (2012) and Ely et al (2017) assumptions regarding customer value and refunds obviate the need for booking limits.

Our focus is on understanding, in a more realistic setting, how the airline’s overbooking policy affects ex ante consumer demand. We model demand as being explicitly uncertain in two ways: first, the number of potential customers willing to buy tickets is itself uncertain; and second, the number of ticket buyers who show up for the subsequent flight is also random. We assume that customers have explicit and heterogeneous levels of disutility for being bumped and that each customer weighs the expected cost and benefit of buying a ticket when making a purchase decision. While this model of customer behavior differs in its details, its spirit follows that of Dana and Petruzzi (2001).

Our analysis explicitly considers all three forms of control that are available to a seller: price, booking limit, and compensation to bumped customers. As in traditional OM models of overbooking, we begin by assuming that price and bumping compensation are fixed and that the only form of control is the booking limit itself. Here we show that the traditional method of setting booking limits most often sets larger booking limits and always earns weakly lower expected profits than an approach that explicitly accounts for the effect of the booking limit on customer demand. We then consider the full set of controls and demonstrate that price and bumping compensation can be used in concert to simplify the problem and decouple decisions regarding compensation and booking limits. That is, by using the “right” price and bumping compensation, the seller can set booking limits without regard to demand, essentially returning the problem of setting booking limits to the traditional OM setting.
As in recent economics research (Fu et al. 2012; Ely at al. 2017), we also consider the use of auctions to decide which customers should be bumped from an overbooked flight. We numerically demonstrate that a simple uniform second-price auction typically sets larger booking limits and earns higher average profits than the optimal scheme that employs fixed bumping compensation across passengers. We also prove that a slight modification of the traditional auction scheme earns higher expected profits.

More broadly, our results provide insights into two dimensions of the overbooking problem. First, they show that, to obtain the best value from overbooking, service providers must explicitly consider all three managerial levels available: price, bumping compensation, and booking limits. Second, they provide evidence that, from a profit perspective, auctions can dominate schemes that use fixed compensation for bumped passengers.

References