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REFUNDS AND COLLUSION

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Refunds and Collusion*

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Abstract

We characterize the conditions under which industry-wide agreements on refund policies weaken price competition. We identify the conditions under which joint industry profit increases with the amount of refunds promised to those consumers who cancel a reservation or return a product. We compare it to similar industry configurations when firms set up shipping and handling charges instead of refunds. Finally, we investigate refund policies under moral hazard.

Keywords: Refunds, Partial refunds, Collusion on refunds, Shipping & handling charges, Moral hazard.

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1. Introduction

Semicollusion refers to explicit and implicit non-price agreements among brand producing firms generally intended to weaken price competition. For many years, researchers of Industrial Organizations have been debating for example whether research joint ventures should be allowed and to what extend they generate price increases above the competitive levels. In this paper we examine the effects of colluding on refund levels. In principle, colluding on refunds should be more alarming than ordinary semicollusive practices since refunds can be viewed as a component of the price. The purpose of this paper is to explore precisely the issue how collusion on refunds affects the intensity of price competition, profits, and consumer welfare.

It is hard to come by examples where service providers or producers explicitly coordinate and declare a joint industry-wide refund policy. Although very little is known about how refunds affect price competition, firms may avoid contracting on a joint industry refund policy fearing that antitrust steps may be taken against their actions. However, from time to time we do see some indications that firms facilitate the enactment of industry-wide refund policies. For example, the International Air Transport Association (IATA) has been assisting in adopting the an accounting system, where one feature of this system is the inclusion of a "refund application processing module," which would handle the entire refund process.[1] Refunds are also practiced by merchants linked to the same payment system such as major credit/charge card organizations. These payment systems enable consumers to present a case to card issuers whenever a service is not delivered to their satisfaction, and to request a "chargeback" on their cards.

In the present paper, we formally introduce *competition* into industries that utilize advance booking systems where some consumers don't show up when the service is delivered. Our model also fits retail industries where some consumers wish to return the product and obtain some refund. Our purpose is investigate whether industry-wide collusion on a joint refund policy can weaken price competition and therefore harm the consumers. Our analysis can be applied to two types of industries. First, to industries providing services like travel arrangements (airline,

[1] See `http://www.iata.org/ps/services/auditlink1.htm` for a complete list of features describing this automated refund process.

train, bus, hotel, car rental), or repair, maintenance, education, and so on. These industries are characterized by services that are *time dependent* and *non-storable*. This means that both buyers and sellers must commit to a certain predetermined time at which the service is set to be delivered. Therefore, service providers tend to utilize advance reservation systems as part of their business and marketing strategies. Second, our analysis applies also to retailers selling *experience goods* where some consumers discover after purchase that there are unsatisfied with the product they have fully paid for.

In the Economics literature there are a few papers analyzing the refundability option as a means for segmenting the market or the demand. Most studies have focused on a single seller. Contributions by Gale and Holmes (1992, 1993) compare a monopolist's advance bookings with socially-optimal ones. Gale (1993) analyzes consumers who learn their preferences only after they are offered an advance purchase option. On this line, Miravete (1996) and more recently Courty and Li (2000) further investigate how consumers who learn their valuation over time can be screened via the introduction of refunds. Courty (2003) investigates resale and rationing strategies of a monopoly that can sell early to uninformed consumers or late to informed consumers. Dana (1998) also investigates market segmentation under advance booking made by price-taking firms. Macskasi (2003) analyzes duopoly with product differentiation where each consumer gets an ex ante signal of her preferred location and only then learns the true location. Finally, Ringbom and Shy (2004) analyze partial refunds set by price-taking firms. The present paper adds to the above literature by focusing on the incentive to semicollude on a joint industry-wide refund policy.

The paper is organized as follows. Section 2 sets up a basic model of a single service provider who sets a price and the amount of refund to be given to those consumers who cancel or simply don't show up. Section 3 extends the model to two service providers who compete in prices *and* the amount of refunds given to consumes who are either not satisfied with a product, or do not show up at the time when the service is scheduled to be delivered. Section 4 solves for a noncooperative equilibrium. Section 5 analyzes collusion on refund levels and its welfare consequences. Section 6 analyzes shipping and handling charges. Section 7 further extends the model by formally analyzing the moral hazard implications of providing refunds. Section 8 summarizes and discusses the findings of this paper.

2. Monopoly, Refunds, and Price Discrimination

This paper is about the incentives to collude on refunds and similar price-related marketing tools. Clearly, any type of collusion can only occur if there are at least two firms. Therefore, the monopoly market structure is irrelevant for our main investigation. However, we still would like to use the monopoly market structure as the benchmark case because it helps us understand the role refunds can play in the extraction of revenue from consumers who differ in their cancellation and no-show behavior.

Consider a single service provider, acting as a monopoly. This service provider simultaneously sets the service price p, and the refund level r that may be given to consumers who either cancel or do not show up at the service delivery time. We assume that the amount of refund cannot exceed the price paid for this service; formally, $r \leq p$.

2.1 Services and products: Interpreting the model

Our model can be interpreted and applied to capture two types of markets:

Services : Where consumers make reservations, prepay for the service, and then request (partial) refund in the event that they cancel or simply do not show up (with some probability $1 - \sigma$) for the delivery of the service. Under this interpretation, consumers show up with probability σ.

Products : Where consumers fully pay for a product, but then are not satisfied with the product (with some probability $1-\sigma$) and utilize the store's refund option. Under this interpretation, there is a probability σ that a customer is satisfied with the product after the purchase.

The first interpretation applies to transportation services such as the airline industry, whereas the second interpretation fits general retailing business. In order to avoid excessive writing, we will be using the service interpretation in some models and the product interpretation for others, but the reader should bear in mind that our intention is to cover both types of industries.

Finally, we *initially* abstract from moral hazard issues by treating the show up probabilities σ as constant parameters. Section 7 extends the model by making σ dependent on the amount of refund on cancellations and no shows given by service providers.

2.2 Costs

The Service provider bears two types of per-customer costs. Let $k \geq 0$ denote the service provider's capacity production cost or the cost of making a reservation for one customer. Note that this cost could be significant if the provider does not have any alternative use (no salvage value) for an unused capacity. Alternatively, it may not exist if capacity has an immediate alternative use upon no shows of consumers. Regardless of its magnitude, we view the parameter k as a sunk cost associated with any booking.

In addition, service providers bear a per-customer cost of operation which we denote by $c \geq 0$. The difference between the *capacity cost* and the *operating cost* is that the latter is borne only if the customer actually shows up for the service, whereas the capacity/reservation cost is borne regardless of whether the customer shows up. Finally, we assume that service providers always buy a sufficient amount of capacity to accommodate all reservations. That is, we deliberately abstract from overbooking as we view it as a completely different strategy, that should be separated from collusion on refunds, at least at this stage of preliminary research.

2.3 Consumers

Consumers are differentiated along two dimensions: The basic benefit they derive from this service, and the probability of showing up to collect a reserved service. Basic benefit can be given a "location" interpretation where the service provider "locates" at point $x = 0$, so that each consumer is indexed by a number $x \in [-0.5, +0.5]$ and derives a benefit of $\beta - \tau|x|$ from this service.

We assume that there are n_H consumers who show up for the delivery of the service (or are satisfied with the product) with probability σ_H. Similarly there are n_L consumers whose probability of showing up is σ_L, where $0 < \sigma_L < \sigma_H < 1$. We assume that the (expected) utility of a consumer indexed by $(\sigma_i, x) \in \{\sigma_H, \sigma_L\} \times [-0.5, +0.5]$ is given by

$$U(\sigma_i, x) \stackrel{\text{def}}{=} \begin{cases} \sigma_i(\beta - \tau|x|) - p + (1 - \sigma_i)\, r & \text{buying this service} \\ 0 & \text{not buying.} \end{cases} \tag{1}$$

The first term measures the expected basic gain from consuming the service, which is the product of the expected probability of showing up times the basic gain. The last term is the expected refund which is the product of the probability of not consuming the service (no-show) and the amount of refund announced by this service provider. Observe that equation (1) is actually an *indirect utility function* where the contingent refund enters this function after a budget constraint is substituted into a basic utility function. We merely take a short cut by starting out with the indirect utility function. Note that price discrimination is possible since consumers differ in their cancellation probabilities that enter into their indirect utility function.

The utility function (1) assumes that the consumers are heterogenous with respect to the *actual consumption* of the service. We would like to propose an alternative formulation of (1) where the consumers are heterogeneous with respect to the disutility inflicted by having to *reserve the service in advance*. Under this interpretation, the utility function could be written as

$$V(\sigma_i, x) \stackrel{\text{def}}{=} \begin{cases} \sigma_i\beta - \tau|x| - p + (1 - \sigma_i)\, r & \text{buying this service} \\ 0 & \text{not buying.} \end{cases} \tag{2}$$

From a technical perspective, the only difference between (1) and (2) is whether the disutility component $-\tau|x|$ is multiplied by the show-up probability σ_i or not. The "sure" dissatisfaction from making the reservation (as opposed to the actual consumption of the service) should be attributed to the cost of making a reservation which may be subjected to transportation costs and value of time costs. Consumers could clearly be differentiated between making the two reservations, say because of two different locations, or different methods (say, Internet reservation versus an in-person reservation).

In what follows, we will be assuming that the utility function (1) holds. To save on space, we will not bring our computations of the monopoly equilibrium under the alternative utility function (2). We will only state that Proposition 2 concerning the effects of refunds under the monopoly market structure, continues to hold under the alternative utility function (2).

