Three Essays in Marketing

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ABSTRACT

This dissertation consists of two essays on the role of selling costs in retailing and one experimental study.

The first essay studies the credibility of non-commitment advertising. To attract potential customers, retailers often advertise low prices with appeals such as *Prices start at $49or One week in the Caribbean from $449.* We offer here an explanation of how such advertisements can construct a credible price image in the absence of any commitment based on the role of selling costs. When retailers must incur costs in the process of selling a product, advertising low prices to lure potential consumers can backfire. This is so because attracting too many consumers who are less likely to purchase the retailer's higher priced products imposes unwanted selling costs, but yields little extra revenue. We show analytically that such advertising can be credible only when there is a substantial difference in retailers' cost types or the selling cost is high.

The second essay analyzes the free-riding problem under the situation where the selling costs are high. Intuitively, we can expect that free-riding will hurt the retailer who provides service. Nonetheless, we analytically show that free-riding actually benefits not only the free-riding retailer, but also the retailer who provides service. The intuition behind this result is that by allowing free-riding, the service provider can induce a softer re-action from its competitor who now enjoy free-riding. Therefore, allowing free-riding can be regarded as a strategic investment which prevents an aggressive response from the other retailer.

The third essay adopts an experimental approach to the study of incentives. The question asked in this work is whether a threat of disappearance changes the way such options are valued. In four experiments using door games, we demonstrate that options that threaten to disappear cause decision makers to invest more effort and money in order to keep

these options open, even when the options themselves seem to be of little interest. The last experiment provides initial evidence that the mechanism underlying the tendency to keep doors open is a type of loss aversion rather than a desire for flexibility.

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Abstract

To attract potential customers, retailers often advertise low prices with appeals such as *"Prices start at $49" or "One week in the Caribbean from $449."* These appeals are deliberately vague in the sense that they give little information about the product which the prices refer to. We offer here an explanation of how such advertisements can construct a credible price image in the absence of any commitment based on the role of selling costs. When retailers must incur costs in the process of selling a product, advertising low prices to lure potential consumers can backfire. This is so because attracting too many consumers who are less likely to purchase the retailer's higher priced products imposes unwanted selling costs, but yields little extra revenue. Hence, a store with a relatively high selling cost will be dissuaded from attempting to employ such a strategy. We show analytically that such advertising can be credible only when there is a substantial difference in retailers' cost types or the selling cost is high.

1. Introduction

A typical retailer carries a large number of items. A large grocery store, for example, generally carries more than 25,000 products on its shelves, while a department store often carries more than 250,000 products. Further still, a travel agency often sells potentially millions of different travel packages. Although consumers would like to know prices of these items prior to visiting the seller, it is often infeasible to advertise all prices to the potential consumers since disseminating relevant information is costly. Instead, the retailers resort to a more simplified strategy of informing consumers of their overall price levels – constructing a favorable "price image."

One method of constructing such an image is to advertise the prices of only a few selected items in the store. Simester (1995) argues that by advertising the low prices of a sample of products, a low-cost retailer can credibly signal its costs on other products to consumers. The rationale behind his theory focuses on the *commitment* role of advertising. If an inefficient high-cost store advertises a very low price for one product, then consumers will buy a large amount of that product. Since the resulting loss dissuades inefficient stores from mimicking efficient stores, consumers can reliably infer that the efficient stores also charge low prices on unadvertised products.

However, Simester's theory does not address those cases where price advertising is unrelated to any specific products and, hence, does not seem to serve a commitment role. Often encountered advertisements, such as "*Everything priced $19.99 or above,*" "*One* *week in the Caribbean from $449," and "Come and see our low prices,"*[1] seem too general and vague to be of any real use for potential consumers.

One caveat in these advertisements is that they do not specify the products, which are directly related to the prices or terms appearing in the advertisement. It could be the price of any product in the same category since the advertisements do not specify the *exact* product (the item is specified too generally to be a commitment in practice). For example, it is unclear whether "One week the Caribbean tour starts from $499" means the price of the Caribbean trip on May 1 or May 2, which are different products. In this sense, "Everything from $49" makes a commitment, but very weak commitment.

Given the legal requirements suggested by the Federal Trade Commission, every agent must have some version of the advertised product for sale at the advertised price (see Gerstner and Hess 1990, and Wilkie et al. 1998 for more detailed discussion about the legal aspect of deceptive advertising practice). Presumably, if a travel agent states "Prices start at $49," he must have some version of the advertised product for sale at the advertised price. However, the prices stated in the advertisements do not need to be met for the products most customers want to buy. For example, one airline advertised the air-fare "Prices start at $49." The cheapest fare one can get is indeed $49, but it is for an infant or senior fare on the Providence to Baltimore route. Also, a travel agent who advertises "Aruba cruise starting at $650," asked a price $1313 for leaving in 4 weeks from the date of his advertising. The $650 price was the price only for leaving on December 15 (Mon.), which was 9 months later than his advertising date, returning

[1] The first one was placed in the window of a store in Harvard Square. The store specializes in shoes, and hundreds of items are available at the store. However, a consumer seldom sees any product priced at $19.99. On average, the prices of shoes in this store are above $40. Obviously, the price the store advertises is not binding, since it does not specify the product. The last two were in the Sunday newspaper.

December 19 (Fri.) with more than 20 people at a group discount rate. A change, such as leaving on December 16 instead of December 15, or not qualifying for the group rate, would increase the price by more than $300. Hence, these advertisements are not technically deceptive or *lying* in this context, but non-binding and non-commitment.

Given this non-committal nature of advertising, are these advertisements mere "cheap talk" without any credibility? Can they help consumers form a reliable price image of the store? This paper gives answers to these questions. In particular, I offer an explanation of how and when advertising can be informative even in the absence of commitment, by arguing that attracting many consumers to the store is costly for many retailers. The explanation focuses on the role of selling costs. When a store incurs some costs to sell a product, such as attempting to find the right product match for the consumers, advertising low prices to lure potential consumers can backfire because attracting too many consumers, who are unlikely to purchase the retailer's higher priced products, imposes unwanted selling costs and yields little extra revenue. Hence, a store with a relatively high selling cost will be dissuaded from attempting to construct a low price image.

I construct a model where a monopoly retailer signals its cost type through non-commitment price advertising. Consumers do not know the true prices of the products before they visit the store, and they infer prices only by observing the retailer's advertisements. Knowing this, the retailer can manipulate the advertising to its advantage. We might expect that this would lead to a situation where no signal is credible and consumers disregard all price advertisements. The signals become meaningless and talk becomes cheap. However, I demonstrate that non-commitment price advertising can actually convey information to consumers by affecting the consumers' expectations over price. While a low-cost retailer will advertise its low-cost and draw a large crowd to its stores, a high-cost retailer will not find it as profitable to advertise (mimic) as a low-cost vendor because it will attract too many consumers and incur costs in serving them. Hence, advertisements without any specific product information still signal the retailer's cost characteristics to the consumers.

Selling Costs

Selling costs are costs a firm incurs to serve a consumer who may or may not purchase a product. For example, a car dealer must expend time and effort for consumers' test-drives, irrespective of whether or not they buy a car. A conventional variable cost is incurred only if a product is sold. However, a selling cost can be incurred without an actual sale. Selling costs can, therefore, be considered an investment by a seller in an attempt to make a sale. A key feature of selling costs is that they are not a function of the number of products sold, but a function of the number of consumers who visit the store, including those who do not make a purchase. Selling costs are also different from fixed costs, since they are a function of firm's strategic decisions, such as advertising. This has an important implication – shopping not only imposes a cost on the buyer (consumers incur traveling cost *to shop*), but also imposes a cost on the seller. Thus, these selling costs give retailers incentives to discourage consumers who are unlikely to make a purchase from visiting their stores. While costs incurred by the buyer have been previously considered, this model considers these types of costs imposed on the seller (Moorthy and Srinivasan's (1995) transaction costs have a similar effect – however, the transaction costs could occur only for those who purchase products while selling costs must be incurred irrespective of purchase decisions of consumers).

Selling costs may result from the effort expended by a sales person assisting a consumer, showing a product, and haggling over the phone. For example, a shoe store needs many salespeople to help consumers find shoes that are the correct size or that match their color preferences, without any guarantee of a sale.[2] In the case of a travel agency, many sales people are employed to answer incoming calls regarding product price and other relevant information, and to help consumers find the best fit between products and their needs. The travel agency that encounters more calls by advertising a lower price message ("From $199" rather than "From $499") incurs a greater cost to answer the increased phone calls that would be generated. Other examples include real estate agents who must transport consumers to multiple prospective homes, and auto retailers who must expend time and effort for consumers' test-drives.

In addition, selling costs can result from opportunity costs. If a store is crowded with consumers who may not buy a product, potential buyers may not bother to come into the congested store. By serving the wrong consumers, the store gives up the opportunity of making another sale. These opportunity costs loom larger especially when there is a capacity constraint for a retailer. Capacity constraint therefore can be regarded as another source of this selling cost (Essegaier, Gupta, and Zhang 2002).

[2] The situation where sales assistance is optimal is analyzed by Wernerfelt (1994).

Literature

Theoretical models, which describe practices related to non-commitment advertising, are examined in the context of loss-leader pricing, add-on pricing, and bait-and-switch advertising, where consumers observe a few advertised products and then make a store-visit decision. In loss-leader models (Hess and Gerstner 1987; Lal and Matutes 1994), consumers decide which store to shop at based on the advertised prices of a good (the loss-leader). But once in the store, they also buy other unadvertised goods that generate higher profits for the store. Hess and Gerstner (1987) focus on the increased sale of complementary products, while Lal and Matutes (1994) assume that products are neither substitutes nor complements. Ellison (2003) and Gabaix and Laibson (2004) address the practice of advertising low prices for one good and sell additional "add-ons" (Ellison 2003) or "shrouded product attributes" (Gabaix and Laibson 2004) at high prices at the point of sale. In Ellison's model, firms use add-ons to soften price-competition by creating price-discrimination of rational consumers, while Gabaix and Laisbon assume that consumers' bounded rationality (or myopia) plays an important role in firms' pricing decisions for add-ons. These loss-leader and add-on pricing models as well as the work of Simester (1995), which is most closely related to the current paper, consider the role of advertising as a commitment device. In Gerstner and Hess's (1990) and Lazear's (1995) bait-and-switch advertising models, the advertised product is actually unavailable, and so consumers buy a substitute product.

There are, however, two major differences between this literature and the current paper. First, the extant literature assumes that consumers know precisely which product the advertised price is associated with. Thus, advertising plays a commitment role. In contrast, I examine the role of advertising in the absence of commitment since consumers do not know which product the advertised price refers to. Second, the extant research has a conclusion that is largely the opposite of this paper. The literature argues that stores can increase store-profit by stimulating store-traffic from loss-leader or bait-and-switch tactics, while I argue that this is not necessarily the case, due to the role of selling costs.

