ADVANCE BOOKING, RESERVATIONS AND REFUNDS
Key words: Advance booking, reservation systems, refund, non-refundable tickets

JEL Classification: M2, L91

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Advance Booking, Reservations and Refunds

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Abstract

We investigate economic and strategic incentives of service providers to engage in advance booking while allowing for a full-refund for those customers who cancel or do not show up at the time when the good or the service is provided. We show that from social welfare and industry profit point of views, the full-refund booking strategy dominates the no-refund booking strategy. We also show that the full-refund booking strategy yields lower profit and social welfare than a market segmentation where different consumers buy tickets with different refundability options. None of the strategies are Pareto dominating any other.

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1 Introduction

Theories of Industrial Organization tend to associate the time of purchase with the time of delivery of goods and services. In practice, there are markets for services and goods where buyers and sellers maintain contacts long before the service or the good are scheduled to be delivered. This pre-delivery contact is usually called \textit{advance booking}, or simply a \textit{reservation}.

Reservation systems are observed in almost all privately-provided services. The most noticeable ones are transportation services such as the airline industry, railroad, and buses. Reservations procedures are also utilized in small businesses such as restaurants, fancy barber shops, and law offices.

Advance booking of orders (ABO) are also found in a wide variety of market for goods (as opposed to services). Almost all bookstores would be willing to order books knowing that some customers will not show up to collect them. In fact, the publishers (the producers in this case) encourage these book orders by letting bookstores return all unsold copies. ABO are also practiced in the sales of large aircraft, such as passenger planes. In this industry, the customers (airline companies) sometime enter into financial difficulties and fail to show up to collect the aircraft.

Clearly, since advance booking and reservations are commonly observed, both buyers and sellers must find them beneficial. For sellers, advance booking serves as an informative predictor of the demand for the service (e.g. Weatherford and Pfeifer, 1994). In case of capacity constraints, advance booking helps the seller in planning how much capacity to produce (such as aircraft size, and frequency of flights, in the case of the airline industry). However, advance booking that is not supported by a prepayment may also have an adverse effect on sellers since customers may not show up to buy the service or the good, thereby leaving the seller with underutilized capacity. For this reason, in some service sectors, such as lawyers, service providers insist on retainers before they make appointments with clients.

For buyers, advance booking is needed to reduced the costs of obtaining complementary goods and especially services. For example, if one makes travel reservations,
the traveler must take time off from work and purchase other items and services for the trip. Thus, travelers will not be able to take time off from work unless they can be assured service. For this reason, car rental companies give their potential customers a *de facto* free option to rent a car. The advance reservation system provides the tool for exercising this option.

However, advance bookings are not uniform across sectors. Perhaps, the key difference lies on the issue of prepayments or refundability. More precisely, a refundable booking insures consumers against their own no shows, at the expense of the service providers. Therefore, refundable bookings must result in higher prices than non-refundable booking (or a prepaid one). Like any other moral hazard problem, refundable booking attracts consumers who are likely to cancel or not show up for the service, and deters consumers who are less likely to cancel and are therefore more price sensitive.

Of course, if service providers can price discriminate between consumers who are likely to show up and consumers who are likely to cancel, both sellers and buyers could become better off. In fact, we demonstrate that this is indeed the case by characterizing a price system that induces consumers with high cancellation rate to purchase expensive refundable tickets, and consumers who are more likely to show up to purchase non-refundable tickets. Therefore, the customers’ self selection in the market can be used as a device for improving the revenue as well as social welfare, provided that the sells picks the “right” prices that separate between the customer groups.

We are not aware of any particular literature in economics dealing with the welfare aspects of advance booking and refunds on no shows. However, this issue has attracted some attention in the fields of operation research and yield management. Weatherford and Pfeifer (1994) argue that service providers benefit from the early booking process by achieving a more accurate estimate of the final demand of the provided good. The literature covering consumers’ self-selection in advance bookings is also sparse. The strategic interaction of the customers has only recently attracted
attention, for example, Mahajan and van Ryzin (1999) study how hotel customers 
can behave strategically in the booking process. Zhao and Zheng (2001) argue that 
late discounts disrupt the credibility of the booking strategies, and for this reason 
late discounts are probably not commonly practiced for reputation reasons. As 
pointed out by Bodily and Pfeifer (1992) the refundability option could also be used 
as a device to control the final showup probabilities of the customers. Customers 
buying non-refundable tickets, will be rather sure that they will end up showing up 
in order to benefit from the service of ticket.