Our analysis focuses on equilibria where both consumer types are served when refunds are offered (but not necessarily when refunds are not offered). The following assumption ensures the participation (bookings) of some type L consumers. Formally,

ASSUMPTION 1. *The expected benefit of each consumer type, net of operating cost, exceeds the sunk unit capacity cost. Formally,* $\sigma_L(\beta - c) > k$.

Clearly, since $\sigma_H > \sigma_L$, Assumption 1 also implies that $\sigma_H(\beta - c) > k$.

2.4 Equilibrium classifications

The reservation utility defined in (1) hints there may exist monopoly equilibria where some consumers do not book this service. Let $\hat{x}_H$ and $\hat{x}_L$ denote type H and type L consumers who are indifferent between booking (prepaying) for the service and not booking at all. From (1) we have

$$\hat{x}_i = \max\left\{0\,,\, \min\left\{\frac{\sigma_i\beta - p + (1-\sigma_i)r}{\tau\sigma_i}\,,\, \frac{1}{2}\right\}\right\}, \quad i = H, L. \tag{3}$$

Therefore, $n_H\hat{x}_H$ type H consumers and $n_L\hat{x}_L$ type L consumers book this service.

Our purpose here is to compute monopoly equilibria with and without refunds to consumers. In both equilibria, the reservation utility defined in (1) implies that partial consumer participation (and none) are possible equilibrium configurations. Figure 1 classifies all possible equilibrium configurations. Formally,

DEFINITION 1. *We say that a monopoly equilibrium results in*

(a) **full participation** *if* $\hat{x}_H = \hat{x}_L = 0.5$*;*

(b) **partial participation** *if* $0 < \hat{x}_L < \hat{x}_H < 0.5$*; and*

(c) an **exclusion** *if* $0 = \hat{x}_L < \hat{x}_H < 0.5$.

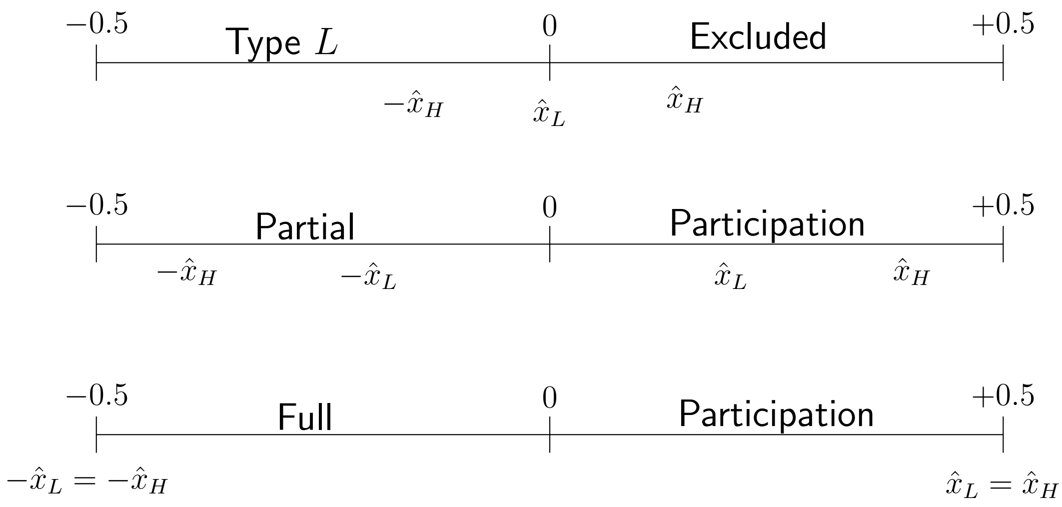

Figure 1: Consumer participation under three possible monopoly equilibria.

Since we use the monopoly model as a benchmark for analyzing incentives to collude on refunds in an oligopoly market structure, we restrict our monopoly analysis to partial-participation and full-participation equilibria only. Therefore, we do not analyze an equilibrium where only type H consumers book the service. We merely would like to point out that the equilibrium where all type L consumers are excluded is most likely to occur when refunds are prohibited so that by setting a high price only type H consumers find it beneficial to book the service.

The remainder of this section on monopoly is organized as follows. Subsection 2.5 computes a partial participation monopoly equilibrium with and without refunds. Subsection 2.6 computes the analogous full participation equilibria. Then, Subsection 2.7 draws the conclusions on the welfare implication of introducing refunds on no-shows and cancellations by a monopoly service provider. Finally, all equilibria are computed under the assumption that service providers cannot offer a menu of price-refund contracts to screen consumers, see Rochet and Stole (2003).

2.5 Monopoly equilibrium under partial participation

We now compute a partial participation equilibrium, first with refunds, and then when refunds are prohibited.

2.5.1 Partial participation: Equilibrium with refunds

Before we state the service provider's profit function, we introduce two variables for measuring output. Let q denote the total number of bookings made, and s denote the *expected* number of show-ups. Formally, $q = 2(n_H\hat{x}_H + n_L\hat{x}_L)$ and $s = 2(\sigma_H n_H \hat{x}_H + \sigma_L n_L \hat{x}_L)$. We multiply by 2 as all participating type i consumers are indexed on $[-\hat{x}_i, \hat{x}_i]$, $i = H, L$. Clearly, $s \leq q$. Thus, the monopoly service provider chooses a price and a refund level to solve

$$\max_{p,r} \pi = q(p-k) - sc - (q-s)r = 2(n_H\hat{x}_H + n_L\hat{x}_L)(p-k) \\ - 2(\sigma_H n_H\hat{x}_H + \sigma_L n_L\hat{x}_L)c - 2[(1-\sigma_H)n_H\hat{x}_H + (1-\sigma_L)n_L\hat{x}_L]r. \quad (4)$$

The first term measures the total revenue net of the per-reservation sunk cost. The second term is the expected operating cost (which depends on the expected number of show-ups). The third term is the expected refund paid to consumers who don't show up or simply cancel their reservation. Observe that refunds enter the profit function (4) through the interaction between capacity production cost and operating cost. These two costs would be endogenous in a more general model, see for example Section 7. That is, in practice capacity cost depends on the number of no-shows which depends on the consumption incentives given by the level of refund.

Substituting (3) for x_H and x_L into (4), and then solving the profit-maximization problem (4) yields the unique monopoly price and refund levels

$$p^r = \frac{c+k+\beta}{2} \quad \text{and} \quad r^r = \frac{c+\beta}{2}, \quad (5)$$

where superscript "r" stands for a regime when refunds are permitted. Second order conditions for the maximization problem (4) are satisfied since $\partial^2\pi/\partial p^2 = -4(n_H\sigma_L + n_L\sigma_H)/(\sigma_H\sigma_L\tau) < 0$, $\partial^2\pi/\partial r^2 = -4[n_H\sigma_L(1-\sigma_H)^2 + n_L\sigma_H(1-\sigma_L)^2]/(\sigma_H\sigma_L\tau) < 0$, and the determinant of the Hessian equals $16 n_H n_L(\sigma_H - \sigma_L)^2/(\sigma_H\sigma_L\tau^2) > 0$, hence the Hessian is negative definite. Substituting (5) into (3), the consumers of each type $i = H, L$ who are indifferent between booking and not booking are given by

$$\hat{x}_H = \frac{\sigma_H(\beta - c) - k}{2\sigma_H\tau} \quad \text{and} \quad \hat{x}_L = \frac{\sigma_L(\beta - c) - k}{2\sigma_L\tau} > 0 \quad (6)$$

by Assumption 1. Clearly, $\hat{x}_H > \hat{x}_L$, which implies that equal consumer densities $n_H = n_L$ constitues a sufficient condition that more type H consumers book the service than type L consumers.

2.5.2 Partial participation: Equilibrium with no refunds

Suppose now that the service provider is prohibited from offering any refund to customers. Formally, substituting $r = 0$ into (3) and then into (4), the profit-maximizing price in the absence of refunds is given by

$$p^{nr} = \frac{\sigma_H \sigma_L (n_H + n_L)(\beta + c) + (n_H \sigma_L + n_L \sigma_H) k}{2(n_H \sigma_L + n_L \sigma_H)}, \tag{7}$$

where superscript "*nr*" stands for no refund. Substituting (7) and $r = 0$ into (3), the type i consumers who are indifferent between booking and not booking are indexed by

$$\hat{x}_i^{nr} = \frac{\sigma_i [n_i \sigma_j + n_j (2\sigma_i - \sigma_j)]\beta - \sigma_H \sigma_L (n_H + n_L) c - (n_H \sigma_L + n_L \sigma_H) k}{2\sigma_i \tau (n_H \sigma_L + n_L \sigma_H)}, \quad i = H, L. \tag{8}$$

Therefore,

$$\hat{x}_H^{nr} - \hat{x}_L^{nr} = \frac{(\sigma_H - \sigma_L)[\sigma_H \sigma_L (n_H + n_L) c + (n_H \sigma_L + n_L \sigma_H) k + \sigma_H \sigma_L (n_H + n_L)\beta]}{2\sigma_H \sigma_L \tau (n_H \sigma_L + n_L \sigma_H)} > 0 \tag{9}$$

meaning that under no refund, more type H consumers book this service than type L consumers.

2.6 Monopoly equilibrium under full participation

We now compute a full participation equilibrium, first with refunds, and then when refunds are prohibited.