Ellison and Ellison (2001) empirically demonstrate that loss-leader or bait-and-switch techniques are effective. They found that loss-leaders clearly attract a large number of consumers who end up buying higher priced substitute products. However, they also found evidence that the consumer pool attracted by a low priced loss-leader has a higher percentage of consumers who do not upgrade. They suggested that this might explain why retailers choose not to be the (lowest) price leader in the on-line computer memory market although they did not model the credibility of the advertising.

This paper is also related to, but different from Milgrom and Roberts' (1986) quality signaling model in the focus of a firm's use of advertising. They focus on the role of advertising in signaling product quality, whereas advertising is used to signal the price of the product in this research. In this regard, my model bears a similarity to the works of Bagwell and Ramey (1995a, 1995b). However, the model in this paper differs from those existing quality and price signaling models principally in the nature of its signaling costs. They argue that a signal can only be credible if it is so costly that a false signal is unattractive - signaling amounts to public "burning of money." The selling cost model in this paper has does not assume such excessive sunken costs for signaling; the cost for signaling is not exogenously given, but endogenously determined by the retailer's strategic action such as advertising.

In a typical signaling model, the instrument used to send a meaningful signal should have the single-crossing property. The model developed in this paper is a one-period game of non-commitment advertising so that there is no repeated purchase, nor are the differential costs from commitment of their claims (see Balachander and Srinivasan 1994; Moorthy and Srinivasan 1995; Moorthy and Winter 2003), which guarantee the single-crossing property in signaling model (see Spence 1974).

The rest of this paper is structured as follows. In Section 2, I present an empirical pilot study, which serves as a motivating example for the model I develop. I then present a formal model of selling costs in Section 3 and analyze it in Section 4. Section 5 concludes.

2. Pilot Study

The following pilot study investigates how non-commitment advertising operates in practice, and serves as a motivating example throughout the paper.

Pilot Study - Travel Industry

The travel industry is well-suited to studying the issue of non-commitment advertising because virtually every advertisement takes on the form of non-commitment advertising. Typical advertisements state the destination, duration (package), and vague price information with the format of "Prices start at $___." It is unclear to which product these prices refer, since these prices could be for any specific date or specific conditions such as group rates or senior citizen discounts. However, if the advertising is informative in the sense that consumers can use it to infer the price image, then the advertised price must be closely correlated with the actual price of popular products.

I collected data on advertised prices of various travel agents from the Sunday newspaper in Boston and San Francisco over a 13-week period. Then I matched the advertised prices in those Sunday newspapers with actual prices quoted by the advertisers in follow-up telephone inquiries. In these inquiries, I asked for the price of the advertised product (destination) four weeks from the date of its advertising. [3] The resulting dataset contains 129 data points (products) from 71 travel agencies (one date point corresponds to one price quote for a certain product).

There are three different types of products – airline tickets, cruises, and all inclusive tour packages. Table 1 presents descriptive statistics for each category. The average advertised prices are $334, $557 and $693 for airline tickets, cruises, and packages, respectively. The variable *Diff* measures the difference between the advertised prices and the actual prices, while the variable *% Quoted Price Higher* represents the difference between quoted and advertised prices over the advertised price.

••• Table 1 •••

One noteworthy finding is that the advertising messages were indeed informative. In general, the higher the advertising price messages, the higher are the actual prices (correlation between the advertising prices and the actual prices over three categories is 0.89, $p<0.01$). Figure 1 of the scatter plot clearly demonstrates this relationship.

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[3] Discussions with travel agents suggested that consumers generally consult travel agents about their travel plans at least three to six weeks ahead of their intended vacation.

••• **Figure 1** •••

Moreover, a closer examination reveals another interesting pattern: the level of information appears to vary by product category. Advertising appears to be most informative for packages, and least informative for airline tickets. The correlation in airline tickets segment ($r_{Airlines} = 0.41$) is smaller than cruises ($r_{Others} = 0.79$; $z = 2.56$, $p < 0.05$). In turn, the correlation in the cruise ($r_{Others} = 0.79$) is smaller than in the packages segment ($r_{Packages} = 0.97$; $z = 4.35$, $p < 0.01$).[4] In later discussion, I will speculate on a potential explanation for this pattern.

Overall, the prices stated in the advertisements seem to represent clearly the actual prices the agents would charge despite the non-commitment nature of these advertising. The agents did not exaggerate their prices too often. For example, one travel agent advertised Aruba tour package at $729, but asked only $675. The manager told me that they have an internal policy that they never advertise the lowest possible price, but the second lowest price so that they would not have consumers who have a wrong impression about the actual price. This is consistent with the idea that many travel agents are actually trying to position themselves so that they could attract only the "right customers."

In the next section, I will offer a rationale for these advertising strategies in terms of a simple model by quantifying the verbal arguments of the selling costs.

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[4] Although the sampling distribution of a correlation is not normally distributed, the asymptotic distribution for Fisher's z-transformation of the correlation follows the normal distribution as following :
$\frac{1}{2}\log(\frac{1+r}{1-r}) \sim N(\frac{1}{2}\log(\frac{1+\rho_0}{1-\rho_0}), \frac{1}{n-3})$, where r is the sample correlation, ρ_0 is the population correlation, and n is the sample size. This Fisher's z is used for statistical testing.

3. The Model

Consider a monopoly retailer who sells a single product at a posted price. The retailer can be either a high cost or a low cost type $i \in \{c_L, c_H\}$, where $c_L = 0$ and $0 < c_H < 1$ for simplicity. The levels of c_L and c_H are also assumed to be common knowledge to a retailer and consumers. With little loss of generality, the quality of the product is given and does not vary with the cost level.[5] The retailer has to decide on a price level for the product and must charge the same price to all consumers. The retailer also has to advertise in order to make customers aware of the product (Zhao 2000), and it has the option of advertising a high or a low price cue $a \in \{m_L, m_H\}$ to signal its own cost type.[6]

The assumption that a retailer must advertise may seem unnatural. However, in some industries such as the travel industry, even high-cost firms have to advertise for the purpose of increasing the awareness of potential customers. Consumers seldom know the existence of an agency that specializes in a tour of Aruba unless they see its advertisements. Also, the content of the advertising message is not important to the model, just as long as customers can distinguish between m_L and m_H. For this reason, the advertising messages, m_L and m_H can be anything that distinguishes the retailer's

[5] In a model where quality varies with the firm's cost type, the underlying intuition and findings were unchanged.

[6] An alternative interpretation is that $a=m_H$ corresponds to not advertising, so that the advertising decision is really a decision between "no message" vs. "low price message." However, this interpretation makes it possible that the advertising cost, by itself, serves as a signaling device as "money burning" (Milgrom and Roberts) even when selling costs are zero.

type. For example, m_L and m_H can be "Everything from $19" and "Everything from $49" or "Price starts at $199" and "Price starts at $499" in the travel agency advertising.[7]

Consumers purchase one or zero units of the product. I assume that there are two segments of consumers: L and D. Each segment has a unit mass of consumers. The consumers in segment L are people who *like* shopping, and herein defined as consumers who incur zero cost of traveling for shopping. On the other hand, the consumers in segment D are those who *dislike* shopping and incur positive cost of traveling ($t>0$) for shopping. Consumers' prior beliefs are that each firm's cost type is equally likely. The decision of a consumer in segment D is whether to visit the store based on the messages received. Consumers who see an advertisement "Everything from $49" in the newspaper may not bother to come to the store, but may spend time and effort to drive down to the store that is located far away from their houses if they see an advertisement "Everything is $19 or above." Once consumers arrive at the store, they observe the true price and make a decision whether to buy or not based on this true price. Even in the travel agency cases, consumers who are interested in the travel package after reading an advertisement in their Sunday newspaper must call that travel agency to know the true price, date, and so on. Making a phone call and asking several questions takes time. All these activities and associated time compose the cost of traveling (t). Note that consumers in segment L always visit the store irrespective of the advertising message because it costs zero for them to visit and examine the product price. In this regard, the distinction between segment L and D is related to the work of Stahl (1996), in which some consumers incur

[7] It is even possible that the high cost type says "My cost type is low," and the low cost type says "My cost type is high," (claiming the opposite) as long as consumers can understand this language. This raises the question: what makes a message effective? Effectiveness depends on consumers' beliefs. Although the construction of customer beliefs is beyond the scope of this paper, it is reasonable to associate the lower cost type with lower price claims.

non-positive search costs while others do not (see also Bagwell and Riordan 1991; Varian 1980; Wolinsky 1983).

I assume that within each segment consumers' willingness to pay (v) for the product is uniformly distributed on $[0,1]$. Preferences can, therefore, be represented by the following utility function.

$$U = \begin{cases} v - p & \textit{if a consumer buys a product at price } p \\ 0 & \textit{if} \quad \textit{not} \end{cases}$$

All consumers who prefer consumption of a product to no purchase at the given price will buy: consumers purchase *iff* $v - p \geq 0$. Demand for a product at price *p* within each segment is, therefore, given by $D(p) = 1 - p$ for $p \in [0,1]$. Once consumers are in the store, the retailer has to incur the selling cost (*k*) per consumer for providing service to them.

The order of events and decisions is summarized in Figure 2.

••• Figure 2 •••

The strategy space available to the retailer in this model consists of the advertising message ($a \in \{m_L, m_H\}$) and the pricing decision ($p \in [0,1]$), contingent on the cost type ($i \in \{c_L, c_H\}$). The consumer's strategy space is: (1) the decision to visit depending on the advertising cue and (2) the purchase decision after observing the true price in the store. The visiting-decision rule of consumers in segment *D* is a function of their price expectations based on their belief about the retailer's type, which is inferred from the observed advertising cue. Hence, changes in the advertising cue may result in a revision of consumers' beliefs regarding the retailer's cost type (which consequently revises the price expectation as well), which will influence the number of consumers who visit the store. On the other hand, consumers in segment L always visit the store and observe the true price irrespective of the advertising cue.

In this model, consumers are assumed to be always sequentially rational: they respond optimally to the strategy of the monopoly retailer even if they observe a price that is different from their expectation (out of equilibrium).

Two crucial assumptions of this paper concern the selling cost and the advertising message of the retailer. First, the retailer incurs a selling cost equal to k per consumer who visits the store. This implies that shopping imposes additional costs on the seller other than the marginal product cost c. The retailer has to provide a certain level of service to all consumers, incurring extra selling cost equal to k per consumer. This selling cost is the same for both cost types.

