Strategic Pricing in a Competitive Airline Environment

Introduction

The airline industry has become more competitive than ever. The hefty introduction of low cost carriers as well as the EU-US open skies agreement have increased the number of operating flights, culminating at more than 9.5 million commercial flights in 2015.\(^1\) Passengers are often offered several flight options from different companies for the same Origin-Destination (O&D) trip. Nowadays, most global airlines routinely use revenue management tools in order to dynamically adjust fare levels and inventory availability so as to maximize revenue. The total capacity is typically segmented into several inventory classes, such that when a class closes, the fare automatically increases to the next price point. The problem of dynamic inventory optimization for airlines has been extensively studied by both academics and practitioners (see, e.g., [TVR06] and [Bel87] and the references therein). The extension where the fare levels are not exogenous has also received some attention (see, e.g., [GH14] and [VNR09]), but to this day, there are no widely implemented systems to dynamically optimize fare levels in a competitive airline environment.

In the airline industry, a typical price ladder consists of the lead-in (i.e., the cheapest fare in the ladder corresponding to the first inventory class and is usually offered several months before the departure date) as well as several sell-ups (i.e., more expensive fares corresponding to higher inventory classes). As we mentioned, the dynamic inventory optimization in an airline context is a very well understood topic and several practical tools have been developed. In contrast, it seems that setting the right lead-in fare still lacks of analytical and data-driven methods. A commonly used strategy for pricing the lead-in fare is to simply match competitors’ fares. More precisely, for a given O&D, the airline will first decide who are the most relevant competitors, and then will set the lead-in fare to match the cheapest option.\(^2\) What could be surprising is that airlines usually match competitor lead-in fares even when the products are differentiated. It is definitely possible to find two flights with different characteristics (e.g., a direct flight and a non-direct flight with a layover of several hours) departing around the same time and yet, the matching policy is applied.

In this project, our goal is to understand if/when airlines should match the lead-in fare of their competitors. We address this question using two complementary research methodologies: (i) by partnering with a major airline company and running a field experiment, and (ii) by developing an analytical game-theoretic model that gives rise to interesting managerial insights. We show that both approaches suggest that matching is not always the right strategy. In addition, we provide some intuitions about the situations where a strategic airline should not match the lead-in fare of its competitors.

Our model and findings allow airline companies to reach a better understanding on when to match the lead-in fare (and when not to). This is one of the most important airline pricing decisions, which actually impacts the entire price ladder, as the sell-up levels are usually set relative to the

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1. https://www.faa.gov/air_traffic/by_the_numbers/
lead-in. Systematic lead-in fare matching can result in a price race to the bottom, which yields significant losses for the whole industry.\(^3\) Our empirical and analytical findings identify conditions under which the airlines can react more strategically to competitors’ changes in real time. Moreover, our approach also explicitly captures non-pricing factors that contribute to passenger utility and ultimately affect the pricing strategy of the airlines. This can be interpreted as a validation of the “agony factor” used by the flight search engine Hipmunk.\(^4\)

Field experiment design

In the first part of this project, we present the design of the field experiment we have conducted with the partner airline. The main objective of this pilot is to deliver a proof of concept that a lead-in fare differential over competition can be an appropriate response under specific circumstances. While matching closely competition is the right response in some cases, it is also important to evaluate the impact of non-pricing factors on the overall competitive picture. We convey that several factors can play a role in this decision such as the Quality Score Index (QSI), the seat factor, and the number of competitors, just to name a few. In particular, we carefully choose a set of 22 O&Ds where the partner airline products are significantly superior relative to competition (e.g., in terms of schedule or number of layovers), and where an appropriate price premium over competition should increase revenue, while maintaining a similar volume intake. We then discuss in detail the five steps of our design, namely: (1) Scope of the experiment; (2) Selecting the right O&Ds; (3) Selecting control and test samples; (4) Managing the fare differentials; and (5) Assessing volume, revenue and market share performance. In the first phase of our experiment, we illustrate the benefit of non-matching the lead-in fare by imposing a price premium for superior products. In the second phase, we vary the magnitude of the price premium in order to estimate the price elasticity with respect to various non-pricing factors. This allows us to quantify our findings as well as to calibrate our analytical model.