2.6.1 Full participation: Equilibrium with refunds

Given that the entire consumer population of both consumer types book this service, solving (3) corresponding to $\hat{x}_H = 0.5$ and $\hat{x}_L = 0.5$ yields

$$p_i \stackrel{\text{def}}{=} p\Big|_{\hat{x}_i = \frac{1}{2}} = \frac{\sigma_i (2\beta - \tau)}{2} + (1 - \sigma_i) r_i, \qquad i = H, L. \tag{10}$$

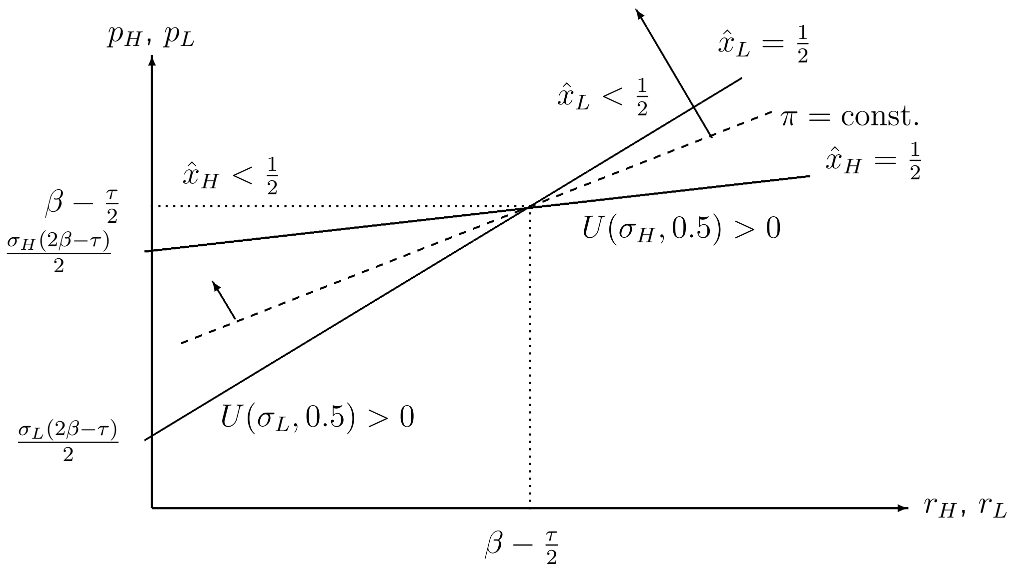

Figure 2: Iso-location (solid) and iso-profit (dashed) loci.
Note: Arrows indicate direction of profit increase.

Equations (10) determine the "iso-location" loci of the price-refund pairs (p_H, r_H) and (p_L, r_L) so that $\hat{x}_H = 0.5$ and $\hat{x}_L = 0.5$, respectively, which are depicted in Figure 2. The prices and refunds p_i and r_i are hypothetical only (i.e., the monopoly can set only a single price and a single refund level for all consumers) and are used to determine consumer's maximum willingness to pay at the extreme location points. Clearly, for a given refund level r_i, any price higher than p_i would generate partial participation $\hat{x}_i < 0.5$. Thus, full-participation occurs only on the south-eastern half-spaces of the two loci. In this region both consumer types obtain nonnegative surpluses so that $U(\sigma_H, x_H) \geq 0$ and $U(\sigma_L, x_L) \geq 0$.

Next, to prove that the intersection point in Figure 2, which is also the unique solution to the system of equations (10), constitutes the profit-maximizing price-refund pair we also draw an iso-profit line in Figure 2. Substituting $\hat{x}_H = \hat{x}_L = 0.5$ into the profit function (4), and then solving for the price under the restriction $\pi =$ constant yields

$$p\Big|_{\pi=\text{constant}} = \widehat{\text{constant}} + \frac{n_H(1-\sigma_H) + n_L(1-\sigma_L)}{n_H + n_L}\, r. \tag{11}$$

The profit-maximizing iso-profit line (11) is drawn in Figure 2 as a straight line cutting between the two loci because (11) clearly indicates that the slope of the iso-profit line is a linear combination of the slopes of the two lines given in (10). Profit clearly rises in the north-westerly direction since a movement in this direction increases the booking price while reducing the refund level. Therefore, we conclude that the full-participation profit-maximizing price and refund levels are given by

$$p^r = r^r = \beta - \frac{\tau}{2}, \tag{12}$$

where superscript "r" stands for a regime when refunds are permitted. Clearly, any price-refund combination to the right and below the equilibrium pair drawn in Figure 2 is associated with having some consumers indexed by 0.5 obtain a strictly positive surplus, which are unprofitable for the monopoly service provider. Thus,

Proposition 1. *In a monopoly equilibrium with full market participation, the profit maximizing refund strategy is to provide full refunds on no-shows and cancellations.*

Proposition 1 is important since it is shown in Proposition 6 below that providing full refunds is also the collusive joint industry-wide refund policy. Thus, under full market coverage, full refunds are likely to be observed as a monopoly collusive outcome independently of the number of firms in the industry.

Finally, as it turns out, the welfare implications of this particular equilibrium happens to coincide with the welfare consequences of a collusion on refund in a duopoly setup analyzed in Section 5 below. For this reason we now only state the level of consumer surplus and profit level associated with the present equilibrium to be discussed later on in Section 5. Hence,

$$CS^r = \sum_{i=H,L} \int_{-0.5}^{0.5} \sigma_i n_i \left(\frac{\tau}{2} - \tau|x|\right) dx = \frac{\delta(n_H + n_L)\tau}{4} \quad \text{and} \tag{13}$$

$$\pi^r = (n_H + n_L)\left[\delta\left(\beta - \frac{\tau}{2} - c\right) - k\right], \text{ where} \tag{14}$$

$$\delta \stackrel{\text{def}}{=} \frac{\sigma_H n_H + \sigma_L n_L}{n_H + n_L}. \tag{15}$$

is the average showing up probability in the population. Note that the basic consumer valuation parameter β does not appear in (13) as it cancels out after the prices given by (12) are subtracted.

2.6.2 Full participation: Equilibrium with no refunds

Suppose now that the service provider is prohibited from giving any refund. Formally, let $r = 0$. The "iso-location" loci given in (10) and Figure 10 clearly indicate that there does not exist a price which would leave all the consumers indexed by $\hat{x}_H = \hat{x}_L = 0.5$ with exactly zero surplus. Thus, (10) and Figure 10 imply that in order to obtain full participation of type L consumers, in the absence of refunds the service provider must lower the price to

$$p^{nr} = \frac{\sigma_L(2\beta - \tau)}{2} < p^r, \tag{16}$$

where superscript "nr" stands for no refunds. Clearly, at this price type H consumers indexed by $\hat{x}_H = 0.5$ obtain a strictly positive surplus which cannot be extracted by the monopoly in the absence of refunds.

2.7 The effect of refunds: A comparison

We now investigate the effects of introducing refunds on monopoly's profit and consumer welfare. Unless indicated otherwise, the following comparisons are valid for both the partial participation equilibrium computed in Section 2.5, and the full participation equilibrium analyzed in Section 2.6.

Proposition 2. *(a) Monopoly's profit are higher when refunds are allowed.*

(b) The introduction of refunds raises the monopoly price.

(c) The introduction of refunds increases the bookings of type L consumers and reduces the bookings of type H consumers (partial participation equilibrium only).

(d) The equilibria with and without refunds are Pareto noncomparable. Type L consumers are weakly better off, whereas type H are strictly worse off under the equilibrium with refunds compared with the equilibrium with no refunds.

Proof. (a) Follows from revealed profitability, since when refunds are allowed the monopoly chooses a strictly positive refund level given by (5) and (12). (b) Subtracting (7) from (5) yields $p^r - p^{nr} = [n_H\sigma_L(1-\sigma_H) + n_L\sigma_H(1-\sigma_L)](\beta + c)/[2(n_H\sigma_L + n_L\sigma_H)] > 0$. The same sign is obtained by subtracting (16) from (12). (c) Subtracting (8) from (6) yields $x^r_H - x^{nr}_H = n_L(\sigma_L - \sigma_H)(\beta+c)/2\tau(n_H\sigma_L+n_L\sigma_H) < 0$, whereas $x^r_L - x^{nr}_L = n_H(\sigma_H - \sigma_L)(\beta+c)/2\tau(n_H\sigma_L+n_L\sigma_H) > 0$. (d) For the partial participation equilibrium, it follows immediately from part (c) since the "location" of the indifferent consumers is proportional to the utility of all consumers of the same type. For the full participation equilibrium, this follows from Figure 2 which shows that at the equilibrium price (16), $U(\sigma_H, 0.5) > 0$; whereas under refunds satisfying (10) both types obtain zero surplus. □

To summarize the monopoly case, we have demonstrated how market segmentation can be achieved with a single price by utilizing a refund policy that sorts out the consumers according to their probability of showing up. We have shown that this market segmentation yields welfare results similar to a monopoly market structure where other price discrimination techniques are feasible. Thus, the present results resemble very much the price discrimination results already pointed out in Varian (1985).

3. A Model of Competition and Refunds

The main difference between competition analyzed in this section, and the monopoly market structure analyzed so far, is that competing service providers utilize the refund system as both a *strategic* device and a *price discrimination* device. The strategic effect clearly does not prevail under monopoly. However both, firms under imperfect competition and a monopoly, utilize refunds as a means to screen consumers according to their probability of showing-up.

Consider a service industry with two imperfectly-competitive service providers, selling two differentiated products/services. The difference between the present model and other models of product differentiation is that in the present model some consumers request refunds on their booking of the service or their purchase of products.