A second assumption is that the advertising message $a \in \{m_L, m_H\}$ makes no commitment. I consider the case where the retailer advertises using the non-commitment message such as "everything from $49." This implies that there is no differential advertising cost for each type. There is no reason to expect the cost of advertising "everything from $19" to be different from advertising "everything from $49" for different cost types. Both advertisements impose the same fixed costs associated, for example, with placing advertisements in the local newspaper or putting them in the show windows. With little loss of generality, the cost of advertising is assumed to be zero.

4. Analysis

The retailer of cost type i has the following profit function when it sets price p and advertising a:

$$\pi(p,a \mid i) = -N(a)\cdot k + D(p,a)(p-c_i) \tag{1}$$

where $N(a)$ is the number of consumers who visit the store after observing advertising message a, and $D(p,a)$ is the demand for a product at price p conditional on consumers already being in the store after observing advertising message a. Note that $N(a)$ will depend on the equilibrium.

A model without traveling costs is presented as an initial benchmark (both segments D and L are now identical). If consumers incur zero traveling cost, there is no need for signaling. All the consumers become informed, since they always know the true price for free (t=0). Thus, the product demand at price p will be $D(p) = 2(1-p)$. The profit function of type i, charging price p (using Equation 1), is,

$$\pi(p \mid i) = D^i(p)(p-c_i) - 2k = 2(1-p)(p-c_i) - 2k$$

Thus, the monopolistic retailer chooses the profit-maximizing price $p_i^m = \frac{1+c_i}{2}$ and $\pi^m(p \mid i) = 2(\frac{1-c_i}{2})^2 - 2k$.

This benchmark places a critical constraint on the selling cost k. The retailer requires (weakly) positive profit in order to participate in the market, $\pi^m \geq 0$. If the selling cost is so high that only a low cost type can make a positive profit, then the mere existence of the retailer in the market would yield a credible signal that it is a low type. Therefore, I assume that k is sufficiently low that both types can e a positive profit:

$$k \leq \frac{(1-c_H)^2}{4} \tag{2}$$

Suppose now that consumers in segment D incur a positive traveling cost t to find the firm's true price. This traveling cost t must be lower than the maximum surplus that any consumer can get under the equilibrium price with no traveling cost case. Therefore, I assume that

$$1-p_i^m \geq t \quad \forall i \quad \Leftrightarrow 1-2t-c_H > 0. \tag{3}$$

Otherwise, no consumer with a traveling cost will participate in the market.

4.1. Separating Equilibrium

The equilibrium concept I will use here is that of Perfect Bayesian Equilibrium. In equilibrium, the consumer's price expectation should be confirmed by the retailer's strategic price decision, and the consumers' decisions are also optimal given the retailer's strategy.

Let us first look at consumers with no traveling cost (segment L). Here, consumers always visit a store free of traveling cost. After visiting a store, they decide whether to purchase based on the observed true price. Therefore, the willingness to pay for the marginal consumer who decides to purchase is $v_L{}^{purch} = p$.

Next, let us turn to consumers who incur traveling costs (segment *D*). The marginal consumer who decides to *visit* a store has the willingness to pay, $v_D^{visit} = p^e(a) + t$, where $p^e(a) = E[p \mid a]$ is the expected price of a consumer in segment *D* when he sees advertising message *a*. Furthermore, the marginal consumer who decides to buy has a willingness to pay, $v_D^{purch} = \max\{p, p^e(a) + t\}$. Because the traveling cost *t* has already been borne when consumers are in the store, consumers whose willingness to pay is greater than *p*, not *p+t*, decide to buy a product. Moreover, the product purchase decision should be understood as a conditional decision of consumers who are already in the store. Thus, the willingness to pay for a marginal consumer who decides to purchase (v_D^{purch}) must exceed that of consumers who decide to visit ($v_D^{visit} = p^e(a) + t$). This explains the need for the 'max' operator on the marginal consumer who decides to purchase.

The number of consumers from both segments who decide to visit a store, $N(a)$, can now be written as a function of the advertising strategy:

$$N(a) = (1 - p^e(a) - t) + 1$$

Consumers in segment *D* decide to visit based on their price expectation, while all consumers in segment *L* will visit a store. Note that the advertising itself does not have a direct effect on price expectations. Rather, it exerts its influence only through consumers' posterior beliefs ($\mu(a)$).[8] Here, μ are consumers' beliefs representing the posterior probability that a retailer is a low type when they see a message *a*. Consumers have common prior beliefs that both types are equally likely, $\mu_0 = \frac{1}{2}$.

[8] Therefore, the price expectation is a function of the posterior beliefs, which are a function of advertising, $p^e(a) = E[p \mid a] = E[p \mid \mu(a)]$.

Now, let us examine the product demand, which is a conditional demand from the consumers who are already in the store. From the purchase-decision of consumers in both segments, the product-demand for type *i* can be written as (for $p \in [0,1-t]$):

$$\begin{aligned} D^i(p \mid N(a)) &= \min\{1-p^e(a)-t, 1-p\}+(1-p) \\ &= \begin{cases} (1-p^e(a)-t)+(1-p) & \text{if} \quad p \le p^e(a)+t \\ 2(1-p) & \text{if} \quad p > p^e(a)+t. \end{cases} \end{aligned} \tag{4}$$

Thus, equation (1) can be rewritten as:

$$\pi(p,a \mid i,\mu) = \begin{cases} (2-p^e(a)-p-t)(p-c_i)-k\cdot N(a) & \text{if} \quad p \le p^e(a)+t \\ 2(1-p)(p-c_i)-k\cdot N(a) & \text{if} \quad p > p^e(a)+t. \end{cases} \tag{5}$$

Here, $\pi(p,a \mid i,\mu)$ represents the profit of a retailer of cost type i, charging *p*, and advertising *a*, when consumers' beliefs are $\mu(a)$.

There are two types of pure strategy equilibria in this game – a separating and a pooling equilibrium. In a separating equilibrium, consumers in segment *D* can correctly infer the retailer's cost type from an advertising message. Their price expectations ($p^e(a)$), given the type inferred, will be consistent with the actual price charged by the profit-maximizing retailer ($p^e(a) = E[p \mid a] = p^*$). This implies that all the consumers with traveling costs (segment *D*) who visit the store buy the product. Hence, the product demand of consumers in this segment will become $1-p^e(a)-t$. The retailer, therefore, maximizes the following profit function in equilibrium:

$$\underset{\substack{p\in[0,1] \\ a\in\{a_L,a_H\}}}{Max} \; \pi(p,a \mid i,\mu) = (2-p^e(a)-t-p)(p-c_i)-k\cdot N(a).$$

From the first-order condition, the profit-maximizing monopoly price can be derived:

$$p_i = \frac{2 - p^e(a) - t + c_i}{2}. \quad (6)$$

In equilibrium, the expected price ($p^e(a)$) is consistent with this optimizing price (p_i). Therefore, in a separating equilibrium, we see an equilibrium advertising strategy (a_i*) and an equilibrium price (p_i*) that a type $i \in \{c_L, c_H\}$ will charge:

$$a_i^* = m_i \quad and \quad p_i^* = \frac{2 + c_i - t}{3}. \quad (7)$$

The equilibrium strategy of consumers with traveling costs (segment *D*) is to visit <u>and</u> purchase if and only if their willingness to pay is $v \geq p^e(a) + t$, where $p^e(a_L) = \frac{2-t}{3}$ and $p^e(a_H) = \frac{2-t+c_H}{3}$. The consumers with no traveling costs (segment *L*) all visit irrespective of the advertising cue, and those with $v \geq p_i^*$ purchase.

It is clear that the equilibrium price p_i^* is greater than the profit maximizing price under no traveling costs, and is increasing in the marginal product cost *c* and decreasing in the traveling cost *t*: [9]

$$p_i^m \leq p_i^* \quad \forall i, \quad and \quad \tfrac{1}{2} \leq p_L^* \leq p_H^*. \quad (8)$$

In this model, the presence of the consumers without traveling costs (segment *L*) is critical for the existence of the equilibrium price policy. If all consumers incur traveling costs (only segment *D* exists), the retailer's price strategy $p^* + t$ dominates the price strategy of charging p^*, because all the consumers who have already borne the sunken

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[9] As the traveling cost *t* increases, the opportunity of hold-up becomes significant. It is tempting to think that the retailer can increase the price and take advantage of the sunken traveling cost. But at the same time, fewer consumers with traveling costs will actually incur traveling costs to visit the store because they expect the retailer's opportunistic behavior. Therefore, consumers whom the retailer will actually have in their store, primarily consist of consumers without traveling costs. As a result, it is optimal for the retailer to focus on the demand from the segment *L*. This forces the retailer to lower the price.

traveling costs t will still decide to purchase a product at this higher price. Anticipating this hold-up problem, consumers whose willingness to pay (v) belong to (p^*+t, p^*+2t) will not visit the store. Only consumers with willingness to pay greater than p^*+2t will visit. Again, knowing this, the retailer will charge p^*+2t instead of p^*+t, and so on. As the price climbs higher, eventually the market collapses because if consumers expect the retailer's opportunism and "discount" the retailer's price by some amount, exactly t, then the retailer can charge *2t more.*[10]

For the existence of a separating equilibrium, the following equilibrium conditions must be satisfied:

$$\pi(p_L^*, m_L \mid c_L, 1) \geq \max_p \pi(p, m_H \mid c_L, 0) \qquad (IC-L)$$

$$\pi(p_H^*, m_H \mid c_H, 0) \geq \max_p \pi(p, m_L \mid c_H, 1) \qquad (IC-H)$$

This implies that the retailer must not want to move to a false advertising strategy. That is, given that consumers expect truthful advertising, the retailer of type i must not pretend to be the other type by sending cue m_{-i}. In the following proposition, I formally state the equilibrium conditions for a separating equilibrium.

[10] This is a classic lemons problem (Akelof 1970). However, in the presence of consumers without traveling costs (segment *L),* the problem does not necessarily arise. By increasing the price, the retailer, at once gains and loses. It gains by taking advantage of traveling costs from the consumers in segment *D*, whereas it also loses because some consumers in segment *L* who might have made a purchase now refuse to do so. Accordingly, there exists an optimal price where the trade-off between the two segments is optimized. Furthermore, this result holds irrespective of the relative size of two segments *L* and *D*. The intuition is that, consumers in segment *D* will not visit the store because of the lemons problem described above when α is very close to zero. Thus, the retailer only ends up with consumers from segment *L* not from *D*. This prompts the retailer to lower the price. Knowing this, some consumers in segment *D* now will visit the store, and this provide incentives for the retailer to increase the price a little. Therefore, there exists an optimal level of price that the retailer charge and consumers can correctly expect.