The paper is organized as follows. Section 2 constructs the basic model and 
derives the pricing equilibria under two cases: Fully refundable booking and non-
refundable booking. Section 3 derives the profit-maximizing booking strategy and 
provides a comprehensive welfare analysis of the two booking strategies. Section 4 
analyzes a service provider who utilizes, both, the fully-refundable booking and the 
non-refundable booking strategies. Section 5 discusses the implications of our model.

2 Refundable versus Non-refundable Booking

Consider a single seller of a certain service or a good to be provided at a certain 
known date. The seller is able to offer two types of advance booking: A non-
refundable ticket for a price of $p^N$, or a fully-refundable ticket at a price $p^R$. The 
production of this good/service exhibits constant returns to scale, with a unit cost 
denoted by $c > 0$.

There are two groups of consumers, indexed by $i = H, L$, who differ according to 
their probability of showing up to collect this good or service. Type $H$ consumers 
have a showing up probability of $\sigma_H$ (i.e., will cancel the reservation with probability 
$(1 - \sigma_H)$); whereas type $L$ have a low showing up probability given by $\sigma_L$. We assume 
that $0 < \sigma_L \leq \sigma_H \leq 1$. There is a total customer $n$ customers. $\alpha_H n$ are of type $H$, 
and $\alpha_L n = (1 - \alpha_H)n$ are of type $L$. Observe that since $n$ is an integer, we must 
have it that $\alpha_H \in \{1/n, 2/n, \ldots, (n - 1)/n\}$. The proportions $\alpha_L$ and $\alpha_L$ and the 
showing up probabilities $\sigma_H$ and $\sigma_L$ are exogenous parameters, and they are not
affected by the strategy chosen by the supplier.

Within each group, consumers differ according to their willingness to pay for this service. Formally, for \( i = H, L \), the utility of a type \( i \) consumer indexed by \( x \geq 0 \) is given by

\[
U_i \overset{\text{def.}}{=} \begin{cases} 
\sigma_i(\beta - \delta x - p^R) & \text{if buys a refundable ticket} \\
\sigma_i(\beta - \delta x) - p^N & \text{if buys a non-refundable ticket} \\
0 & \text{if does not buy this good/service.}
\end{cases}
\] (1)

The utility functions (1) imply that a consumer indexed by \( x \) derives a basic utility of \( \beta - \delta x \) if he shows up (with probability \( \sigma_i \)). If the ticket is refundable he pays only if he does not cancel, thus with probability \( \sigma_i \). In contrast, if the ticket is not refundable, the ticket is paid regardless of whether the consumer shows up.

### 2.1 Refundable tickets

Suppose that the seller offers advance booking for a fully-refundable price of \( p^R \). Let \( x_H \) denote the consumption index of a type \( H \) consumer, which makes her indifferent between buying and not buying this good. \( x_L \) is similarly defined. From (1), \( x_i \) is implicitly defined by \( \sigma_i(\beta - \delta x_i - p^R) = 0, i = H, L \). Hence,

\[
x_H = x_L = \frac{\beta - p^R}{\delta}.
\] (2)

In the absence of overbooking, the seller must produce \( n \cdot (\alpha_H \cdot x_H + \alpha_L \cdot x_L) \) units. Therefore, the production cost \( cn \cdot (\alpha_H \cdot x_H + \alpha_L \cdot x_L) \) is independent of the showing up probabilities. However, since tickets are fully-refundable, the revenue is affected by these probabilities. Thus, the seller chooses a refundable ticket price \( p^R \) to solve

\[
\max_{p^R} \frac{\pi^R}{n} = (\alpha_H x_H \sigma_H + \alpha_L x_L \sigma_L) p^R - (\alpha_H x_H + \alpha_L x_L)c,
\] (3)