3.1 Service providers

There are two service providers labeled by $j = A, B$. Let p_A and p_B be the prices they charge for booking their prepaid services, and r_A and r_B the refund they each promise to any consumer who prepays for the service but later cancels or simply does not show up. Thus, in addition to setting prices, each service provider utilizes a refund policy where each provider must inform consumers how much of the prepayed price is refundable in the event that the customer does not show up during the time when the service is delivered, or if the customer is simply unsatisfied the product.

3.2 Consumers

The n_H and n_L type H and L consumers whom we have already characterized in Subsection 2.3, are indexed by x $(0 \le x \le 1)$ that measures the distance (disutility) from service provider A, whereas $(1 - x)$ measures the distance from B. Thus, x serves as the standard Hotelling index of differentiation. Similar to the utility for a single service (1), we assume that the (expected) utility of a consumer indexed by $(\sigma_i, x) \in \{\sigma_H, \sigma_L\} \times [0, 1]$ is given by

$$U(\sigma_i, x) \stackrel{\text{def}}{=} \begin{cases} \sigma_i(\beta - \tau x) - p_A + (1 - \sigma_i)\, r_A & \text{buying service } A \\ \sigma_i[\beta - \tau(1 - x)] - p_B + (1 - \sigma_i)\, r_B & \text{buying service } B. \end{cases} \tag{17}$$

The parameter β measures consumers' basic utility from the service, and τ measures the degree of service differentiation, which is inversely related to the degree of competition between the two service providers. That is, competition becomes more intense when τ takes lower values. The utility function (17) reveals that the net benefit, $\beta - \tau x$ or $\beta - \tau(1 - x)$, is collected only if the consumer shows up (with probability σ_i), which we also assumed for the single service case, (1).

Observe the utility function (17) does not have a reservation utility. The reason for that is that reservation utility may generate partially served market equilibrium where some consumers around $x = 0.5$ will choose not to book this service. However, this market configuration was already analyzed in Section 2. For this reason, we do not assume any reservation utility which means that all consumers either book service A or service B. Finally, similar to the alternative utility function proposed by (2) for the single service provider case, we can easily write an alternative formulation for the utility (17) under two service providers, where consumers bear a disutility (transportation costs) from making a reservation regardless of whether they actually end up showing up at the service delivery time.

3.3 Profits of service providers

Let q_A and q_B denote the endogenously determined number of consumers who each book (buy) one unit of service from providers A and B, respectively. Since not all consumers end up showing up at the service delivery time (alternatively, since some consumers are not satisfied and end up returning the product) we denote by s_A and s_B the *expected* number of consumers who show up at the service delivery time. Clearly, $0 \leq s_j \leq q_j$ for all $j = A, B$. Therefore, the (expected) profit of each service provider j is given by

$$\pi_j(p_j, r_j) = (p_j - k)q_j - c\, s_j - r_j(q_j - s_j), \quad j = A, B. \tag{18}$$

The first term measures the revenue net of the reservation cost (cost of producing the product under the second interpretation). The second term measures the operating cost borne only if consumers actually show up to be served. The last term is the expected total refunds to consumers who don't show up for the service they have paid for.

4. Noncooperative Equilibrium Prices and Refunds

Consider a single-stage game where each service provider $j = A, B$ determines both the service booking price, p_j and the refund r_j to consumers who do not show up at the service delivery time. We look for a Nash equilibrium in $\langle p_A, r_A \rangle$ and $\langle p_B, r_B \rangle$.

4.1 Equilibrium prices and refund levels

The utility function (17) implies that a type i consumer who is indifferent between booking service A and B is determined by $\sigma_i(\beta - \tau \hat{x}_i) - p_A + (1-\sigma_i)r_A = \sigma_i[\beta - \tau(1-\hat{x}_i)] - p_B + (1-\sigma_i)r_B$.

Hence,

$$\hat{x}_i = \frac{p_B - p_A + (1-\sigma_i)(r_A - r_B) + \sigma_i \tau}{2\sigma_i \tau} \quad \text{for each type } i = H, L. \tag{19}$$

Thus, the fractions of A and B buyers increase with the amount of refunds r_A and r_B, respectively. Clearly, the difference between the proportions $\hat{x}_H$ and $\hat{x}_L$ disappears when $\sigma_L \to 1$ and $\sigma_H \to 1$ since in this case all buyers always show up meaning that no one asks for any refund.

From (19) we can compute the number of bookings (number of customers) made with each provider, and the expected number of show-ups:

$$\begin{aligned} q_A &= n_H \hat{x}_H + n_L \hat{x}_L & q_B &= n_H(1-\hat{x}_H) + n_L(1-\hat{x}_L) \\ s_A &= n_H \sigma_H \hat{x}_H + n_L \sigma_L \hat{x}_L & s_B &= n_H \sigma_H (1-\hat{x}_H) + n_L \sigma_L (1-\hat{x}_L). \end{aligned} \tag{20}$$

Substituting (19) into (20), and then into (18), maximizing π_A with respect to p_A and r_A, and π_B with respect to p_B and r_B, and then solving the four first-order conditions yield

$$r_A = r_B = c + \tau, \quad p_A = p_B = c + k + \tau, \quad \pi_A = \pi_B = \frac{\delta(n_H + n_L)\tau}{2}. \tag{21}$$

Thus, equilibrium profit consists of the markup τ multiplied by the expected number of show-ups per firm $\delta(n_H + n_L)/2$, where δ is the average show-up probability defined by (15). Second-order conditions are satisfied since $\partial^2 \pi_j / \partial(p_j)^2 = -(n_H \sigma_L + n_L \sigma_H)/(\sigma_H \sigma_L \tau) < 0$, $\partial^2 \pi_j / \partial(r_j)^2 = -[n_H \sigma_L (1-\sigma_H)^2 + n_L \sigma_H (1-\sigma_L)^2]/(\sigma_H \sigma_L \tau) < 0$, and the determinant of the Hessian equals $-n_H n_L (\sigma_H - \sigma_L)^2/(\sigma_H \sigma_L \tau^2) > 0$.

The equilibrium values (21) imply the following proposition.

Proposition 3. *The noncooperative equilibrium refund to customers who do not show up consists of the entire price net of the capacity cost. Formally, $r_A = p_A - k$ and $r_B = p_B - k$.*

In other words, competitive refunds consist of the operating cost saving on a no-show, c, plus the duopoly price markup τ. This implies that service providers do not make any profit on customers who cancel. Hence, all profits are extracted only from consumers who do show up for the service (or are satisfied with the product under the second interpretation given in Section 2.1). Intuitively, competition on refunds generates an intensive competition on type L consumers. Since type L

consumers are less likely to show up, competition on refunds leads to a full insurance for those who cancel.

4.2 Equilibrium prices when refunds are not offered

Suppose now that for some reason service providers are prohibited from giving refunds to consumes. In order to compute the noncooperative equilibrium prices, substituting $r_A = r_B = 0$ into (19), then into (20), and then into (18), maximizing π_A with respect to p_A and π_B with respect to p_B, and then solving the two first-order conditions yield

$$p_A = p_B = k + \gamma(c + \tau), \quad \text{where} \quad 0 < \gamma \stackrel{\text{def}}{=} \frac{\sigma_H \sigma_L (n_H + n_L)}{n_H \sigma_L + n_L \sigma_H} < 1. \tag{22}$$

Thus, when refunds are not offered, the noncooperative prices equal the sunk reservation cost k plus a fraction of the sum of the operating cost and the differentiation parameter τ. Hence,

$$\pi_A = \pi_B = \frac{\sigma_H \sigma_L \tau (n_H + n_L)^2 - c n_H n_L (\sigma_H - \sigma_L)^2}{2(n_H \sigma_L + n_L \sigma_H)}. \tag{23}$$

Comparing the equilibrium values when refunds are not offered (22) and (23) to the values when refunds are offered (21) yields the following proposition.

Proposition 4. *Competition in refunds and prices generates higher equilibrium prices and higher profit levels than competition in prices only.*

Clearly, firms' commitment to provide refunds is a commitment to be subjected to higher expected costs that depend on the number of no-shows. This explains why prices are higher when refunds are offered. The interesting part of this proposition is that the introduction of multidimensional competition (refunds and prices) instead of price competition only, still results in a profit increase. This shows that the profit gained by the price discrimination screening effect dominates profit decreasing competitive effects generated by the increase in the dimension of the strategy space.

4.3 Welfare under competition in refunds and prices

We define consumer surplus as the sum of consumers' utilities (17) evaluated at the equilibrium prices and refund levels. Formally,

$$CS \stackrel{\text{def}}{=} \sum_{i=H,L} n_i \int_0^{0.5} [\sigma_i(\beta - \tau x) - p_A + (1-\sigma_i) r_A] \, dx$$
$$+ \sum_{i=H,L} n_i \int_{0.5}^{1} \{\sigma_i[\beta - \tau(1-x)] - p_B + (1-\sigma_i) r_B\} \, dx. \quad (24)$$

Substituting the equilibrium prices and refund levels (21) into (24) yields

$$CS = \left(\beta - c - \frac{5\tau}{4}\right)(n_H\sigma_H + n_L\sigma_L) - k(n_H + n_L). \quad (25)$$

Social welfare is defined by the sum of consumer surplus (25) and aggregate industry profit (21). Therefore,

$$W \stackrel{\text{def}}{=} CS + \pi_A + \pi_B = \left(\beta - c - \frac{\tau}{4}\right)(n_H\sigma_H + n_L\sigma_L) - k(n_H + n_L). \quad (26)$$

As expected, social welfare is the sum of basic utility net of operating cost and the average transportation cost, all multiplied by the expected number of consumers who show up, minus the sunk booking costs for the entire consumer population.

