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Price discrimination through refund contracts in airlines[☆]

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ABSTRACT

This paper shows how an airline monopoly uses refundable and non-refundable tickets to screen consumers who are uncertain about their travel. Our theoretical model predicts that the difference between these two fares diminishes as individual demand uncertainty is resolved. Using an original data set from U.S. airline markets, we find strong evidence supporting our model. Price discrimination opportunities through refund contracts decline as the departure date nears and individuals learn about their demand.

1. Introduction

Consider a potential traveler who is planning to buy a plane ticket in advance. However, at this moment, he is not certain whether he will travel. Let his valuation for traveling be v. If the airline offers him a refundable ticket now, he will be willing to pay v for that ticket. But if the airline offers him a non-refundable ticket, his willingness to pay should be less than v.[1] Once he knows with certainty whether he wants to travel, there is no reason why he should be willing to pay more for a refundable ticket than for a non-refundable ticket.

This paper presents a theory that explains how a monopolist can use refundable and non-refundable tickets to screen consumers and extract more surplus when consumers have to select a contract before knowing their demand with certainty.[2] In the simple two-period model, the airline will offer both ticket types in advance to consumers who are uncertain about their demand and have different willingness to pay. We derive optimal refundable and non-refundable fares that depend on each consumer's willingness to pay and the probability of travel. Consumers with high willingness to pay buy refundable tickets, and consumers with low willingness to pay buy non-refundable tickets. Furthermore, we find that the difference between these two fares consists of a quality component—the refundability value—and a price-discrimination component. A comparative-statics analysis provides an empirical implication of the model: the gap between the two fares diminishes as the date of departure approaches and consumers become more certain about their individual demand. Therefore, the airline's ability to separate consumer types and to price discriminate vanishes.

In the empirical section we test the main empirical implication of the theory. We collected from the online travel agency Expedia.com an original panel data set of refundable fares, non-refundable fares, and seat inventories across 96 U.S. domestic monopoly routes at various days prior to the departure date. The data collection focuses on posted one-way

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[1] This ex-ante willingness to pay for a non-refundable ticket is analogous to the option price in Cicchetti and Freeman (1971). Schmalensee (1972) and Graham (1981) show that the option price may be greater or smaller than the expected willingness to pay.

[2] Even though we focus on airlines, the results can also be applied to other industries where goods are sold in advance with a refundable option, such as cruises, car rentals, and lodging.

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economy-class fares to control for price differentials associated with other ticket restrictions, such as Saturday-night stayover, minimum and maximum stay, first-class travel, and connecting legs. These restrictions are commonly used as 'fences' to implement other forms of price discrimination and congestion pricing and to deal with aggregate demand uncertainty. The panel structure of the data controls for unobservable time-invariant carrier-, route-, and flight-specific characteristics. Moreover, the fact that both fares were collected at the same time for the same seat allows us to control for unobserved time-variant seat-specific characteristics. The estimation method, which takes into account the dynamic adjustment between the difference in fares and seat inventories, shows strong evidence that price discrimination through refund contracts vanishes as the departure date nears. In addition, a nonparametric specification indicates that most of the individual demand uncertainty, as implied by the carriers' pricing strategy, is resolved during the last two weeks before departure.[3]

In the literature, Gale and Holmes (1993) and Dana (1998) use advanced-purchase discounts as a means of price discrimination to improve capacity utilization in monopolistic and competitive markets respectively. In contrast, we show that an airline monopoly can use a refundability option to screen consumers and increase the airline's expected profit. Courty and Li (2000) suggest a theoretical model for a monopolist that price discriminates via refund contracts consisting of a price a buyer has to pay in advance and a refund the buyer can receive after he learns his valuation of the good. While Courty and Li's purpose is to find an optimal refund contract consisting of an advance payment and a refundable amount, our goal is to find an optimal contract consisting of a refundable price and a non-refundable price for each type. In a related work, Akan et al. (2011) present a generalization of Courty and Li (2000) with consumers who learn their valuations gradually and with a seller that can vary the length of time during which the tickets are refundable. Bilotkach (2009) presents a model explaining refund contracts under costly capacity and demand uncertainty.

The rest of the paper is structured as follows. Section 2 presents the theoretical model, including the consumer's problem and the airline's problem, and describes the airline's price menu in equilibrium. Section 3 presents the empirical analysis by first describing the data, then setting the empirical model, and closing with the results. Section 4 concludes.