Proposition 1 (Separating equilibrium). *A pure strategy Bayesian separating equilibrium, where a retailer truthfully advertises its type, and an uninformed consumer believes that advertising message is truthful (i.e., $\mu = 1$ when $a = m_L$, and $\mu = 0$ when $a = m_H$), exists if*

$$\frac{4t+1}{3} \leq c_H \quad \text{and} \quad k^* \leq k \qquad \textbf{(I)}$$

$$\textit{where } k^* = \frac{1}{6 \cdot c_H}\left\{(1-c_H)(1-c_H+8t)-2t^2\right\},$$

Moreover, this separating equilibrium is the unique equilibrium that satisfies the Cho-Kreps Intuitive Criteria under Condition (I).

Proof. See Appendix I.

In Appendix I, I first show that the low cost type retailer never wants to advertise m_H in Lemma A1 and derive the necessary condition for (IC-H) in Lemma A2. From these results, I prove the existence of a separating equilibrium under Condition (I). Next, I demonstrate that in regions in which a separating equilibrium exists, neither pooling nor mixed strategy equilibria survive the intuitive criteria (Cho and Kreps 1987).[11] This completes the proof of Proposition 1.

Roughly, Proposition 1 states that a separating equilibrium exists if both the difference in two cost types $c_H - c_L$ and the selling cost are relatively large. The intuition

[11] It should be clear that there exists an equivalent separating equilibrium in which a high cost type advertises m_L and a low type selects m_H. Given the absence of commitment the model does not require any conditions on the content of the advertising message and so m_L and m_H are arbitrary messages that can be reassigned without loss of generality. The uniqueness in this context means that no equilibria exist outside the class of separating equilibrium described above.

behind Condition (I) is straightforward. As shown in Figure 3, area *A* is the equilibrium demand from segment *D* for a high-type retailer. If a high-type retailer pretends to be a low type by advertising m_L, then consumers in segment *D* expect that the price is $p^e(m_L)$, and those whose willingness to pay is greater than $p^e(m_L)+t$ would visit the store. More importantly, only some of those who come to the store (not all of them) buy a product, since the actual price that the deviating retailer would charge is $p_H^d > p^e(m_L)+t$, where p_H^d is the profit-maximizing price when the high type deviates, $p_H^d = \arg\max_p \pi(p, m_L \mid c_H, 1)$ (see Appendix I for derivation of p_H^d). This deviating advertising strategy works in opposite directions for the retailer's profit. On the one hand, it can draw more people than in equilibrium (area *A*+*B*+*C*). Hence, it may increase the sales of a product (area *B*). On the other hand, this false advertising draws some unwanted people from whom the retailer has to incur unintended extra selling costs by serving them without earning a profit (area *C*). Hence, this increases the total selling costs. Area *C* in Figure 3 can be interpreted as an *adverse selection* problem.

••• Figure 3 •••

The first condition of Proposition 1 implies that adverse selection (area *C*) becomes a more serious problem when the difference in the two cost types is large relative to consumer traveling costs ($c_H - c_L \geq \frac{4t+1}{3}$). As the cost difference $c_H - c_L$ becomes larger, the deviating price for the high cost type (p_H^d) becomes larger, and so does area *C*. When the two cost types are quite different, only few consumers will eventually buy at a high-type retailer, despite their sunken travel costs. However, the large cost difference is not sufficient – the mere existence of the adverse selection itself does not prevent the retailer from deviating. If there is no cost for serving a customer in the store, attracting more customers in the store is always profitable for the retailer, no matter how small a portion of them actually switch to purchase. What really makes deviation an unprofitable strategy is the existence of relatively high selling cost k. Hence, special emphasis should be placed on the role of the selling cost. A sufficiently high unit selling cost (k) makes it no longer innocuous to attract consumers to whom it is difficult to sell. The total selling cost the retailer incurs is the number of unwanted consumers (area C) multiplied by the unit selling cost (k). Together, the conditions specified in Proposition 1 discipline the retailer to advertise truthfully.

To provide a graphical representation of the equilibria, I plotted the separating equilibrium area in $(k - c_H)$ parameter space (Figure 4). Recall that c_H actually denotes the cost difference $c_H - c_L$ as $c_L = 0$. Suppressed in this two-dimensional diagram is the consumer's travel cost t. Given small t, the red colored area $\boldsymbol{S}$ represents the parameter space where the separating equilibrium exists. The credibility of non-commitment advertising can be established if the selling costs are high and cost differences are large. Note that the minimal level of selling cost k^* depends on the cost difference $c_H - c_L$. When the cost difference is large, the high cost type retailer will be inundated with consumers who do not purchase if it mimics a low cost type. As a result, even small selling cost will be sufficient to punish the deviating retailer. Thus, k^* decreases as the cost difference $c_H - c_L$ increases. This suggests that k^* and $c_H - c_L$ actually work as substitutes. For example, given a selling cost k_1 in Figure 3, a separating equilibrium is more likely as $c_H - c_L$ increases. Similarly, given a specific cost difference c_1 in Figure 3, a separating equilibrium is also more likely as k increases. However, it should be also noted that k^* never converges to zero.[12] Hence, it is not possible that non-commitment advertising serves as a signal when $k = 0$, despite the large $c_H - c_L$. The high selling cost is a necessary condition although the level of this necessary condition can be weakened by the cost difference of the retailers.

••• Figure 4 •••

Note that the strategy profile described here is indeed a pure strategy perfect Bayesian equilibrium. Analyzing the game backwards, it is optimal to buy for consumers whose willingness to pay is greater than the price (Stage 4). At Stage 3, the retailer will incur the selling cost k, since the expected benefit of selling a product is greater than zero. This is so because only consumers whose willingness to pay is greater than price will visit the store and $k \le \left(\frac{1-c_H}{2}\right)^2$. At Stage 2, consumers' beliefs are consistent with the strategy via Bayes' rule. Furthermore, consumers correctly expect the equilibrium price, and the retailer's strategy is optimal given these beliefs and expectations. At Stage 1, the retailer's advertising decision is optimal under Proposition 1.

4.2. Other Equilibria

The existence of pooling and mixed strategy equilibria is of substantive interest. While pooling and mixed strategy equilibria may exist within some parameter regions, it is already shown that they never co-exist with separating equilibria (Proposition 1). The

[12] k converges to zero only at $c_H = 1$ but $c_H \in [0.1)$ for positive traveling cost t from equation (3).

blue colored area ***O*** of Figure 4 is the parameter space where pooling equilibria or mixed strategy equilibria exist. Under these equilibria, the advertising is not fully informative. Presumably, in these regions advertising may simply represent cheap talk.

In a pooling equilibrium, both types choose the same advertising message. As a result, consumers cannot use the advertising message to update their expectations about the firm's cost type, and so their posterior beliefs revert to their prior beliefs. In this equilibrium, the advertising is therefore uninformative.

In mixed strategy equilibria, different cost types randomize over their choice of m_L and m_H. Because the likelihood that each type will choose each strategy may vary, customers can generally use the advertising message to update their expectations about the firm's type, but uncertainty remains (the posteriors are not degenerate). The following Proposition 2 and 3 help us understand the characteristics of these equilibria.

Proposition 2. *In any totally mixed strategy equilibrium where both types randomize in the choice of their advertising message, both types must randomize with the same probability.*

Proof. See Appendix II.

Proposition 3. *A semi-separating equilibrium, in which the low cost type always chooses m_L and only the high cost type randomizes between m_L and m_H with probability β, and $1-\beta$, can exists. Moreover, the probability β, with which the high cost type randomizes price message m_L, monotonically decreases,*

(1) as the selling cost k increases: $\frac{d\beta}{dk} < 0$,

(2) as the cost difference $c_H - c_L$ *increases:* $\frac{d\beta}{dc_H} < 0$.

Proof. See Appendix II.

I can now characterize the information that is revealed by advertising within the mixed equilibria. In a totally mixed equilibria, the advertising is completely uninformative, since customers are not able to use the advertising to update their expectations about the retailer's type (Proposition 2). The only informative cases are the semi-separating equilibria in which the informativeness of the advertising monotonically increases as the selling cost and the cost difference increases (Proposition 3).

Collectively, these findings with Proposition 1 suggest two important comparative static results. Advertising is more likely to be informative when (1) selling costs are high or (2) the difference in the cost types is large. Both changes make a separating equilibrium more likely (Proposition 1). Moreover, these factors also increase the information revealed by advertising under semi-separating equilibrium (Proposition 3), which is the only case where any information can be revealed in the absence of a separating equilibrium (Proposition 2).

These comparative static results may also help to explain the pattern observed in the Pilot study. Recall that the advertised prices were most informative for travel packages, and least informative for airline tickets. In the travel industry, the primary source of selling costs is the time and effort expended by a sales person to close a deal. Sales assistants are responsible for answering incoming calls regarding product and price information about their products. It is therefore easier to sell the standardized product for which consumers can easily collect information from various sources such as airline tickets or cruises (offered by a few large companies) than non-standardized products. For example, one could easily find information about a Caribbean cruise offered by Royal Caribbean Cruise from several websites or by calling one of the retailers. With sufficient information about the product, a consumer does not need to bother to incur additional search costs in securing product information other than price information when he calls another store. However, when retailers sell all-inclusive packages, it is highly store-specific and non-standardized. This implies that even if retailers have seemingly similar product packages, consumers must ask for all the details of the package. Hence, it is reasonable to assume that selling costs differ according to the products the agents are selling – the selling cost for a travel package is higher than for airline tickets or cruises.

Our observations in the Pilot study appear to be consistent with the selling costs story. First, the comparison between the airline tickets and cruises suggests the effect of varying wholesale cost difference when selling costs are similar. In both cases, agents sell a highly standardized product, suggesting a similar selling cost. However, the products have different types of cost structures. Travel agents who sell airline tickets tend to have smaller wholesale cost differences because they are all provided with their tickets of various airline carriers through coordinating bodies for the airlines (suppliers) at the same wholesale costs.[13] On the other hand, agents who specialize in cruises or travel package must deal with each supplier directly in order to work out the cost structure of their product. In this case, the product wholesale cost is a function of how well an agent

[13] The two coordinating bodies for the airlines are the Airlines Reporting Corporation (*ARC*) and the International Airlines Travel Agency Network (*IATAN*). A member of *ARC* are entitled to order and use *ARC* standard ticket stock for issuing airline tickets on any carrier that participates in *ARC*'s Standard Ticket & Aread Settlement Plan (*ASP*). Once an agency is listed by *ARC*, it is able to write airline tickets on the vast majority of domestic and international carriers. While agents are not required to be appointed through *ARC*, if they want to sell airline tickets or obtain reduced rate tickets, the efficiencies offered by *ARC*'s central appointment, standard ticket stock and *ASP* are important (American Society of Travel Agents, 2002).

negotiates with a supplier. As a result, the selling cost model predicts that advertising is more likely to be informative for cruises than for airline tickets. The data in the pilot study here appear to be consistent with this prediction: the correlation between advertised prices and the actual prices in airline tickets ($r_{Airlines} = 0.408$) is smaller than in cruises ($r_{Cruises} = 0.796$; $z = 2.56$, $p < 0.052$).