5. Collusion on Refund Levels

In this section we approach our main investigation which is to characterize the conditions under which service providers have incentives to agree on a joint industry-wide refund policy. We then compare the semicollusive refund levels to the noncooperative levels characterized in the previous section.

We model semicollusion as a two-stage game. In Stage I, both service providers determine their refund levels r_A and r_B as to maximize joint profit $\pi_A + \pi_B$. In Stage II, refunds levels are taken as given, and each service provider chooses a price to maximize her own profit, taking the price of the other provider as given. We now solve for a subgame-perfect equilibrium.

5.1 Stage II: Equilibrium prices

Suppose that both service providers are already committed to the amount of refund they give on no-shows. Formally, let r_A and r_B be given. Substituting (19) into (20), and then into (18), maximizing π_A with respect to p_A, and π_B with respect to p_B yields

$$p_j = k + \gamma(c+\tau) + (1-\gamma)r_j, \quad \text{for provider } j = A, B, \tag{27}$$

where the parameter γ is defined in (22). The price functions (27) highlights the fact that higher refund levels serve as a commitment on higher expected costs which result in higher booking prices. Second-order conditions for maxima are easily verified by computing $\partial^2\pi_j/\partial p_j^2 = -(n_H\sigma_L + n_L\sigma_H)/(\sigma_H\sigma_L\tau) < 0$. Next, observe that

$$p_B - p_A = \frac{(r_B - r_A)[n_H\sigma_L(1-\sigma_H) + n_L\sigma_H(1-\sigma_L)]}{n_H\sigma_L + n_L\sigma_H}.$$

Therefore,

Observation 5. *The firm committed to a higher refund ends up charging a higher price. Formally, $p_B \geq p_A$ if and only if $r_B \geq r_A$.*

Thus, since a provider's price best-response function monotonically increases with respect to her refund commitment, a commitment on a higher refund level serves as a tool for increasing costs and therefore the booking price paid by consumers.

5.2 Stage I: Collusion on refunds

In the first stage both service providers compete in refunds, knowing how refunds will affect equilibrium prices. Substituting (27) into (20) and (19), and both into (18) and rearranging the terms yield the following linear-quadratic semi-collusive joint profit function.

$$\pi_A + \pi_B = \frac{n_H n_L(\sigma_H - \sigma_L)^2}{2(n_H\sigma_L + n_L\sigma_H)}\left\{\frac{1}{\tau}[r_A, r_B]\begin{bmatrix} -1 & 1 \\ 1 & -1 \end{bmatrix}\begin{bmatrix} r_A \\ r_B \end{bmatrix} + [r_A, r_B]\begin{bmatrix} 1 \\ 1 \end{bmatrix} - 2c\right\} + \frac{\sigma_L\sigma_H(n_H+n_L)^2\,\tau}{(n_H\sigma_L + n_L\sigma_H)}. \tag{28}$$

Next, observe that $\pi_A + \pi_B$ is linear quadratic with respect to the refund levels, where the quadratic part is negative semi-definite with a maximum value of 0 along $r_A = r_B$, and where the linear part is upward sloping in the direction $r_A = r_B$.[2] Geometrically, the collusive profit is a ridge surface in the refunds, sloping upward in the direction $r_A = r_B$. Therefore, industry profit is maximized when the firms agree on a common refund. For any collusive refund level satisfying $r = r_A = r_B$, the profits are

$$\pi_A = \pi_B = \frac{n_H n_L(\sigma_H - \sigma_L)^2(r - c) + \sigma_L\sigma_H(n_H + n_L)^2 \cdot \tau}{2(n_H\sigma_L + n_L\sigma_H)}. \tag{29}$$

Clearly, the industry profit increases with the collusive refund level r. Intuitively, committing on paying higher refunds on no-shows raises expected costs that are rolled over in the form of higher booking prices. The resulting noncooperative equilibrium prices $p = p_A = p_B$ corresponding to the collusive refund level r are obtained by substituting the refund rate into equation (27). Hence,

$$p = k + \gamma(c + \tau) + (1 - \gamma)r, \tag{30}$$

where the parameter γ is defined in (22). Thus, consumers who book the service prepay for the sunk booking cost and a linear combination of operating costs plus markup and the refund commitment. Comparing the equilibrium price when firms collude on r (30), to the equilibrium prices under no collusion (21), reveals that (30) is a linear combination of the marginal operating cost plus duopoly mark up *and the refund level* r.

Equation (30) postulates the exact relationship between the collusive refund level and the noncooperative equilibrium price which is plotted in Figure 3. Thus, the collusive refund levels are lower than the noncooperative price when the refunds are sufficiently low. In addition, the price is linearly increasing in refunds with a slope smaller than one. Therefore, there exists a unique refund level where the prices and refunds coincide, which we denote by $\bar{p} = \bar{r}$, that can be solved directly from equation (30) to take the form

$$\bar{p} = \bar{r} = \frac{k}{\gamma} + c + \tau \tag{31}$$

[2] $\det \nabla^2 (\pi_A + \pi_B) = 0$ and $\nabla (\pi_A + \pi_B)|_{r_A = r_B} = \frac{n_H n_L(\sigma_H - \sigma_L)^2}{2(n_H\sigma_L + n_L\sigma_H)} \cdot \begin{bmatrix} 1 \\ 1 \end{bmatrix} > \mathbf{0}$.

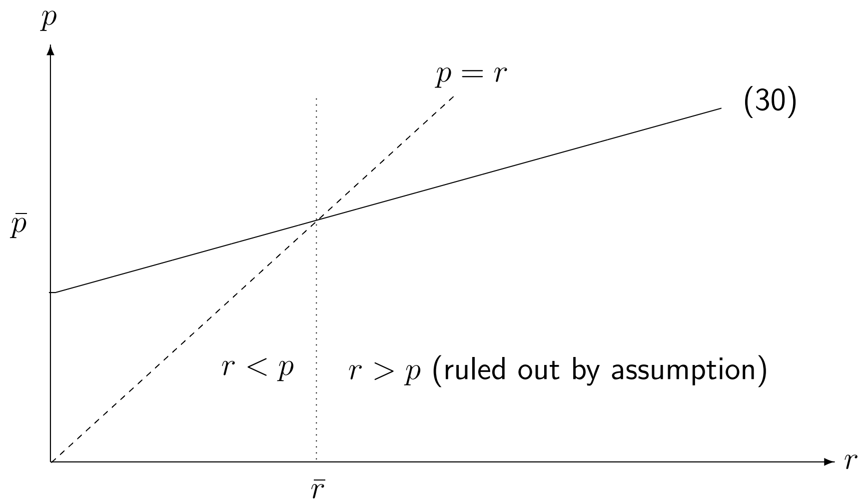

Figure 3: Noncooperative equilibrium price as a function of the colluded refund level.

Figure 3 shows that all refund levels exceeding $\bar{r}$ are greater than the booking price. At these levels, refunds can be viewed as a partial subsidy to those consumers who do not show up, which we ruled out by the restrictions $r_j \leq p_j$, $j = A, B$.

The following proposition summarizes our results on the effects of collusion on refunds.

Proposition 6. *(a) The collusive industry-wide refund policy is to provide full refunds. The resulting noncooperative equilibrium prices are finite, uniquely determined, and are given by (31).*

(b) The difference between the collusive refund and the noncooperatively-determined refund is proportional to the capacity cost parameter k.

(c) If the observed refund levels exceed the sum of the operation cost and the duopoly market, that is $r > c + \tau$, then we know that the firms are colluding.

Notice that Proposition 6(a) is less obvious than one may initially think, since nowhere in this paper we assumed that prices and refunds should be finite. In fact, the utility function (17) does not have any minimum reservation level. What part (a) shows that as long as refunds cannot exceed prepaid prices, collusive outcomes satisfying $r_A = r_B \leq p_A = p_B = +\infty$ are not profitable. Proposition 6(b) can be verified by subtracting the collusive refund level (31) from the noncooperative equilibrium level (21), to obtain k/γ. Hence, the collusive refund and the noncooperative refund levels coincide when the sunk capacity cost is $k = 0$. Therefore, we can infer the following corollary.

Corollary 7. *Collusion on a joint refund policy is more likely to be observed in industries with large capacity costs.*

Corollary 7 proposes an hypothesis that collusive refund levels may be higher in industries with large sunk capacity costs such as the airline and car rental industries than in industries with low sunk per-customer capacity cost.

Proposition 6(c) proposes a method for detecting collusion on refunds by observing the booking prices p_A and p_B, and then comparing these prices with the marginal operating cost, the differentiation parameter, and the observed refund levels.