2. Theoretical analysis

Consider a monopolistic airline that sells homogeneous seats on a flight to consumers whose type, high (H) or low (L), is not observable to the airline. In airline markets, it is common to see consumers buy tickets in advance despite uncertainty in their travel plans. In our two-period model, consumers have unit demands and have to decide whether to buy a ticket in period 1. However, they learn in period 2 whether they want to fly or not (i.e., demand equals 1 or 0). Let travel and no travel be mutually exclusive states of nature in which a consumer wants and does not want to travel respectively. The risk in the state of nature that each consumer faces is an individual risk that is independent from those of other consumers. For $\theta = H,L$, we let π_θ denote the probability that type θ consumer wants to travel and hence $1 - \pi_\theta$ the probability that the consumer does not want to travel. Both types have a positive valuation of traveling v_θ and share the same utility function u with $u' > 0$ and $u'' \leq 0$. We normalize u so that $u(0) = 0$.

2.1. The consumer's problem

In period 1, the airline offers refundable and non-refundable tickets to all consumers. If a type θ consumer buys a refundable ticket at price p in period 1 and learns that he wants to travel in period 2, then he will use the ticket and his utility will be $u(v_\theta - p)$. If he learns that he does not want to travel, he will request a refund and his utility will be his status quo, $u(0)$, which is equal to zero. In contrast, if the consumer buys a non-refundable ticket at price p, his utility will be $u(v_\theta - p)$ if he wants to travel and $u(-p)$ otherwise. Under expected utility theory, type θ consumer's expected utility from buying a refundable ticket at price p is denoted by

$$U_\theta^r(p) = \pi_\theta u(v_\theta - p) \tag{1}$$

and type θ consumer's expected utility from buying a non-refundable ticket at price p is denoted by

$$U_\theta^{nr}(p) = \pi_\theta u(v_\theta - p) + (1 - \pi_\theta) u(-p). \tag{2}$$

Note that there is no time value of money. If a consumer does not buy a ticket, his utility in period 2 will be zero in both states.[4] Then type θ's reservation price for a refundable ticket is v_θ and type θ's reservation price for a non-refundable ticket is c_θ such that $U_\theta^{nr}(c_\theta) = 0$; i.e.,

$$\pi_\theta u(v_\theta - c_\theta) + (1 - \pi_\theta) u(-c_\theta) = 0.^{5} \tag{3}$$

Note that c_θ is an increasing continuous function of π_θ from [0,1] onto $[0, v_\theta]$.

Now we explain how a consumer decides which type of ticket to buy when the airline simultaneously offers non-refundable and refundable tickets in period 1. Formally, let the airline offer a price menu (p^{nr}, p^r) in which p^{nr} represents a non-refundable price and p^r represents a refundable price. Each consumer's action set includes buy a refundable ticket, buy a non-refundable ticket, and not buy a ticket. We find that type θ consumers' best response is given by:

(i) buy a refundable ticket if $U_\theta^r(p^r) \geq U_\theta^{nr}(p^{nr})$ and $U_\theta^r(p^r) \geq 0$,
(ii) buy a non-refundable ticket if $U_\theta^{nr}(p^{nr}) > U_\theta^r(p^r)$ and $U_\theta^{nr}(p^{nr}) \geq 0$, and
(iii) buy no ticket if $U_\theta^{nr}(p^{nr}) < 0$ and $U_\theta^r(p^r) < 0$.

2.2. The airline's problem

We now turn to the airline's pricing problem. In particular, we are interested in a separating equilibrium where type H consumers buy refundable tickets and type L consumers buy non-refundable tickets. We solve for the optimal separating price menu and show that it constitutes an equilibrium under reasonable conditions.

Let the numbers of type H and type L consumers in period 1 be N_H and N_L and the expected numbers of type H and type L consumers that want to travel in period 2 be $n_H = \pi_H N_H$ and $n_L = \pi_L N_L$ respectively. The airline, which has zero marginal cost and a capacity of at least $n_H + n_L$, announces p^{nr} and p^r at the beginning of period 1. Since the airline does not know each consumer's type, we let the airline derive its belief about each consumer type from N_H and N_L. After observing the prices, consumers' strategies could be either pooling (i.e., both types choose the same action) or separating (i.e., each type chooses a different action). We define an equilibrium as a combination of the airline's beliefs and strategy (p^{nr}, p^r) and each consumer's strategy given θ and (p^{nr}, p^r) so that the airline's expected profit and each consumer's expected utility are maximized.

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[3] There are many ways that uncertainty could be resolved. In this paper, by resolved uncertainty we mean an increase in the probability that an individual wants to travel on a particular date, conditional on showing up to buy a ticket, as the trip date nears. These results, in addition, help explain the large price dispersion in airlines documented in Borenstein and Rose (1994) and more recently in Gerardi and Shapiro (2009).

[4] It is possible to extend the model by imposing a cost on the consumer who wants to travel but does not have a ticket so that his utility is lower than zero. However, the differences in the results are immaterial.

[5] For example, if $u(x) = \ln(1 + x / 1000)$, $v_L = 500$, and $\pi_L = 0.6$, then we find that $c_L = 268$.