where \( x_H \) and \( x_L \) are given in (2). To reduce the amount of writing, we define the constants

\[
\psi_1 \overset{\text{def.}}{=} \alpha_H \sigma_H + \alpha_L \sigma_L = \alpha_H \sigma_H + (1 - \alpha_H) \sigma_L
\] (4)

\[
\psi_2 \overset{\text{def.}}{=} \alpha_H \sigma_L + \alpha_L \sigma_H = \alpha_H \sigma_L + (1 - \alpha_H) \sigma_H.
\] (5)
The constant $\psi_1$ is the aggregate showing up probability. Then, solving (3), the unique (refundable) profit-maximizing price and profit levels are given by

$$p_R = \frac{\beta \psi_1 + c}{2\psi_1}, \text{ and}$$

(6)

$$\pi_R = \frac{n[\beta \psi_1 - c]^2}{4\delta \psi_1} = \delta n \psi_1 (x_R)^2.$$  

(7)

The market sizes (to be multiplied by $n\alpha_H$ and $n\alpha_L$, respectively) are

$$x_R = x_L = \frac{\beta \psi_1 - c}{2\delta \psi_1}.$$  

(8)

Finally, Appendix A derives the general expression for the consumer surplus which is

$$CS = \frac{\delta n}{2} \left( \alpha_H \sigma_H x_H^2 + \alpha_L \sigma_L x_L^2 \right).$$  

(9)

We define social welfare as the sum of aggregate consumer surplus and the profit of the firm. Therefore,

$$CS^R = \frac{n[\beta \psi_1 - c]^2}{8\delta \psi_1}.$$  

(10)

We define the social welfare defined as the aggregate of a firm’s profit and consumer surplus becomes

$$SW^R = CS^R + \pi^R = \frac{3n[\beta \psi_1 - c]^2}{8\delta \psi_1} = 1.5\pi^R.$$  

(11)

### 2.2 Non-refundable tickets

We now analyze the case where advance booking implies a commitment to pay a ticket price of $p^N$ regardless of whether the customer cancels the reservation or not. In practice, the consumers prepay for the service and do not obtain any refund for no shows or a cancellation. The utility function (1) implies that the consumers indifferent between buying and not buying are solved from $\sigma_i(\beta - \delta x_i) - p^N = 0$, $i = H, L$. Hence,

$$x_H = \frac{\beta \sigma_H - p^N}{\delta \sigma_H} \text{ and } x_L = \frac{\beta \sigma_L - p^N}{\delta \sigma_L}.$$  

(12)
The seller chooses a non-refundable ticket price $p^N$ to solve

$$\max_{p^N} \pi^N = n(p^N - c)(\alpha_H x_H + \alpha_L x_L),$$ \hspace{1cm} (13)

where $x_H$ and $x_L$ are given in (12). Solving (13), the unique non-refundable ticket price and the resulting profit level are given by

$$p^N = \frac{\beta \sigma_H \sigma_L + c \psi_2}{2 \psi_2} \quad \text{and} \quad \pi^N = \frac{n [\beta \sigma_H \sigma_L - c \psi_2]^2}{4 \delta \sigma_H \sigma_L \psi_2}. \hspace{1cm} (14)$$

where $\psi_2$ is defined in (4). Substituting $p^N$ into (12) yields

$$x^N_H = \frac{\beta \sigma_H [2 \psi_2 - \sigma_L] - c \psi_2}{2 \delta \sigma_H \psi_2} \quad \text{and} \quad (15)$$

$$x^N_L = \frac{\beta \sigma_L [2 \psi_2 - \sigma_H] - c \psi_2}{2 \delta \sigma_L \psi_2}. \hspace{1cm} (16)$$

It can be verified by straight forward substitution of (15) and (16) into the general expression of the consumer surplus (9) that the consumer surplus is

$$CS^N = \frac{n [\beta \sigma_H \sigma_L - c \psi_2]^2}{8 \delta \sigma_H \sigma_L \psi_2}. \hspace{1cm} (17)$$