Analytical model

In the second part of this project, we present a game-theoretic model with several airlines engaged in price competition for expected revenue maximization. We assume that each airline holds a fixed level of inventory for the lead-in product, and aims to optimize its fare. All airlines combined face an aggregate passenger demand, which can be either deterministic or stochastic. Their strategic actions involve the decision of the lead-in fare, which is constrained by a lower bound (e.g., to ensure a positive operating profit) and an upper bound (e.g., to avoid interference with higher fare classes). As demand materializes, passengers choose airline products to maximize their utility.

We first consider passengers whose booking decisions are based exclusively on fares. In other words, passengers will choose the airline offering the lowest fare, then the second lowest, etc. If two or more airlines offer the same price, the corresponding demand is split equally between these airlines. From an airline’s standpoint, market share, and, in turn, expected revenue, are determined by the number of competitors with (i) strictly lower lead-in fares, (ii) the same lead-in fare, and (iii) strictly higher lead-in fares. This setting builds upon the Bertrand competition game in

\(^3\)http://www.forbes.com/sites/greatspeculations/2015/06/11/airlines-stocks-drop-as-fear-of-price-war-clouds-the-industry/#6169fb6a42d5

\(^4\)https://www.hipmunk.com/
a continuous strategy space with capacity constraints, but introduces new discontinuities in the payoff functions resulting from the price-matching dynamics. We are interested in computing the Nash equilibrium of this game.

The analysis of this game yields three main results. First, if demand is below a given threshold, then price-matching is the unique pure-strategy Nash equilibrium: all the airlines should strategically set the lowest lead-in fare possible. This leads to a phenomenon commonly observed and often referred to as price race to the bottom. Second, if demand is above the threshold, then there exists no pure-strategy Nash equilibrium, but a unique mixed-strategy Nash equilibrium. This Nash equilibrium assigns a positive probability to the smallest fare possible (a “matching strategy”), and the remaining probability to a continuous strategy in the neighborhood of the upper bound of the lead-in fare (a “non-matching strategy”). In other words, the optimal strategy involves setting higher lead-in fares (according to a continuous probability distribution), and, depending on the demand level, some promotions at lower fares. Third, this mixed-strategy Nash equilibrium converges to a price-matching equilibrium as the number of airlines grows indefinitely.

We then relax the assumption that passengers’ choices depend exclusively on price. Following Hipmunk’s “agony factor” and the results of our field experiment, we assume that additional (non-pricing) factors underlie passenger choices, such as the number of layovers, the trip duration, the scheduled time, etc. We show that there is no price-matching equilibrium in this case, as the airlines with the better product offerings can gain a strategic advantage by setting higher prices than their competitors. Finally, we present two extensions with: (i) multiple fare products (e.g., a lead-in fare and a higher-class fare), and (ii) passenger heterogeneity (i.e., a proportion of passengers making booking decisions based exclusively on prices, and the remaining portion decides based on price considerations as well as other factors). We characterize the mixed-strategy Nash equilibrium, and show that the insights derived earlier still hold in this more realistic setting.

The results show that lead-in fare matching is indeed an optimal strategy under strict conditions but deviations from a price-matching equilibrium can provide significant revenue upsides to competing airlines in situations of high demand, concentrated markets, and product differentiation. First, under high demand, the airlines will have strategic incentives to increase their lead-in fares and avoid a price race to the bottom, even with non-differentiated product offerings. Second, the smaller the number of competing airlines, the stronger the incentives to deviate from a price-matching equilibrium. Third, product differentiation also creates opportunities for the airlines to strategically vary their lead-in fares so as to generate higher revenues.

References