Comparing the travel packages and cruises also illustrates the effect of different selling costs when the wholesale cost difference is similar. Agents who sell travel packages and cruises have the similar cost structure because the wholesale cost depends on individual ability in both cases, but their selling costs are different in the two markets. Travel packages tend to incur higher selling costs than cruises because of the store-specific and non-standardized nature of the product. Therefore, advertising is more likely to be informative for travel packages than for cruises. The data again appears to support this - the correlation in cruises ($r_{Cruises} = 0.796$) is smaller than that in the packages ($r_{Packages} = 0.968$; $z = 4.35$, $p < 0.000$).

I have asserted that a non-commitment advertising message can convey information. Although I have focused on a monopoly model, the intuition easily extends to competitive markets. Suppose that there exist two competing firms that are located at the two ends of a linear city [0,1]. They do not know each other's cost type and can advertise either m_L or m_H. The selling costs intuition applies as before. The high cost firm does not want to be flooded with the wrong consumers for whom it has to incur high selling costs without earning any revenue. However, the calculation of equilibrium prices is more complicated (see Moorthy and Winter 2003).

5. Conclusion and Discussion

Approaching the right potential customers is crucial for retailers' success. Kotler and Armstrong (2001) pointed out that "if the sales force starts chasing anyone who is breathing and seems to have a budget, you risk accumulating a roster of expensive-to-serve, hard-to-satisfy customers who never respond to whatever value proposition you have." This assertion becomes more important if we consider selling costs. Selling costs are costs that a retailer incurs to serve a consumer who may or may not purchase a product. An important feature of selling costs is that they are a function of the number of consumers who visit the store, including consumers who do not make a purchase. These selling costs, therefore, may give retailers incentives to "*de-market*" (Gerstner et al. 1993, Kotler and Levy 1971) or discourage some types of consumers from visiting the store. This has many important implications for marketing strategies, one of which I investigate in this paper.

In particular, I explore the effect that selling costs have on retailers' advertising strategies. Retailers often advertise prices that are unrelated to any specific products or terms of sales, such as *"Prices start at $49"* and *"One week in the Caribbean from $449."* These seem too general and vague to be of any value to consumers. Why do so many retailers use this advertising strategy and what can consumers infer from its usage? I offer an explanation for how stores can use this advertising strategy and how consumers credibly construct price images even in the absence of commitment. If a high-priced store advertises a low price, it attracts too many consumers who are unlikely to buy its products. This imposes unwanted selling costs and yields little extra revenue. I analytically demonstrate that this can lead to truthful advertising, and that this is more likely to occur when there is a large difference in retailers' cost types, or when the selling cost is high.

Other implications of selling costs can be easily observed in product line decisions and consumers' strategic behavior. Hoping to avoid unnecessary selling costs, retailers would like to screen out consumers who are unlikely to make a purchase. They can accomplish this by changing their product offerings or service levels in such a way so as to dissuade unwanted consumers from visiting the store. For example, a well-known jewelry store restricts several popular and inexpensive silver items to its online store. By keeping these items out of its retail stores, it hopes to dissuade more price-sensitive consumers from visiting these stores, where selling costs are high.

In another attempt to avoid unnecessary selling costs, retailers often try to identify cues that can identify a consumer's type. This practice prompts consumers to strategically signal their types to the retailer. For example, a consumer may wear a worn-out pair of jeans to show a car dealer that he is price-sensitive. Similarly, many customers save shopping bags from expensive retailers to carry on future shopping trips in order to convince retailers to invest in providing adequate service by signaling that they are serious buyers.

Finally, this selling cost sheds some light on the practice of online advertising mystery: why do we see extremely low price claims more often in online advertising? We can easily observe many Internet sites claiming that they are "absolutely free," but they are never free. The answer might be the difference in selling costs. Online firms' selling costs are much lower, or virtually zero, so that they can afford to attract shoppers with such an extreme claim even if only few of them would make a purchase at the actual price. However, brick and mortar sellers would incur huge costs if people in the store do not buy once they observe the actual prices. Whether bait-and-switch tactic or informative advertising is the optimal advertising strategy hinges on the selling cost structure of the firms.

The effect of the selling cost is not limited to these few examples. I hope that this work will stimulate additional future research in this area.

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Table 1. Summary statistics

Specification	*Description*	*Obs.*	*Mean*	*Standard Deviation*	*Min.*	*Max.*
Airline ticket	*Advertising price ($)*	37	334.22	108.41	165	577
	Actual Price($)		466.16	113.94	301	689
	Difference ($)		131.95	121	0	513
	Diff/Ad (%)		0.538	0.695	0	3.06
Cruises	*Advertising price ($)*	24	556.57	253.47	169	1249
	Actual Price ($)		905.46	354.34	316	1815
	Difference ($)		348.83	216.29	10	763
	Diff/Ad (%)		0.736	0.575	0.016	2.14
Tour Package	*Advertising price ($)*	74	692.67	287.96	189	1599
	Actual Price ($)		795.01	319.69	311	1780
	Difference ($)		102.34	82.38	-67	319
	Diff/Ad (%)		0.17	0.178	-0.10	1.20

Figure 1. Scatter Plot

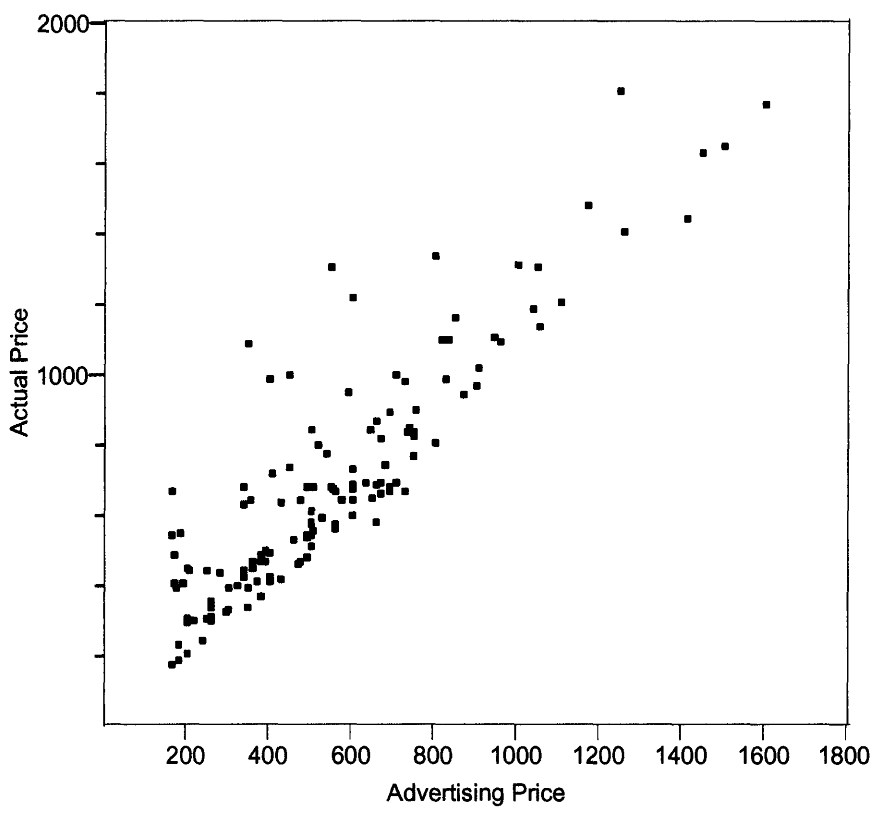


Figure 2. Time line for the game

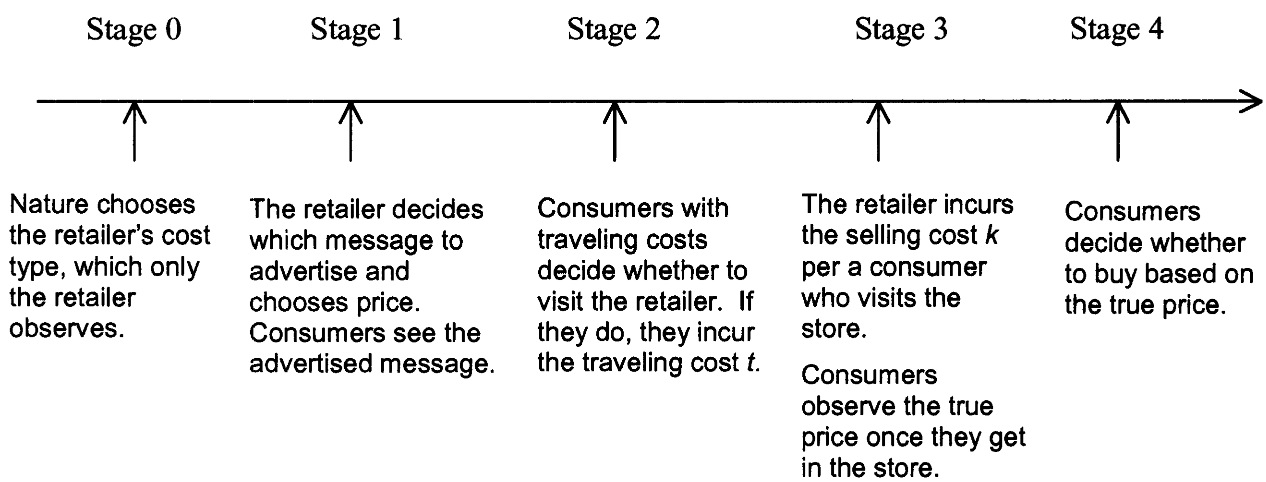
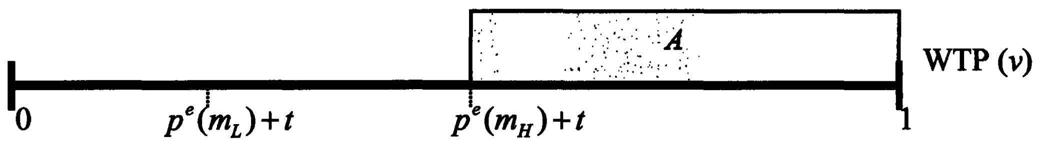


Figure 3. Demand from the segment *D* for the high cost type

Advertising a_H (equilibrium situation):



Advertising a_L (deviation situation):