Hence the social welfare is

$$SW^N = \frac{3n [\beta \sigma_H \sigma_L - c \psi_2]^2}{8 \delta \sigma_H \sigma_L \psi_2} = 1.5 \pi^N. \hspace{1cm} (18)$$

### 3 Profit-maximizing booking strategy

Sections 2.1 and 2.2 analyzed a single service provider who utilizes one of two extreme booking strategies: Selling fully-refundable tickets or non-refundable tickets. The equilibrium prices and profit levels depend on the relative magnitudes of the parameters characterizing our consumers, the showup probabilities $\sigma_H$ and $\sigma_L$, the composition of the customer pool, $\alpha_H$ and $\alpha_L$, and the population size $n$.

In order for the market participations given in (6) and (14) to be non-negative, it is necessary that the consumers’ valuation of the good is sufficiently high relative to its unit production cost, that is

**Assumption 1.** $\beta/c > \max(\psi_2/(\sigma_H \sigma_L), 1/\psi_1)$. 


Next we compare the profits under the refundable and non-refundable strategies. Under Assumption 1, the difference between the profits (6) and (14) is

\[ k_0 \Delta \pi \overset{\text{def.}}{=} \frac{4\delta}{n} [\pi^R - \pi^N] = \frac{[\beta \psi_1 - c]^2}{\psi_1} - \frac{[\beta \sigma_H \sigma_L - c \psi_2]^2}{\sigma_H \sigma_L \psi_2} = \frac{\alpha_H (1 - \alpha_H) (\sigma_H - \sigma_L)^2}{\sigma_H \sigma_L \psi_1 \psi_2} \left[ \beta^2 \sigma_H \sigma_L \psi_1 - c^2 \psi_2 \right]. \] (19)

Hence, the choice between a refundable and non-refundable strategy depends on the sign of \((\beta^2 \sigma_H \sigma_L \psi_1 - c^2 \psi_2)\) in (19), which turns out to be non-negative. Therefore, we now state the following proposition which is proved in Appendix B.

Proposition 1.

a. Selling refundable tickets yields a higher profit than selling non-refundable tickets as long as the two types of consumers have strictly different showing up probabilities. Formally, \(\sigma_H > \sigma_L\) if and only if \(\pi^R > \pi^N\) and \(\sigma_H = \sigma_L\) if and only if \(\pi^R = \pi^N\).

b. Aggregate consumer surplus is higher under the refundable booking strategy compared with the non-refundable booking strategy. Formally, \(0.5\pi^N = CS^N \leq CS^R = 0.5\pi^R\).

Proposition 1 (a) can be explained as follows. Selling refundable tickets provides an insurance to consumers against no shows. When there is only one type of consumers (i.e., \(\sigma_H = \sigma_L\)), the difference between the price of a refundable ticket and a non-refundable ticket captures exactly the expected loss from a no-show. In this case, both, the seller and the (identical) buyers are indifferent between the two booking strategies. However, when consumer types diverge \(\sigma_H > \sigma_L\), the seller extracts a higher surplus by “insuring” consumers against no-shows by selling them refundable tickets. Part (b) of Proposition 1 states that the sale of refundable tickets enhances the social welfare.

In order to gain a better understanding why divergence between consumer types makes the refundable booking strategy more profitable than non-refundable booking,
we look at market participations of the two groups. If $\sigma_L < \sigma_H$, then $\psi_1, \psi_2 \in (\sigma_L, \sigma_H)$. Comparing (2) with (16) and (15) yields:

\[
\begin{align*}
  x_N^H &= \frac{\beta}{2\delta} - \frac{c}{2\delta \sigma_H} + \frac{\beta(\psi_2 - \sigma_L)}{2\delta \psi_2} \\
  &> \frac{\beta}{2\delta} - \frac{c}{2\delta \sigma_H} > \frac{\beta}{2\delta} - \frac{c}{2\delta \psi_1} = x_R^H = \\
  x_R^L &> \frac{\beta}{2\delta} - \frac{c}{2\delta \sigma_L} \\
  &> \frac{\beta}{2\delta} - \frac{c}{2\delta \sigma_L} + \frac{\beta(\psi_2 - \sigma_H)}{2\delta \psi_2} = x_L^N.
\end{align*}
\]

Therefore, we can state the following proposition.