Finally, to compute the collusive profit levels, substitute (31) for r into (29) to obtain

$$\pi_A + \pi_B = 2\pi_A = 2\pi_B = \frac{n_H n_L k(\sigma_H - \sigma_L)^2}{\sigma_H \sigma_L (n_H + n_L)} + \delta(n_H + n_L)\tau, \tag{32}$$

where δ is defined by (15). To compute the exact gain in industry profit resulting from the ability to semicollude on refund levels, subtracting (21) from (32), and multiplying by 2 (for two service providers), yields

$$2\pi_j^{\text{collude}} - 2\pi_j^{\text{compete}} = \frac{n_H n_L k(\sigma_H - \sigma_L)^2}{\sigma_H \sigma_L} > 0. \tag{33}$$

5.3 Collusion on refunds: A welfare analysis

On the consumption side, collusion has two opposing effects on consumer welfare. First, collusion raises expected consumer welfare since it increases the refund in the event of a no-show. Second, higher refunds increase booking prices, thereby reducing consumer welfare. To compute consumer surplus when service providers collude on a joint refund policy, substituting (31) into (24) obtains

$$CS^{\text{collude}} = \delta(n_H + n_L)\left(\beta - \frac{k}{\gamma} - c - \frac{5}{4}\tau\right) = \delta(n_H + n_L)\left(\beta - \frac{\tau}{4} - \bar{p}\right). \tag{34}$$

Subtracting (25) from (34) yields the following proposition.

Proposition 8. *Colluding on refund levels reduces consumer welfare only if the capacity cost is strictly positive. Formally, the change in consumer surplus resulting from the collusion is given by*

$$CS^{\text{collude}} - CS^{\text{compete}} = -\frac{n_H n_L k(\sigma_H - \sigma_L)^2}{\sigma_H \sigma_L} < 0. \tag{35}$$

Finally, observe that the loss in consumer surplus (35) equals exactly to the gain in industry profits (33), resulting from allowing service providers to collude on refunds (but of course not on prices). Hence,

Proposition 9. *Semicollusion on a joint industry refund policy does not affect aggregate social welfare, as all the additional extracted consumer surplus is fully absorbed by the increase in profit of service providers.*

5.4 Collusion on refunds: Duopoly versus monopoly

We conclude our analysis of collusion on refunds under price competition with a comparison to the monopoly market structure under full market participation analyzed in Subsection 2.6. This analysis would shed some light on how much "monopoly power" is gained by the ability to collude on refunds in a duopoly market structure.

Subtracting (13) from (34) yields

$$CS^{\text{collude}} - CS^{\text{monopoly}} = \delta(n_H + n_L)\left(\beta - \frac{\tau}{2} - \bar{p}\right) = \delta(n_H + n_L)\left(\beta - \frac{k}{\gamma} - c - \frac{3\tau}{2}\right). \tag{36}$$

In addition, comparing this difference with the difference in industry profit by also subtracting (14) from (32) immediately reveal that

$$CS^{\text{collude}} - CS^{\text{monopoly}} = \pi^{\text{monopoly}} - \pi^{\text{collude}}. \tag{37}$$

Figure 4 provides a visual comparison of consumer surplus under duopoly with refund collusion to the single-seller monopoly market equilibrium. Equations (36) and Figure 4 imply the following proposition.

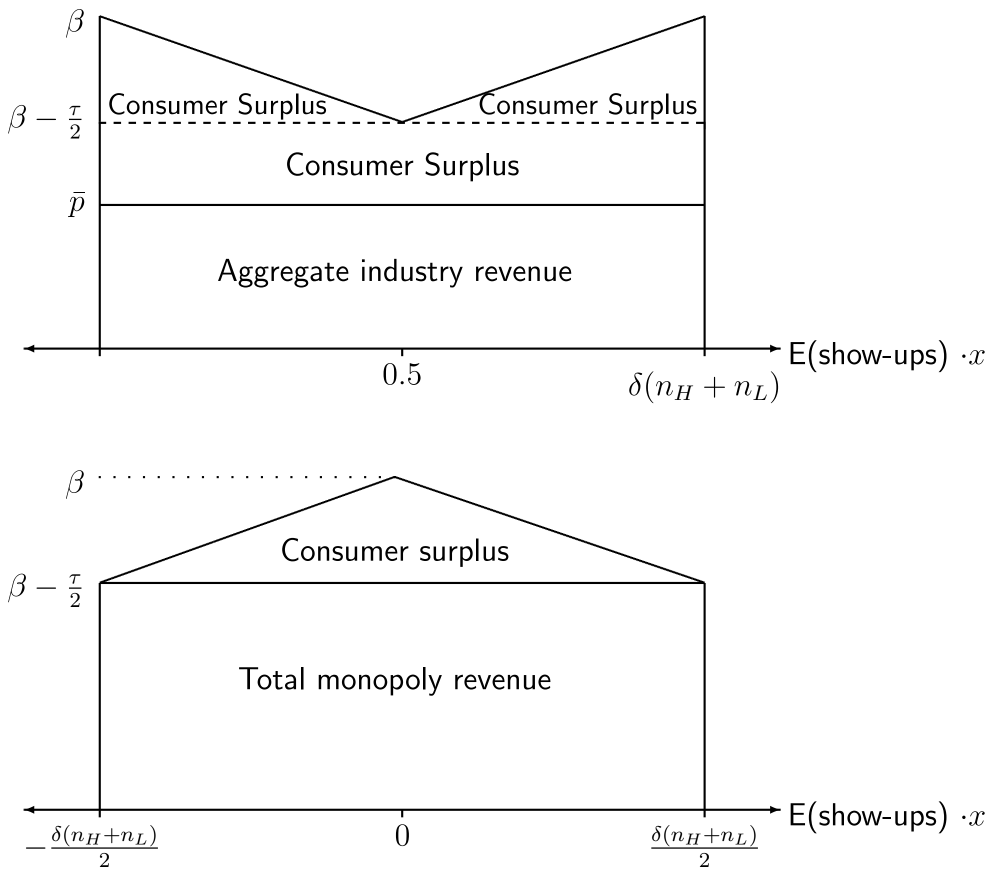

Figure 4: A Welfare comparison of duopolistic service providers (top) versus monopoly (bottom) under full market participation.

Proposition 10. *(a) The difference between the consumer surplus under duopolistic service providers colluding on refunds only, and a monopoly market structure yielding full participation equals the expected number of show-ups multiplied by the equilibrium price difference.*

(b) The above difference also equals the reduction in industry profit. Hence,

(c) The two market structures yield the same level of social welfare.

Part (c) should come at no surprise since Proposition 10 basically compares two market structures under full consumer participation. Hence, the only meaningful differences are how rents are allocated between firms and consumers. Part (a) clearly indicates that despite the collusion on refunds, a duopoly market structure under price competition is strictly preferred by consumers to the monopoly market structure. Figure 4 provides a visual illustration of this rent allocation.

6. Shipping and Handling (s&h) Charges

Shipping and handling charges (as opposed to refunds) are widely observed in some industries, most notably, in all mail-order companies. Shipping and handling can be interpreted as a portion of the price which is not refunded under any circumstance. Formally, let h_A and h_B denote these charges. The utility function (17) is now given by

$$U(\sigma_i, x) \stackrel{\text{def}}{=} \begin{cases} \sigma_i(\beta - \tau x - p_A) - h_A & \text{buying service } A \\ \sigma_i[\beta - \tau(1-x) - p_B] - h_B & \text{buying service } B, \end{cases} \tag{38}$$

for each consumer of type $i = H, L$. The profit functions (18) are now modified to

$$\pi_j = (h_j - k)q_j + (p_j - c)s_j, \quad j = A, B, \tag{39}$$

where q_j and s_j maintain the same definitions as before (number of reservations and the number of those who show up).

6.1 Noncooperative equilibrium s&h charges

We now compute a Nash equilibrium in $\langle p_A, h_A\rangle$, and $\langle p_B, h_B\rangle$, for the profit functions defined by (39). The utility function (38) implies that a type i consumer who is indifferent between purchasing from A and B is identified by

$$\hat{x}_i = \frac{h_B - h_A + \sigma_i(\tau + p_B - p_A)}{2\tau\sigma_i}, \qquad i = H, L. \tag{40}$$

Substituting (40) into (20), then into (39), and then maximizing π_j with respect to p_j and h_j, $j = A, B$, generate four first-order conditions. Solving the four equations obtains the noncooperative equilibrium prices, s&h fees, and equilibrium profit levels given by

$$p_A = p_B = c + \tau, \quad h_A = h_B = k, \quad \text{and} \quad \pi_A = \pi_B = \frac{\tau(n_H\sigma_H + n_L\sigma_L)}{2}. \tag{41}$$

Second order conditions are satisfied as $\partial^2\pi_j/\partial p_j^2 = -(n_H\sigma_H + n_L\sigma_L)/\tau < 0$, $\partial^2\pi_j/\partial h_j^2 = -(n_H\sigma_L + n_L\sigma_L)/(\sigma_H\sigma_L\tau) < 0$, and the Hessian is given by $n_H n_L(\sigma_H - \sigma_L)^2/2 > 0$.

We summarize our results on noncooperative s&h charges with the following proposition.

Proposition 11. *(a) The noncooperative equilibrium s&h charges equal the sunk booking cost k, whereas the refundable price equals the sum of the unit operation cost and the duopoly markup. Hence,*

(b) The s&h noncooperative game and the refund noncooperative game generate identical profit levels and consumer surplus.

Proposition 11(b) follows directly by comparing (41) with (21), and Proposition 3. The equilibrium consumer surplus given by (25) can be similarly verified for the utility functions (38) and the s&h equilibrium values (41).