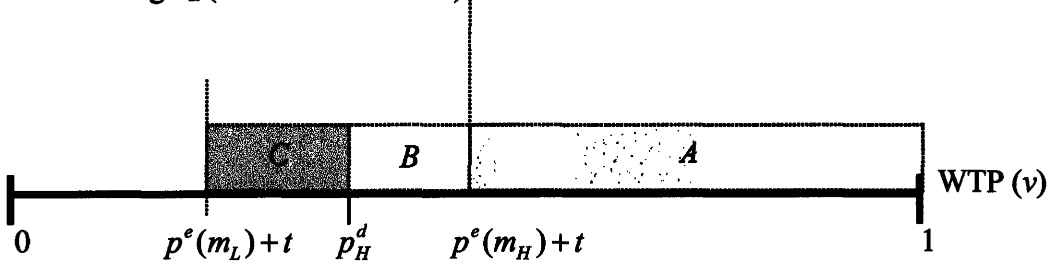
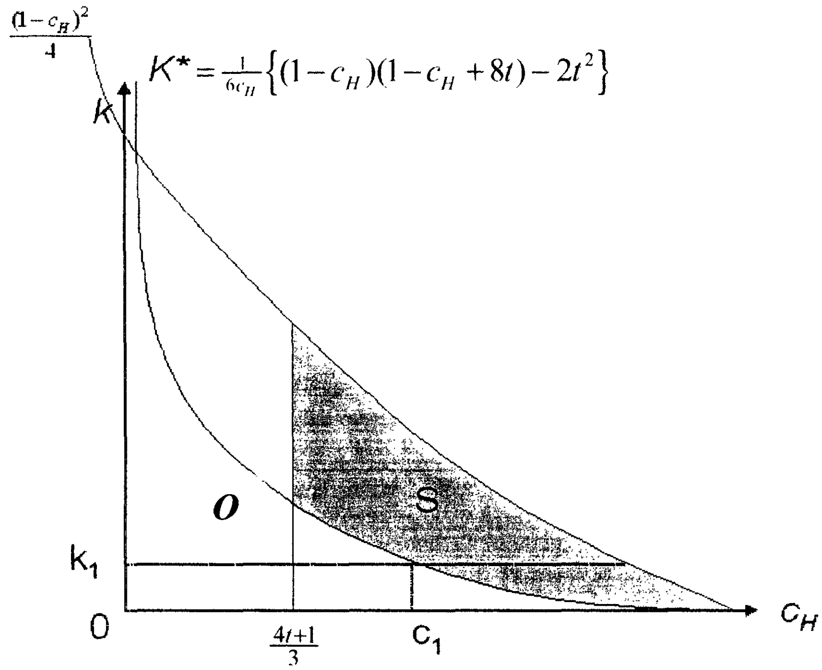


Figure 4. Graphical representation of separating equilibrium region



Appendix I – *Proof of Proposition 1.*

Proof of existence of a Separating equilibrium.

First, I show two lemmas. With these lemmas, I will derive the existence result of Propsoition1.

Lemma A1 (IC-L) *The low type never advertises m_H (no deviation of low type).*

(Pf) First, let $p_L^d = \arg\max_p \pi(p, m_H | c_L, 0)$ denote the price that a low type will charge in deviation. This price cannot be greater than $p^e(m_H)+t$. Suppose not (that is the retailer charge a price greater than $p^e(m_H)+t$), then the demand the deviated retailer faces will be $2(1-p)$ from equation (4). The retailer's profit can be maximumized p_L^m if there is no constraint on the price range. However, the price must be greater than $p^e(m_H)+t$. Because of the concavity of the profit function $\pi = 2(1-p)(p-c_L)$, the retailer can now maximize its profit by charging the boundary condition $p^e(m_H)+t$ (again, the price should be in the range such that $p_L^m \le p^e(m_H)+t \le p$).

Therefore, the demand the low type will face is, $D^L(p, m_H) = (1-p^e(m_H)-t)+(1-p)$. And the deviating profit is $\max_p \pi(p, m_H | c_L, 0) = \{(1-p^e(m_H)-t)+(1-p)\}(p-c_L) - k \cdot N(m_H)$.

From first order condition, we get $p = \frac{2-p^e(m_H)-t+c_L}{2}$ (equation (6)).

By substituting $p^e(m_H)$ here, we get the deviation price for a low type,

$p_L^d = \frac{4-c_H-2t}{6} (\le p_L{}^*)$. The deviating profit will be

$\max_p \pi(p, m_H | c_L, 0) = \pi(p_L^d, m_H | c_L, 0) = \{(1-p^e(m_H)-t)+(1-p_L^d)\}(p_L^d - c_L) - k\ N(m_H)$

The (IC-L) is rewritten as $\pi\left(p_L^*, m_L \middle| c_L, 1\right) - \max_p \pi\left(p, m_H \middle| c_L, 0\right) \geq 0$

$$\Leftrightarrow [\{2-2p^*(m_L)-t\}\cdot p_L^* - \{2-p^e(m_H)-t-p_L^d\}\cdot p_L^d] \geq k\cdot[N(m_L)-N(m_H)] = \tfrac{c_H}{3}\cdot k$$

$$\Leftrightarrow \tfrac{c_H}{6}\cdot(\tfrac{4(2-t)-c_H}{6}) \geq \tfrac{c_H}{3}\cdot k \Leftrightarrow k \leq \tfrac{8-4t-c_H}{12} \leq \tfrac{2}{3}.$$

It is obvious that this inequality always holds since $k < \frac{1}{4}$ from equation (2). ■

Lemma A2 (No separating equilibrium) *When traveling cost is relatively high to the cost difference ($c_H < \frac{4t+1}{3}$), then a high type always advertises m_H. Therefore, consumers can never tell the retailer type from advertising message (no separating equilibrium exists).*

(Pf) Let $p_H^d = \arg\max_p \pi\left(p, m_L \middle| c_H, 1\right)$ denote the price that a high type will charge when it deviates. The condition $\frac{3c_H-1}{4} < t$ holds *if and only if* $p_H^m \leq p_L^* + t$.

Thus, p_H^d cannot be greater than $p_L^* + t$ ($p_H^d \leq p_L^* + t$). This comes from the fact that $\pi\left(p_L^* + t, m_L \middle| c_H, 1\right) \geq \pi\left(p, m_L \middle| c_H, 1\right)$ for all $p > p_L^* + t$ because of the concavity of $\pi(p, m_L \mid c_H, 1) = 2(1-p)(p-c_H)$ (from equation (4)). Once we know that $p_H^d \leq p_L^* + t$, then the demand the retailer of high type will face and deviation price she will charge, as we see in Lemma A1, is $D^H(p, m_L) = (1-p^e(m_L)-t)+(1-p)$ and $p_H^d = \frac{4+3c_H-2t}{6}$, where $p_H^* \leq p_H^d \leq p_L^* + t$.

The (IC-H) is now rewritten as $\pi\left(p_H^*, m_H \middle| c_H, 0\right) - \max_p \pi\left(p, m_L \middle| c_H, 1\right) \geq 0 \Leftrightarrow \frac{c_H}{3}\cdot k \geq \frac{c_H}{6}$.

It is a contradiction (since $k < \frac{1}{4}$). ■

Now, let's turn to the Proposition 1.

The condition $c_H \geq \frac{4t+1}{3}$ guarantees $p_H^m > p_L*+t$. This implies that now the retailer's profit-maximizing monopoly price $p_H^m = \frac{1+c_H}{2}$ is feasible when the high type deviates from its equilibrium price, and therefore, $p_H^d = p_H^m$. Also, the deviate profit will be $\max_p \pi(p, m_L | c_H, 1) = \pi(p_H^m, m_L | c_H, 1) = 2(1-p_H^m)(p_H^m - c_H)$. The (IC-H) is now rewritten as

$$\underbrace{k\cdot[N(m_L)-N(m_H)]}_{Additional\ selling\ costs} \geq \underbrace{[2(1-p_H^m)\cdot(p_H^m-c_H)-\{2-2p_H*-t\}\cdot(p_H*-c_H)]}_{Additional\ profits\ from\ increased\ demand\ by\ deviation}$$

$$\Leftrightarrow \frac{c_H}{3}\cdot k \geq \frac{(1-c_H)^2}{2} - \left(\frac{2-t-2c_H}{3}\right)^2 = \frac{1}{18}\{9(1-c)^2 - 2(2-2c-t)^2\}$$

$$\Leftrightarrow k \geq \frac{1}{6c_H}\left\{(3+2\sqrt{2})(1-c_H)-\sqrt{2}t)\right\}\left\{(3-2\sqrt{2})(1-c_H)-\sqrt{2}t)\right\}$$

Above inequality suggests that the high selling costs guarantees the satisfaction of IC condition for a high type when a consumer traveling cost is relatively small comparing to the cost difference. With Lemma A1 and A2, this completes the existence result of Proposition 1. ■

Proof of Uniqueness of separating equilibrium.

We first show that a pooling equilibrium cannot survive Intuitive Crieteria under Condition (I). In a pooling equilibrium, consumers do not know whether they will encounter a low cost type or a high cost type retailer. Thus, consumers in segment D visit the store when $v - p^{po} - t \geq 0$, where $p^{po} = \frac{p_L^{po}+p_H^{po}}{2}$ denotes the consumers' expected price under a pooling equilibrium, and p_L^{po} and p_H^{po} are the expected prices that a low type and a high type will charge, respectively. The demand the retailer will encounter when it charge p will be:

$$D(p \mid i) = \min\{1 - p^{po} - t, 1 - p\} + (1 - p)$$
$$= \begin{cases} 2 - p^{po} - t - p & \text{if} \quad p \le p^{po} + t \\ 2(1 - p) & \text{if} \quad p > p^{po} + t \end{cases} \qquad \text{(A1)}$$

Thus, the profit function that the retailer maximizes will be:

$$\pi(p, a \mid i, \mu_0) = \begin{cases} (2 - p^{po} - t - p)(p - c_i) - k \cdot (2 - p^{po} - t) & \text{when} \quad p \le p^{po} + t \\ 2(1 - p)(p - c_i) - k \cdot (2 - p^{po} - t) & \text{when} \quad p > p^{po} + t \end{cases} \qquad \text{(A2)}$$

Additionally, it is possible to demonstrate that when a retailer of a different type faces the same consumer beliefs, the low type always wants to charge a lower price for a product than the high type.