**Proposition 2.** If $\sigma_H > \sigma_L$ then the participation of consumers with high probability of cancellation is higher under the refundable booking strategy than under the non-refundable booking strategy. Also, the participation of consumers with low probability of cancellation is lower under the refundable booking strategy than under the non-refundable booking strategy. Formally, $x_N^L < x_L^R = x_R^H < x_N^H$.

Proposition 2 shows that the higher price associated with refundable booking decreases the participation of consumers with high showing up probability. All this means that the strategy of refundable booking is targeted towards consumers with a low showing up probability (high probability of cancellation). By offering these consumers insurance against their frequent no-shows, the seller is able to extract a higher aggregate surplus from consumers.

In the next section we study the implications of a successful discrimination between consumers with high probability of showing up (low cancellation rate), and consumers with low probability of showing up (high cancellation rate).

### 4 Price Discrimination

So far, our analysis was conducted under the assumption that that the seller’s action set is confined to allowing either refundable bookings or non-refundable bookings. In this section we enlarge the seller’s action set by allowing the seller to sell, both,
refundable and non-refundable tickets. Thus, the seller sets a non-refundable advance booking price of $p^N$ to target consumers with high probability of showing up, and a fully-refundable price of $p^R$ to target consumers with low probability of showing up.

For this “self-selection” consumer equilibrium to exist, the utility function (1) implies that the discriminating prices $p^N$ and $p^R$ must satisfy

$$\sigma_H(\beta - \delta x) - p^N \geq \sigma_H(\beta - \delta x - p^R) \iff p^N \leq \sigma_H \cdot p^R \quad (21a)$$

$$\sigma_L(\beta - \delta x) - p^N \leq \sigma_L(\beta - \delta x - p^R) \iff p^N \geq \sigma_L \cdot p^R. \quad (21b)$$

Condition (21a) means that type $H$ consumers are better off by buying the non-refundable service thereby paying a (lower) non-refundable price. Condition (21b) means that the reverse holds for type $L$ consumers, simply because consumers with a low probability of showing up are better off insuring themselves by making a refundable booking. Figure 1 illustrates the range of prices for the possible consumer equilibria.

For a sufficiently low $p^N$ (relative to $p^R$), both types of consumers make non-refundable bookings. For a relative high $p^N$, both types purchase only refundable

Figure 1: Ranges of consumer equilibrium with refundable and non-refundable booking strategies.
In this section, we analyze the intermediate price range which separates the consumers, so consumers with a high probability of showing up purchase non-refundable tickets, whereas type $L$ consumers purchase only refundable tickets. In this equilibrium, the seller chooses $p^N$ and $p^R$ to solve

$$\max_{p^N, p^R_{subject to}} \pi = \frac{\alpha_H(p^N - c)x_H + \alpha_L(\sigma_L p^R - c)x_L}{n} = \alpha_H(p^N - c)\frac{\beta \sigma_H - p^N}{\delta \sigma_H} + \alpha_L(\sigma_L p^R - c)\frac{\beta - p^R}{\delta},$$

where $x_H$ was substituted from (12), and $x_L$ from (2). As the objective function is a negative definite quadratic form in $p^R$ and $p^N$, the solution is straightforward. The unconstrained optimum,

$$p^R = \frac{(\beta \sigma_L + c)}{(2\sigma_L)} \text{ and } p^N = \frac{(\beta \sigma_H + c)}{2},$$

is admissible as $\sigma_L p^R \leq p^N = (\sigma_H \beta + c) / 2 \leq \sigma_H p^R$. Therefore, a market segmentation is fully incentive compatible. The optimal participation rates become

$$x^D_H = \frac{\beta \sigma_H - c}{2\delta \sigma_H}, \text{ and }$$

$$x^D_L = \frac{\beta \sigma_L - c}{2\delta \sigma_L},$$

respectively. As corollary of the inequality sequence (20) we make the following observation.