6.2 Collusion on s&h charges

Suppose now that both firms can agree on a common industry-wide s&h charge denoted by $h = h_A = h_B$, before price competition begins. Substituting (40) into (20), then into (39), and then maximizing π_j with respect to p_j, for $j = A, B$, yield

$$p_j(h_j) = \frac{c(n_H\sigma_H + n_L\sigma_L) - h_j(n_H + n_L) + k(n_H + n_L) + \tau(n_H\sigma_H + n_L\sigma_L)}{n_H\sigma_H + n_L\sigma_L}. \quad (42)$$

Therefore, a rise in the s&h charge h_j results in a compensatory price reduction during the price competition stage. The corresponding profit levels $\pi_j(h_j, h_\ell)$ where $j, \ell = A, B$ as functions of given refund levels are then given by

$$\pi_j(h_j, h_\ell) = \frac{n_H n_L(\sigma_H - \sigma_L)^2 \left[k(h_j - h_\ell) - h_j^2 + h_j h_\ell\right] + \sigma_H\sigma_L\tau^2(n_H\sigma_H + n_L\sigma_L)^2}{2\sigma_H\sigma_L\tau(n_H\sigma_H + n_L\sigma_L)}. \quad (43)$$

In order to compute the collusive s&h charge, substituting $h_A = h_B = h$ into (43) yields that $\pi_A = \pi_B = (n_H\sigma_H + n_L\sigma_L)\tau/2$, which is independent of h. Therefore,

Proposition 12. *Profits of service providers are invariant with respect to the collusive level of the s&h charge. Thus, firms have no incentives to collude on an industry-wide s&h charge.*

Proposition 12 can be explained by observing how the noncooperative prices adjust when the collusive s&h charge varies. More precisely, (41) shows that increasing h by, say, \$1 would result in a price reduction of $(n_H\sigma_H + n_L\sigma_L)/(n_H + n_L)$ which is the expected revenue from those who show up for the service (those who are satisfied with the product under the second interpretation). Hence, the increase in the s&h revenue is exactly offset by the decline in price revenues. The reason for the difference in incentives to collude on s&h charges and refunds is explored in the concluding section.

7. Refunds and Moral Hazard

We say that consumer behavior exhibits *moral hazard* if an increase in the refund level offered by a service provider results in an increase in the number of no-shows and cancellations. Clearly, so far our analysis abstracted from any moral hazard issue by assuming that the showing-up probabilities σ_H and σ_L were exogenously-given constants.

In this section we develop a moral hazard model which would generate endogenously-determined show-up probabilities. We first describe the imperfectly competitive equilibrium determination of refund levels and prices. We then conclude with characterizing the equilibrium in which the service providers collude on refunds but continue to compete in prices.

7.1 Decisions

The interaction between consumers and the two competing service providers is divided into three stages:

I. Noncooperative price and refund competition : Providers set $\langle p_A, r_A\rangle$ and $\langle p_B, r_B\rangle$ taking the competitor's actions as given.

II. Consumers choose providers : and decide whether to book with service provider A or service provider B, and prepay p_A and p_B, respectively for their bookings.

III. Consumers' cancellation option : Consumers draw their random benefit component $\tilde{\beta}$, and then decide whether to cancel the service and obtain a refund, or to proceed with the reservation and consume the service.

Clearly, the major difference between this model and our previous analysis is not only the internalization of the show-up probabilities but also the explicit treatment of the booking price as a sunk cost. More precisely, when reaching Stage III of this game, consumers' decision whether to cancel is independent of the price that is paid during Stage II of the game. This decision depends only on the realization of the random basic utility from the service, transportation costs, and of course the refund level.

7.2 Consumers

We now modify the utility function (17) by letting the basic valuation $\tilde{\beta}$ become a random variable uniformly distributed on the unit interval $[0,1]$. In addition, the show-up probabilities are no longer taken as exogenously-determined parameters; instead the show-up probabilities become variables $\sigma_A(x)$ and $\sigma_B(x)$ which depend on the consumer type x as well as whether the consumer is booked on service A or B. The utility function of a consumer indexed by $x \in [0,1]$ is now given by

$$U(x) \stackrel{\text{def}}{=} \begin{cases} \sigma_A(x)[\alpha + E\tilde{\beta} - \tau x] - p_A + [1-\sigma_A(x)]r_A & \text{Buying service } A \\ \sigma_B(x)[\alpha + E\tilde{\beta} - \tau(1-x)] - p_B + [1-\sigma_B(x)]r_B & \text{Buying service } B, \end{cases} \tag{44}$$

where $\alpha \geq \tau/2$ is the certain basic benefit component, whereas $E\tilde{\beta}$ is the expected random basic benefit from consuming the service. We now analyze consumers' decision whether to cancel a booked service during Stage III. Since at Stage III consumers have already paid for the service, the paid prices p_A and p_B are treated as sunk costs. Hence, a consumer indexed by $x \in [0,1]$ who has already booked service A will not cancel the reservation if $\alpha + \tilde{\beta} - \tau x \geq r_A$, where $0 \leq \tilde{\beta} \leq 1$ is the realized basic valuation random component. Similarly a consumer who is booked service B will not cancel if $\alpha + \tilde{\beta} - \tau(1-x) \geq r_B$. Formally, a consumer indexed by x who is booked and prepaid for service A, or service B respectively, will not cancel the service in Stage III if their realized benefits satisfy

$$\tilde{\beta} \geq r_A - \alpha + \tau x, \text{ and} \quad (45a)$$

$$\tilde{\beta} \geq r_B - \alpha + \tau(1 - x). \quad (45b)$$

Equations (45a) and (45b) constitute the dividing thresholds of the realized benefit as functions of the offered refund levels, r_A and r_B , and consumers' disutility index, x. Figure 7 plots these dividing thresholds on the $\langle x, \tilde{\beta} \rangle$ space. In Figure 5, the regions above the curves (45a) and

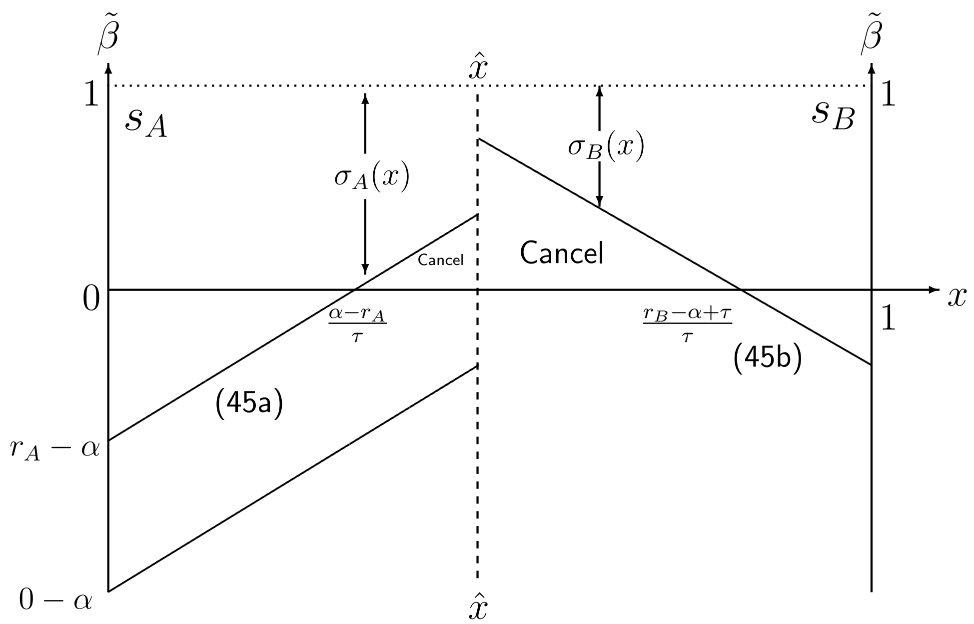

Figure 5: Consumers' cancellation decisions as functions of the realized benefit component $\tilde{\beta}$ and the disutility index x.

(45b), and the horizontal axis constitute the set of booked consumers who do not cancel and therefore end up consuming the service. In contrast, the consumers indexed by values of x near $1/2$ and who realize low values of $\tilde{\beta}$ may end up cancelling their reservations in order to obtain the corresponding refunds, r_A and r_B. Figure 5 turns out to be very instructive. Since we assumed that $\tilde{\beta} \in [0, 1]$, the distance between the dividing curves, $\tilde{\beta} = 0$ and $\tilde{\beta} = 1$ measures exactly the probabilities of showing up $\sigma_A(x)$ and $\sigma_A(x)$. The dependence on x brings us to the following observation.

Observation 13. *In a model with moral hazard, different consumer types may end up having different probabilities of showing up. Formally,*

$$\sigma_A(x) = \min\{1, \max\{0, 1+\alpha-\tau x-r_A\}\}, \text{ whereas} \tag{46}$$

$$\sigma_B(x) = \min\{1, \max\{0, 1+\alpha-\tau(1-x)-r_B\}\}. \tag{47}$$

Observation 13 demonstrates the complexity of the moral hazard extension of our model. When refunds are high, consumers indexed by an x around 0.5 have high probability of cancelling the booking compared with those indexed near 0 or 1 who may not cancel at all (unless offered sufficiently high refund levels). Finally, Figure 5 demonstrates that a rise in the offered refund levels, r_A and r_B, would shift upward the dividing lines thereby increasing the expected number of cancellations (reducing s_A and s_B).