Lemma B1. *In any pooling equilibrium in which both cost types adopt the same advertising strategy, the low type always charges a lower price(* p_L^{po} *) than the high type would charge (* p_H^{po} *).*

Proof. Suppose that both types charge the same price. Then it must be p^{po}. This is because consumers' expectation (p^{po}) must be confirmed by the retailer's price strategy in equilibrium. Also, p^{po} must satisfy

$$p^{po} = \arg\max_p \pi(p, a \mid c_L, \tfrac{1}{2}) = \arg\max_p \pi(p, a \mid c_H, \tfrac{1}{2})$$

$$= \arg\max_p (2 - p^{po} - t - p)(p - c_i) - k \cdot (2 - p^{po} - t), \qquad \forall i \in \{L, H\}$$

It can't hold unless $c_L = c_H$. Therefore, it must be the case that $p_L^{po} \neq p_H^{po}$.

Next, suppose that $p_H^{po} < p_L^{po}$. There are two possible cases. First, $p_L^{po} \leq p^{po} + t$, then both types follow the same profit function,

$\pi(p, a \mid c_i, \frac{1}{2}) = (2 - p^{po} - t - p)(p - c_i) - k \cdot (2 - p^{po} - t)$. Thus, $p_L^{po} < p_H^{po}$, since $c_L = 0 < c_H$. This contradicts the assumption. Second, suppose $p^{po} + t < p_L^{po}$, then this leads to the following profit functions (note that c_L=0)

$$\pi(p, a \mid c_L, \tfrac{1}{2}) = 2(1 - p)(p) - k \cdot (2 - p^{po} - t),$$

$$\pi(p, a \mid c_H, \tfrac{1}{2}) = (2 - p^{po} - t - p)(p - c_H) - k \cdot (2 - p^{po} - t)$$

Then, from *F.O.C.*, we can derive optimal p_L and p_H price. And set $p^{po} = \frac{p_H^{po} + p_L^{po}}{2}$, then we see an equilibrium price that a type $i \in \{c_L, c_H\}$ will charge $p_L^{po} = \frac{1}{2} < p_H^{po} = \frac{7 - 4t + 4c_H}{10}$ (since $1 - 2t - c_H > 0$ from equation (2)). This again contradicts the assumption.

Therefore, we can have that $p_L^{po} \leq p^{po} \leq p_H^{po}$. ■

Next, in order to find the appropriate profit function of each type, we still need to consider the two cases – one where $p_L^{po} < p_H^{po} < p^{po} + t$, and the other where $p_L^{po} < p^{po} + t \leq p_H^{po}$.

Lemma B2. A pooling equilibrium such that $p_L^{po} < p_H^{po} < p^{po} + t$ cannot exist under Condition (I).

(Pf) Let's consider the case, $p_L^{po} < p_H^{po} < p^{po} + t$. We now can rewrite the profit functions,

$$\pi(p, m_p \mid c_L, \tfrac{1}{2}) = (2 - p^{po} - t - p)(p) - k \cdot (2 - p^{po} - t)$$
$$\pi(p, m_p \mid c_H, \tfrac{1}{2}) = (2 - p^{po} - t - p)(p - c_H) - k \cdot (2 - p^{po} - t)$$

From the first-order condition, we can derive optimal p_L and p_H price $p_L = \frac{(2-p^{po}-t)}{2}$, and $p_H = \frac{(2-p^{po}-t+c_H)}{2}$. Set $p^{po} = \frac{p_H^{po}+p_L^{po}}{2}$, then we see an equilibrium price that a type $i \in \{c_L, c_H\}$ will charge in pooling equilibrium $p_L^{po} = \frac{8-4t-c_H}{12}$, $p_H^{po} = \frac{8-4t+5c_H}{12}$, and $p^{po} = \frac{8-4t+2c_H}{12}$.

It is clear that $p_L^{po} < p_H^{po} < p^{po} + t$ *if and only if* $c_H < 4t$. It is easy to show that this cannot coexist with Condition (I), which guarantees the existence of separating equilibrium. For both to coexist, it must be the case that $\frac{1+4t}{3} \le c_H < 4t$, which implies that $\frac{1}{8} < t$. However, we can easily show that Condition (I) cannot hold when $\frac{1}{8} < t$. Therefore, we can conclude that this pooling equilibrium cannot exist under Condition (I). ■

Now, we only need to consider the case, $p_L^{po} < p^{po} + t \le p_H^{po}$. The profit functions of each type are

$$\begin{aligned} \pi(p, m_p \mid L, \tfrac{1}{2}) &= (2 - p^{po} - t - p)(p) - k \cdot (2 - p^{po} - t) \\ \pi(p, m_p \mid H, \tfrac{1}{2}) &= 2(1-p)(p - c_H) - k \cdot (2 - p^{po} - t) \end{aligned} \qquad \text{(A3)}$$

From the first-order condition, we derive $p_L = \frac{(2-p^{po}-t)}{2}$, and $p_H = \frac{1+c_H}{2}$. In equilibrium, $p^{po} = \frac{p_H^{po}+p_L^{po}}{2}$, so that, $p_L^{po} = \frac{7-4t-c_H}{10}$, $p_H^{po} = \frac{1+c_H}{2}$, and $p^{po} = \frac{3-t+c_H}{5}$. It is clear that $p_L^{po} < p^{po} + t \le p_H^{po}$ if and only if $c_H \ge \frac{1+8t}{3}$. Clearly, this pooling equilibrium can exist under Condition (I).

It is also assumed that consumers adopt the intuitive criteria (Cho and Kreps 1987) to eliminate unrealistic beliefs (out-of-equilibrium refinement). In particular, we show that inequality $\pi^{po} - \pi(p_H{*}, m_{-p} \mid c_H, 0) \ge 0$ always holds under Condition (I). This implies that if a retailer sends a price message m_{-p}, consumers believe that a retailer is a low cost type because only a low type can earn more than its equilibrium profit by sending m_{-p} under Condition (I). For this reason, consumers can reasonably conclude that a retailer who deviates from the pooling equilibrium strategy under Condition (I) is a low-type (*out-of-equilibrium*).

Lemma B3 (Intuitive Criteria). *If a retailer advertises m_{-p}, consumers can reasonably believe that the retailer is a low-type because only a low-type retailer can earn more than their equilibrium profit by deviating from the pooling equilibrium under the condition (I).*

Proof. Under Condition (I), the following inequality holds (note that advertising message does not have a direct effect on the profit, it only affects through consumers' posterior beliefs):

$$\pi(p_H*, m_{-p} \mid c_H, 0) = \max_p \pi(p, m_{-p} \mid c_H, 0) \geq \max_p \pi(p, m_{-p} \mid c_H, 1)$$

Let $\pi_H^{po} = \pi(p_H^{po}, m_p \mid c_H, \frac{1}{2})$ be the pooling equilibrium profit for a high-type. Now, we only need to show that $\pi_H{}^{po} - \pi(p_H*, m_{-p} \mid c_H, 0) \geq 0$ under Condition (I).

$$\begin{aligned}\pi_H{}^{po} - \pi(p_H*, m_{-p} \mid c_H, 0) \geq 0 &\Leftrightarrow 2(1-p^m)(p^m - c_H) - (2 - 2p_H * - t)(p_H * - c_H) \geq k \cdot \left[N(m_p) - N(m_{-p})\right] \\ &\Leftrightarrow 5 \cdot \left[(1-c_H)^2 + 8(1-c_H) \cdot t - 2t^2\right] \geq 6k \cdot \left[1 - 2t + 2c_H\right]\end{aligned}$$

We know that $k \leq (\frac{1-c_H}{2})^2$. Applying this to (*RHS*), then we get,

$$(RHS) \leq 6 \cdot \tfrac{(1-c_H)^2}{4} \cdot \left[1 - 2t + 2c_H\right]$$

Furthermore, it is easy to show that

$$5\cdot\left[(1-c_H)^2+8(1-c_H)\cdot t-2t^2\right]\geq 6\cdot\tfrac{(1-c_H)^2}{4}\cdot[1-2t+2c_H]$$

$$\Leftrightarrow \{5-\tfrac{3}{2}(1-2t+2c_H)\}\cdot(1-c_H)^2+5\left\{8\cdot(1-c_H)t-2t^2\right\}\geq 0 \text{ (since } 1-c_H\geq 2t\text{)}.$$

Therefore, inequality $\pi_H{}^{po}-\pi(p_H*,m_{-p}\mid c_H,0)\geq 0$ always holds under Condition (I).

This implies that the best that can be had by sending m_{-p} is dominated by what a high type gets in the equilibrium, when consumers believe a deviating firm is a high type (the most favorable consumer beliefs for a high-type under condition (I)). For this reason, consumers can reasonably conclude that retailer who deviates from the pooling equilibrium strategy is a low-type (*out-of-equilibrium*). ■

Now, we are ready to prove the uniqueness of Proposition 1.

First, we show that a separating equilibrium exists. Condition (I) guarantees the existence of the separating equilibrium from Proposition 1. Second, we show a pooling equilibrium does not exist. Under Condition (I), a pooling equilibrium exists only if $\pi(p_L^{po},m_p\mid c_L,\tfrac{1}{2})\geq \max_p \pi(p,m_{-p}\mid c_L,1)$ or $k\geq\tfrac{1}{4}(A+2B)$, where $A=\tfrac{7-4t-c_H}{5}$ and $B=\tfrac{2-t}{3}$. Furthermore, it is obvious that $k\geq\tfrac{1}{4}(A+2B)=\tfrac{41-22t-3c_H}{60}\geq\left(\tfrac{1-c_H}{2}\right)^2$. This implies that a pooling equilibrium cannot exist under Condition (I). Lastly, we need to show the nonexistence of mixed strategy equilibrium. It is clear that all strategies that are employed with positive density under a mixed strategy equilibrium must yield the same expected profit for the retailer. However, sending a high price message is dominated by sending a low type message for the low cost type retailer under Condition (I). Accordingly, the low type retailer never sends a high price message, which implies that it never randomizes its advertising strategy, which enforces the high cost type never randomize either. Thus, there exists no mixed strategy equilibrium under the range where a separating equilibrium exists. This completes the uniqueness of Proposition 1. ■

From the existence and the uniqueness of separating equilibrium, we now complete the proof of Proposition 1. ***Q.E.D.***

Appendix II – *Proof of Proposition 2.*

Proof of Proposition 2 (Both type mixing equilibrium).

