

# **Interpreting "3 seats left": An empirical analysis of airline inventory announcements**

Katherine Ashley, Pnina Feldman, Jun Li

# Interpreting "3 seats left": An empirical analysis of airline inventory announcements

## 1 Motivation

In recent years, retailers and service providers have increasingly chosen to provide information about future price and inventory levels to their customers, using messages such as “3 units left at this price.” How truthful is the information provided by firms, and how are customer and firm decisions affected by these announcements? If customers are rational and forward-looking, then we would expect them to interpret messages from the firm strategically, and to incorporate any credible information into their purchase timing decisions. Furthermore, making an announcement about the amount of inventory remaining at the current price may affect the firm’s willingness to adjust prices in subsequent periods.

Several modeling papers have addressed the credibility of cheap talk announcements in both inventory and queueing settings. However, there is scant empirical evidence of how customers actually respond to cheap talk announcements from firms. In one recent paper, Yu et al. (2014) use data from a call center to measure the impact of delay announcements on customers’ decisions about whether to abandon the queue. To the best of our knowledge, there has been no similar empirical investigation in an inventory setting, where the messages relate to the number of units remaining at the current price. We contribute to the literature by analyzing the use of inventory announcements in the air travel industry.

The market for air travel is a particularly interesting setting for this research question, for several reasons. First, the airline industry operates under wafer-thin margins of less than 3% overall, with even lower margins for U.S. legacy carriers. Therefore, any decisions that influence demand patterns are particularly consequential: understanding how consumers react to inventory information is crucial for carriers to optimize their announcement policies. Second, while inventory messages are common enough to influence millions of purchase decisions, there is considerable variation in announcement practices across firms. For example, a customer searching for airline tickets on United.com may see an itinerary with the announcement “8 seats left at this price”; on Delta and American, announcements are only made when the number of seats remaining at the current price is 3 or fewer. Meanwhile, US Airways doesn’t show inventory announcements for any flights on its booking website. Third, because price changes for airline tickets are often large in magnitude, the problem of correctly timing the ticket purchase is an important one for consumers. Li et al. (2014) show that there is evidence of strategic consumer behavior in the market for airline tickets; if the messages provided by the firm are informative, then the strategic customers will take the inventory announcements into account when deciding when to buy. Finally, inventory announcements could be particularly valuable to customers due to the volatile nature of air-ticket prices. For the same reason, sharing information may affect airlines’ ability to adjust prices dynamically after announcements are made.

This research answers three central questions: (1) How much information is contained in airline inven-

tory announcements?) (2) How do announcements affect customer purchase decisions? and (3) How does making an announcement influence a firm’s pricing decisions in future periods?

## **2 Data**

We use an original data set consisting of millions of observations, collected from the airline booking websites of four major U.S. airlines: American, Delta, United, and US Airways. For each airline, we used data from the Bureau of Transportation Statistics’ Airline Origin and Destination Survey to identify near-monopoly markets: origin-destination pairs where at least 80% of traffic between the two cities is operated by the relevant carrier. Of the routes meeting this criterion, we selected markets with an average of at least 20 ticket sales per day across all available flights. For each market, we collected itinerary listing and seat map data for roundtrip flights with daily departure dates from January 15, 2015 through April 15, 2015. For each departure date, we collect data for 3-day and 7-day lengths of stay.

The itinerary data include origin and destination airports; departure and arrival times; nonstop or connecting status; flight number(s); price; fare class; and inventory announcement. For each flight in each itinerary, we collect the number of seats filled and available from the seat maps that are provided on the airline website. Because a single airline accounts for almost all traffic on the near-monopoly routes in our study, the search results shown on the operating airline’s website are a good representation of the choice set customers face when booking a trip in that market. Data were collected daily from Fall 2014 through Spring 2015, so we observe at least two months of price and seat availability history for each itinerary. We cannot directly observe when sales take place, but we do see changes in seat map availability over time. Previous research, such as Williams (2013), has shown that airline seat map changes are good proxy for bookings. The dataset that we have constructed captures hundreds of thousands of ticket sales, for over 10,000 unique origin-destination/travel date combinations.

## **3 Model and Estimation**

The first question we address in our paper is the informativeness of airline inventory announcements. Because carriers use sophisticated pricing algorithms that result in constant opening, closing, and reopening of more than two dozens of fare classes, measuring the informational value of inventory announcements is more nuanced than it may seem on the surface. We define “informativeness” as the ability of inventory announcements to improve predictions of future price changes: both direction and size. We measure the incremental value of incorporating inventory announcements into the information set to predict future price changes.

To study the impact of announcements on customer decisions, we use a dynamic discrete choice model. For a given market and travel date, customer arrivals in each period are a function of market characteristics, itinerary characteristics, and time to departure. After a customer observes the available itineraries, associated prices, and inventory announcements, he forms a belief about future price changes. Based on this belief, he

will choose to purchase an itinerary, wait for the next period, or leave the market without buying a ticket. Inventory announcements impact customer choices by modifying their beliefs about price trajectories. To evaluate the effect of announcement on a firm's future pricing decisions, we compare ticket price paths of announcing and non-announcing airlines, controlling for market- and itinerary-level characteristics.

## 4 Results

We find that airlines are making frequent use of inventory announcements: among the carriers that announce, approximately 14-25% of itineraries show an inventory message, with even higher frequencies (up to 35%) in the three weeks leading up to departure, when a high percentage of ticket sales take place. Additionally, we show that inventory announcements contain substantial information about future prices, but their informativeness is limited to directional changes: a price increase is 33-60% more likely after an announcement is made, but the announcement does not help customers predict the magnitude of the increase. Furthermore, inventory announcement does not predict prices going up perfectly. We observe 8% inventory announcements followed by price decrease, with an average size of \$50, and this is likely to happen when the departure date is between 3 and 8 weeks in the future.

We find strong evidence that customers are using the information contained in these messages to time their purchases: after controlling for other factors, we estimate an increase in the rate at which seats are filled of 7-9% after an announcement is made. Implications of announcements for the firm's future price trajectory are forthcoming. In the next stage of our research, we will extend our analysis to markets in which an announcing airline (Delta or United) competes with an airline that does not announce (U.S. Airways) in a near-duopoly setting. We have collected data for 40 such markets, over the same time period used for our main analyses. Inventory announcements play a slightly different role in these markets, because the customer's choice set includes itineraries from two different airlines. Understanding the dynamics of these markets will lead to a more complete picture of how airlines use inventory announcements strategically to increase profits.

## References

- Li, J., Granados, N., and Nettekssine, S. (2014). Are consumers strategic? Structural estimation from the air-travel industry. *Management Science*, 60(9):2114–2137.
- Williams, K. R. (2013). Dynamic airline pricing and seat availability. Working paper, University of Minnesota.
- Yu, Q., Allon, G., and Bassamboo, A. (2014). How do delay announcements shape customer behavior? An empirical study. *Management Science*, forthcoming.