**Proposition 3.**

a. Compared with a refundable strategy, a market segmentation reduces the participation rate for customers with low showing up probability; but, consumers with low probability of showing up are better off when the seller sells both types of tickets than when he sells only non-refundable tickets. Formally, $\sigma_L < \sigma_H \implies x^N_L < x^D_L < x^R_L$. 

b. Compared with a refundable strategy, a market segmentation increases the participation rate for customers with high showing up probability; but, consumers with a high probability of showing up are worse off when the seller sells both types of tickets than when sells only non-refundable tickets. Formally, \( \sigma_L < \sigma_H \implies x_R^H < x_D^H < x_N^H \).

Substituting the optimized values from (23,24) into (22), and (25,26) into (9) yield

\[
\pi_D = n \cdot \frac{\beta^3 \psi_1 - 2\beta \sigma_H \sigma_L c + \psi_2 c^2}{4 \delta \sigma_H \sigma_L}, \quad \text{and} \quad (27)
\]

\[
CS_D = 0.5 \pi_D = n \cdot \frac{\beta^3 \psi_1 - 2\beta \sigma_H \sigma_L c + \psi_2 c^2}{8 \delta \sigma_H \sigma_L}. \quad (28)
\]

Finally, using a revealed profitability argument, we can conclude that the profit associated with market segmentation (selling refundable and non-refundable tickets) must exceed the profit associated with selling either only refundable tickets or only non-refundable tickets. This follows from the fact that our optimization is not restricted by the incentive compatibility constraints. Our next proposition confirms this intuition.

**Proposition 4.** A market segmentation booking strategy involving selling, both, refundable and non-refundable tickets yield higher profit than selling only one type of tickets. Formally, \( \sigma_H > \sigma_L \) if and only if \( \pi_D > \pi_R \) and \( \sigma_H = \sigma_L \) if and only if \( \pi_D = \pi_R \).

**Proof.** Within the scope of this strategy, \( \sigma_H \geq \sigma_L \). Finally, it can be verified that

\[
4\delta \psi_1 \sigma_H \sigma_L n^{-1} \left[ \pi_D - \pi_R \right] = c^2 \alpha_H \alpha_L (\sigma_H - \sigma_L)^2.
\]

\(\Box\)

Finally, we summarize the welfare effects of a market segmentation strategy.

**Proposition 5.** Selling tickets by segmenting the market according to customers willingness to pay for the refundability feature, yield a higher profit, a higher consumer surplus, and consequently a higher social welfare when compared with sales without segmentation.
Clearly, the fact that price discrimination may lead to a welfare improvement is not novel (see Varian, 1985). Here we demonstrate that the welfare improvement can be achieved via the refundability option which leads to a self-selection of the type of booking according to the probability of showing up.

5 Discussion

Our research demonstrated that the widespread use of refundable bookings is not necessarily an outcome of competition, but a marketing tool by itself intended to increase the surplus extracted from consumers. In particular, by offering refundable tickets the seller expands the market participation of consumers who are most likely to cancel, since the refundability option serves as an insurance for them.

In Proposition 5 we demonstrate that price discrimination that leads to separation of consumers with high showing up probability from consumers with low showing up probability is preferable from a social point of view. Indeed, in the airlines industry we do observe extensive use of price discrimination where economy-class tickets are often booked on over 20 different booking classes. Some of these classes state explicitly that the tickets are not refundable. These booking classes are popular among tourists who can commit to showing up for the flight. Other booking classes, in particular business-class tickets, are targeted towards business travelers who happen to have high cancellation rates.

However, we are still puzzled by the fact that several other industries do not utilize multiple refundability options on their advanced booking systems. For example, most car rental companies utilize fully-refundable booking so consumers with low cancellation rates cannot gain from cheaper non-refundable reservations. Similar phenomena are observed in the hotel industry in the United States where most hotel keep the reservation until 6 P.M. with no obligation on the part of consumers. We cannot explain this observation in a model with a single seller, but we conjecture that some type of competition may lead to the diminishing use of price discrimination and the adoption of a single booking strategy involving selling fully-refundable
tickets only.