Figure 5 and Observation 13 imply that the show-up probabilities of a consumer indexed by $\hat{x}$ when booking service A or B are determined by $\sigma_A(\hat{x}) = 1+\alpha-\tau\hat{x}-r_A$, and $\sigma_B(\hat{x}) = 1+\alpha-\tau(1-\hat{x})-r_B$. Substituting these probabilities into the utility functions (44) imply that the consumer type $\hat{x}$ who is indifferent between booking services A and B is indexed by

$$\hat{x} = \frac{1}{2} + \frac{2(r_B-r_A)\tau + 2r_B^2 - (4\alpha+1)r_B - 2r_A^2 + (4\alpha+1)r_A - 2p_B + 2p_A}{4\tau^2 + (4r_B+4r_A-8\alpha-6)\tau}. \tag{48}$$

As before, the number of bookings made with each provider are $q_A = 1-q_B = \hat{x}$. The expected number of showing-ups s_A and s_B are computed from Figure 5 by

$$\begin{aligned} s_A &= \int_0^{\hat{x}} \sigma_A(x)dx = \int_0^{\hat{x}} [1-r_A+\alpha-\tau x]\,dx - \frac{(\alpha-r_A)^2}{2\tau}\cdot \mathbf{1}_{\{r_A<\alpha\}} && \text{(49a)} \\ &= \hat{x}\left[1-r_A+\alpha-\frac{\hat{x}}{2}\tau\right] - \frac{(\alpha-r_A)^2}{2\tau}\cdot\mathbf{1}_{\{r_A<\alpha\}}, \text{ and} \\ s_B &= \int_{1-\hat{x}}^{1} \sigma_B(x)dx = \int_{\hat{x}}^{1} [1-r_B+\alpha-\tau(1-x)]\,dx - \frac{(\alpha-r_B)^2}{2\tau}\cdot\mathbf{1}_{\{r_B<\alpha\}} && \text{(49b)} \\ &= 1-r_B+\alpha-\frac{\tau}{2}-\hat{x}\left[1-r_B+\alpha-\left(1-\frac{\hat{x}}{2}\right)\tau\right] - \frac{(\alpha-r_B)^2}{2\tau}\cdot\mathbf{1}_{\{r_B<\alpha\}} \end{aligned}$$

For the remainder of this section we *assume* that $\alpha = 1/2$. In view of Figure 5, this assumption makes the consumer $x = 1/2$ indifferent between cancelling and no cancelling when there are no refunds, $r_A = r_B = 0$. The lowest curve in Figure 5 shows that assuming $\alpha > \tau/2$ generates a situation that small refund levels do not influence the probability of showing up as there will be no cancellations at all. We find this case to be less interesting, hence for this reason we confine our analysis to one particular case where $\alpha = \tau/2$, where expression (48) simplifies to

$$\hat{x} = \frac{1}{2} + \frac{2(p_B - p_A) - r_A(1 - 2r_A) + r_B(1 - 2r_B)}{(6 - 4r_A - 4r_B)\tau}. \tag{50}$$

7.3 Price and refund competition

Due to the complexity of the problem we restrict our analysis to symmetric outcomes. The profit functions are obtained by substituting for $\hat{x}$ from (50) into (49a) and (49b), and then into (18). The unique solution to the first order conditions $\partial\pi_A/\partial p_A = \partial\pi_A/\partial r_A = \partial\pi_B/\partial p_B = \partial\pi_B/\partial r_B = 0$ is $r_A = r_B = 1$, which is inadmissible, since (50) implies that $\partial\hat{x}/\partial p_A < 0$ and $\partial\hat{x}/\partial p_B > 0$ if and only if $r_A + r_B < 3/2$. Therefore, a symmetric Nash equilibrium should be the corner solution $r_A = r_B = 0$, (or possibly the extremely competitive point where $r_A = r_B = 3/4$). Recalculating the price competition with the restriction $r_A = r_B = 0$ reveals that

$$r_A = r_B = 0 \quad \text{implies} \quad p_A = p_B = k + c + \frac{3\tau}{2} \quad \text{and} \quad \pi_A + \pi_B = \frac{3\tau}{2}. \tag{51}$$

Finally, the refund levels $r = r_A = r_B = r = 3/4$ cannot be an equilibrium since (50) implies that $\partial\hat{x}/\partial p_A \to -\infty$ as $r \nearrow 3/2$. Intuitively, when $r = 3/2$, consumers view both services as homogenous so price undercutting leads to zero profits. Therefore,

Proposition 14. *Providing no refunds on no-shows, $r_A = r_B = 0$, constitutes the only possible symmetric pure strategy Nash-equilibrium for the present moral hazard model.*

Intuitively, setting $r_A = r_B = 0$ maximizes the showing up probability. At 100% show-ups, zero refunds actually equalizes the show-up probability among all consumer types so that $\sigma_A(x) = \sigma_B(x) = 1$ for every consumer $x \in [0, 1]$.

7.4 Collusion on refunds

Consider a two-stage semicolluding decision process where service providers first collude on a common refund level $r = r_A = r_B$, and then compete in prices. The following proposition is proved in Appendix A

Proposition 15. *Collusion on refunds results in service providers agreeing to provide no refunds to consumers, $r_A = r_B = 0$. Therefore, the resulting noncooperative equilibrium prices and profit levels are given by (51).*

Proposition 15 is best understood by referring to Figure 5 that illustrates that giving no refunds by setting $r = 0$ maximizes the expected number of show-ups by simply eliminating all cancellations by consumers. This enables service providers to compete in prices over the entire market. Finally, comparing Proposition 15 with Proposition 14 reveals that from *firms's perspective*, there is no industry failure since both service providers will not be giving any refund independently of whether they cooperate on don't cooperate on a joint industry-wide refund policy. This result stands in contrast to markets with no moral hazard effects, where fixed probabilities of cancellations generate incentives for service providers to jointly increase the refund levels beyond the noncooperative levels.

8. Conclusion

The purpose of this research is to identify situations where industry-wide explicit or implicit agreements on joint refund policies weaken price competition and reduce consumer welfare. If service providers can commit on a joint industry-wide refund policy before they compete in prices, they will raise refund levels above the competitively-determined refund levels. In this case, collusion on refunds reduces consumer welfare.

However, Section 6 demonstrates that unlike the collusion on refunds case, service providers have no incentive to collude on maintaining an industry-wide joint policy regarding shipping and handling nonrefundable charges. Thus, although the noncooperative equilibria when firms compete on refund levels and when firms compete on s&h charges generate identical equilibrium allocations in all respects, the semicollusive market structures yield different outcomes. In order to understand why these two models yield extremely different results when semicollusion is allowed, we need to take a closer look at the refund and the s&h strategies and try to identify the differences between these two strategic variables.

The main difference between refunds and s&h charges is that refunds translate into price reductions in no-show events, whereas s&h charges generate certain price increases. Thus, the asymmetry between refunds and s&h charges stems from the fact that *refunds serve as a commitment to incur probable future costs* whereas s&h in fact does not alter the cost structure (higher s&h immediately translate into price reductions under price competition). For this reason, service providers can enhance their profit by committing on refunds that are higher than the noncooperative levels as this commitment translates into a higher cost at the price competition stage. In contrast, committing on higher s&h translates into price reductions, thereby making a collusion on s&h nonprofitable.

We have shown that in the absence of moral hazard behavior, noncooperative equilibrium prices and profits increase with the amount of refund promised to consumers on no-shows. This monotonicity was demonstrated in three stages: First, Proposition 2 states that a monopoly service provider charges a higher price and earns a higher profit when the monopoly sets both the refund level and the price, compared with a market structure where refunds cannot be offered. Secondly, Proposition 4 states that equilibrium prices and profits rise when firms can compete in refund levels in addition to competing in prices. Thirdly, Proposition 6 states that prices and profits rise even further once we move from a noncooperative equilibrium in refunds and prices to a semicollusion market structure where service providers collude on refunds but continue to compete in prices.

The above-mentioned results imply that high refund levels should be a major concern for regulators and consumer-rights organization. However, in practice consumer-rights organizations and regulators tend to be concerned that firms do not refund their customers enough. This "puzzle" can be explained by the fact that consumer organizations tend to focus more on sellers' liability to replace faulty products and therefore are less concerned with the price increase implications associated with providing refunds for functioning products and services.

Our analysis demonstrates why we observe high refunds on car rentals, whereas the refunds are lower for items delivered via mail orders. One reason for the low refund on mail orders could be the high capacity cost associated the fulfillment of orders. These mail order firms do not have any incentives to refund the profit generated by the duopoly markup τ. Our model suggests that a profit maximizing mail order firm should announce a "full money back guarantee" only on the operation part of the cost c, and include the capacity cost k as well as the profit margin τ in their announced "shipping and handling" charges.

Appendix A. Proof of Proposition 15

Substituting for s_A, s_B, $\hat{x}$, and $r = r_A = r_B$ into the profit functions (18) and thereafter solving for the stationary points satisfying $\partial\pi_i/\partial r = 0$, $\partial\pi_i/\partial p_i = 0$, yields $r > \alpha = \frac{\tau}{2} \Longrightarrow r = \frac{\tau+4c}{8}$ and $p = k+c+\frac{3\tau}{2} - \frac{15\tau^2+64\tau c+16c^2}{64}$, and $r < \alpha = \frac{\tau}{2} \Longrightarrow r = \frac{2c}{3}$ and $p = k+c+\frac{3\tau}{2} - \frac{12\tau c-2c^2}{9}$. However, both the noncooperative equilibrium price and corresponding expected number of show-ups are higher when $r = 0$ and $p = k+c+3\tau/2$ as compared with the above candidates. Therefore colluding on $r = 0$ dominates the competing alternatives. Finally, note that $r = 0$ generates full participation of consumers in the sense that all consumers end up showing up. □

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