All this leads us to suggest an extension of the model to imperfect competition where sellers compete not only on prices, but also on the refundability option. Clearly, if competing brands are confined to utilizing only a single booking strategy, the equilibrium would involve all competing firms selling fully-refundable tickets. However, we conjecture that if price discrimination becomes an option, firms would still utilize refundable tickets only, which would differ from our conclusion about a monopoly service provider. Another reason for the lack of widespread use of non-refundability, might be the fact that the firms are not actually able to to sell non-refundable tickets. This is the case if the customer can enforce refundability through consumer rights organizations, or if non-refundability is connected with a reputation loss for the firm.

Another line of extension would involve a commonly observed business strategy known as overbooking. Overbooking is commonly observed in the airline industry and in some hotels. Overbooking irritates consumers who happen to show up just to find that the reservation cannot be exercised since the service provider reached full capacity utilization. The integration of overbooking and the refundability option into a single model would bring us closer to reality, at least for the airline industry case, but this extension goes beyond the scope of the present paper.
Appendix

A Refundable tickets

We define aggregate consumer surplus as the sum of utilities. As, $\beta - \delta x_i - p^R = 0$ for $i = H, L$, we observe that

$$\int_0^{x_i} (\beta - \delta x - p^R)dx = \frac{\delta x_i^2}{2}. \quad (29)$$

In the fully refundable case, the consumer surplus becomes

$$C_{SR} \overset{def.}{=} n \left( \alpha_H \int_0^{x_H} \sigma_H (\beta - \delta x - p^R)dx + \alpha_L \int_0^{x_L} \sigma_L (\beta - \delta x - p^R)dx \right)$$

$$= \frac{n\delta}{2} (\alpha \sigma_H x_H^2 + \alpha_L \sigma_L x_L^2). \quad (30)$$

In the non-refundable case the consumer surplus becomes

$$C_{SN} \overset{def.}{=} n \left( \alpha_H \int_0^{x_H} [\sigma_H (\beta - \delta x) - p^N] dx + \alpha_L \int_0^{x_L} [\sigma_L (\beta - \delta x) - p^N] dx \right)$$

$$= \frac{n\delta}{2} (\alpha \sigma_H x_H^2 + \alpha_L \sigma_L x_L^2). \quad (31)$$

Finally in the price discrimination case:

$$C_{SD} \overset{def.}{=} n \left( \alpha_H \int_0^{x_H} [\sigma_H (\beta - \delta x) - p^N] dx + \alpha_L \int_0^{x_L} \sigma_L (\beta - \delta x - p^R)dx \right)$$

$$= \frac{n\delta}{2} (\alpha \sigma_H x_H^2 + \alpha_L \sigma_L x_L^2). \quad (32)$$

B Proof of Proposition 1

Proof. Part (a) Claims that $\sigma_H = \sigma_L \iff \pi^R = \pi^N$ and $\sigma_H > \sigma_L \iff \pi^R > \pi^N$. $\sigma_H = \sigma_L \Rightarrow \pi^R = \pi^N$ is trivial as $\sigma_H = \sigma_L \Rightarrow \sigma_H = \sigma_L = \psi_1 = \psi_2$. Next, we prove that $\sigma_H > \sigma_L \Rightarrow \pi^R > \pi^N$, which is a necessary and sufficient condition for the equivalences in Proposition 1 (a). Assume that the market participation is positive during a refundable as well as during a non-refundable strategy. Then, $\beta/c > \max(\psi_2/(\sigma_H \sigma_L), 1/\psi_1)$, which immediately implies that $\beta^2 \sigma_H \sigma_L \psi_1 - c^2 \psi_2$...
>\psi_2 (\beta \psi_1 - c) > 0. Hence, we would observe a non-refundable strategy, only in the case the participation in the refundable market is zero and \(1/\psi_1 \geq \beta/c > \psi_2/(\sigma_H \sigma_L)\).

But, \(1/\psi_1 > \psi_2/(\sigma_H \sigma_L)\) is impossible as \(\sigma_H \sigma_L - \psi_1 \psi_2 = -\alpha_H (1 - \alpha_H) (\sigma_H - \sigma_L)^2 < 0\).

Part (b) a corollary of equations (10) and (17).

References


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