Suppose that a low cost type retailer randomizes between advertising m_L (with probability α) and m_H (with $1-\alpha$). So does the high cost type retailer with probability β and $1-\beta$. Consumers' belief after observing m_L or m_H follows Bayes' rule:

$$\mu(m_L) = \frac{\frac{1}{2}}{\frac{1}{2}\alpha+\frac{1}{2}\beta} = \frac{\alpha}{\alpha+\beta}$$
$$\mu(m_H) = \frac{\frac{1}{2}(1-\alpha)}{\frac{1}{2}(1-\alpha)+\frac{1}{2}(1-\beta)} = \frac{1-\alpha}{2-\alpha-\beta}$$

For the low type to be willing to randomize, the profit from either case make the retailer indifferent between two strategies:

$$\max_p \pi(p, m_H \mid c_L, \tfrac{1-\alpha}{2-\alpha-\beta}) = \max_p \pi(p, m_L \mid c_L, \tfrac{\alpha}{\alpha+\beta}) \qquad \text{(A4)}$$

Lemma C1 $\max_p \pi(p,a \mid i,\mu_1) \le \max_p \pi(p,a \mid i,\mu_2)$ *if and only if* $\mu_1 \le \mu_2$ for each *i.*

Using Lemma, it is easy to show that equation (A4) holds if and only if $\alpha = \beta(\neq 0)$. Thus, the posterior beliefs revert to their prior beliefs about the retailer type, $\mu(m_L) = \frac{\alpha}{\alpha+\beta} = \frac{1}{2}$, and $\mu(m_H) = \frac{1-\alpha}{2-\alpha-\beta} = \frac{1}{2}$. Otherwise ($\alpha \neq \beta$), the low type does not randomize. ***Q.E.D.***

Proof of Proposition 3 (Semi-separating equilibrium).

First, we will show that there can exist semi-separating strategies. Suppose that a low cost retailer advertises price message m_L, but the high cost type randomizes between advertising m_L (with probability β) and advertising m_H (with $1-\beta$). Consumers' belief after observing m_L or m_H follows Bayes' rule:

$$\mu(m_L) = \frac{\frac{1}{2}}{\frac{1}{2}+\frac{1}{2}\beta} = \frac{1}{1+\beta}$$

and the usual inference after separating yields

$$\mu(m_H) = 0$$

Note that $\mu(m_L) > \mu_0$. Since the low cost type always chooses m_L but the high cost type does so only with probability α, observing m_L makes it more likely that the retailer has a low cost. Also, as $\alpha \downarrow 0$, $\mu(m_L) \uparrow 1$, and as $\alpha \uparrow 1$, $\mu(m_L) \to \mu_0$. ■

For the high cost type to be willing to randomize between separating by advertising m_L and pooling by m_H, the profit must make that retailer indifferent between the two:

$$\pi(p_H^*, m_H \mid c_H, 0) = \max_p \pi(p, m_L \mid c_H, \tfrac{1}{1+\beta}) \quad \text{(A5)}$$

Let $p^m = \frac{1}{1+\beta} \cdot p_L^m + \frac{\beta}{1+\beta} \cdot p_H^m$ denote the consumers' expected price under a semi-separating equilibrium, and p_L^m, p_H^m are the expected prices that a low type and a high type will charge, respectively. Next, in order to find the appropriate profit function of the high type, $\pi(p, m_L \mid c_H, \frac{1}{1+\beta})$, we need to consider the two cases – one where $p_L^m < p_H^m < p^m + t$, and the other where $p_L^m < p^m + t \leq p_H^m$. It is easily shown that there cannot exist $\alpha \in [0,1]$ that satisfies the $p_L^m < p_H^m < p^m + t$. Hence, we only need to consider the case $p_L^m < p^m + t \leq p_H^m$. The profit functions of both types are:

$$\pi(p, m_L \mid c_L, \tfrac{1}{1+\beta}) = (2 - p^m - t - p) \cdot p - k \cdot (2 - p^m - t)$$

$$\pi(p, m_L \mid c_H, \tfrac{1}{1+\beta}) = 2(1 - p) \cdot (p - c_H) - k \cdot (2 - p^m - t)$$

From *FOC.*, and the fact that $p^m = \frac{1}{1+\beta} \cdot p_L^m + \frac{\beta}{1+\beta} \cdot p_H^m$, we have $p_L^m = \frac{2-p^m-t}{2}$, $p_H^m = \frac{1+c_H}{2}$,

and $p^m = \frac{(2-t)+(1+c_H)\cdot\beta}{3+2\beta}$. Again, plug this result in equation (A5), then we can calculate the appropriate probability β:

$$\pi(p_H*, m_H \mid c_H, 0) = \max_p \pi(p, m_L \mid c_H, \tfrac{1}{1+\beta}) \Leftrightarrow 2(\tfrac{1-c_H}{2})^2 - (\tfrac{2-2c_H-t}{3})^2 = k(p_H * - p^m)$$

$$\Leftrightarrow \tfrac{1}{18}[(3+2\sqrt{2})(1-c_H) - \sqrt{2}t][(3-2\sqrt{2})(1-c_H) + \sqrt{2}t] = k \cdot (\tfrac{3c_H + (1-c_H-2t)\beta}{3(3+2\beta)})$$

(A7)

Given k, c_H, we can solve equation (A7), so that the probability β.

Now, let

$$F(\beta, k, c_H) = \tfrac{1}{18}[(3+2\sqrt{2})(1-c_H) - \sqrt{2}t][(3-2\sqrt{2})(1-c_H) + \sqrt{2}t] - k \cdot (\tfrac{3c_H + (1-c_H-2t)\beta}{3(3+2\beta)}) = 0$$

Also, let $F_\beta = \frac{\partial F}{\partial \beta}, F_{c_H} = \frac{\partial F}{\partial c_H}$, and $F_k = \frac{\partial F}{\partial k}$.

By the Implicit Function Theorem, we can easily know that

$$\frac{d\beta}{dk} = -\frac{F_k}{F_\beta} < 0$$
$$\frac{d\beta}{dc_H} = -\frac{F_{c_H}}{F_\beta} < 0 .$$

This complete the proof of Proposition 3 ***Q.E.D.***

Chapter 2:

How Free-Riding on Customer Service Affects Competition

How Free-Riding on Customer Service Affects Competition

Abstract

The free-riding problem is ubiquitous when all the pre-sales activities needed to sell a product can be conducted separately from the actual sale of the product itself. Intuitively, we can expect that free-riding will hurt the retailer who provides service. Nonetheless, we analytically show that free-riding actually benefits not only the free-riding retailer, but also the retailer who provides service. The intuition behind this result is that by allowing free-riding, the service provider can induce a softer re-action from its competitor who now enjoy free-riding. The free-rider has less incentive to compete with the service provider in price to attract more consumers because many consumers will eventually switch to them due to free-riding. This induced soft strategic response enables the service provider to charge a higher price than its cost and enjoy the strictly positive profit which otherwise would have been wiped away by the head to head price competition. Therefore, allowing free-riding can be regarded as a strategic investment which prevents an aggressive response from the other retailer.

1. Introduction

Imagine a college student who is planning to purchase some audio equipment. Not knowing precisely which product fits her need best, she may go to a local audio store and ask the assistance of their knowledgeable sales people. The sales people incur some time and effort to help a college student by listening to her needs carefully and by offering solid advice. Since the local audio store must pay for these salespeople, this will obviously be reflected in the price of their audio equipment. Knowing this, the student may return home and order it from an online retailer who is offering the same product at a lower price.

What this frugal college student has done is to free-ride off the local brick-and mortar store's selling effort or service in order to find out the best match between her needs and audio products. She enjoyed the opportunity to try out some equipment, which the other retailer does not offer, and then she finally got online retailer's lower price. Consumers usually do this with many products, especially those that require a large amount of pre-sales service, which allows them to touch or try out the product, such as furniture or clothes. With the increasing importance of the selling costs incurred for this pre-sales service (Shin 2004), one of the most substantial problem that many retailers have encountered is the free-riding problem. Moreover, as consumers increasingly purchase products from their home through online retailers, consumers' ability to judge the quality of the products they buy is significantly reduced. In such environments, the free-riding problem becomes even more substantive issue for traditional brick and mortar stores.

The free-riding problem is not limited to brick and mortar retailers who are facing increased competition from online retailers. The free-riding problem is rather ubiquitous when all the pre-sales activities needed to sell a product, such as providing informed sales advice to consumers, can be conducted separately from the actual sales of the product itself. Hence, it is possible for one retail store to engage in the activity necessary to sell the product, but for a different lower-priced store to make the final sale.

Conventionally, we expect that free-riding[14] in a retail market will hurt the profit of the retailer that provides service (for a survey see Lilien and Kotler 1992, Carlton and Chevalier 2000). We can easily see the cost of free-riding for a retailer who offers service. However, it is hard to see any benefit of free-riding for the same retailer. Nonetheless, we suggest that free-riding actually benefit not only the free-riding retailer, but also the retailer who is being freely ridded.

We follow Wernerfelt's (1994) idea that sales assistance improves the quality of matching between consumer's need and a product. In markets where consumer's situation determines his needs, but the number of possible situations is very large, the map identifying the best match between a consumer's situation and a product is only known to the sales assistant. In our example, a college student does not know precisely what to buy among so many alternatives: she does not know whether to buy a single crystal silver silway MK II with purity level 99% for her new 48 *Bose* system. For example, there are more than 140 different product items just for *audio cable* – it is hard to find the best matching product without knowledgeable sales advice.

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[14] The term free riding can be applied to two situations: firm's free riding off each other and customer's free riding off the retailer. In this study, we focus on the first application and hereafter, we use the term free riding in respect of firm's free riding off each other.

Traditionally, many retail stores have tried to keep consumers from free-riding by using various devices, such as territorial restrictions or exclusive dealership for a certain manufacturer (Carlton and Chevalier 2001). The idea is to make it hard for customers to compare products and prices from different retail outlets. However, the proliferation of the Internet puts pressure on this idea and has almost obliterated it completely. Most brick and mortar retailers are now vulnerable to the free-riding problem from their Internet competitors. The increased competition from online forces retailers to lower their prices in an attempt to prevent the free-riding problem. However, many brick and mortar retailers are limited in their ability to reduce prices, and thus the free-riding problem, together with the selling cost, would forces these retailers to eliminate their incentive to provide sales service (Carlton and Chevalier 2001; Wu et. Al 2004). However, many retailers are still providing sales service and thriving despite the free riding problem. Are they just doomed to vanish in the near future? How can they cope with the threat of free-riding and keep providing costly service?

An interesting insight from the current analysis is that a service providing retailer can differentiate itself from other competitors (who free ride off its sales effort) by offering service. In other words, offering service is a differentiation mechanism and thus may soften price competition. More importantly, it is free-riding that makes this differentiation mechanism sustained. The result suggests that the retailer who offers a service can be better off than when the free-riding is prohibited.

The intuition behind this counter intuitive result (i.e., the retailers can be better off because of free-riding) is that by allowing free-riding, a retailer who provides a service can induce a softer re-action from its competitor who now enjoys free-riding. The competitor (free-rider) has less incentive to compete with the service providing retailer in price to attract more consumers because many consumers will eventually switch to them due to free-riding. This induced soft strategic response enables the service provider to charge higher price. Therefore, allowing free-riding can be regarded as a strategic investment by the service provider in preventing an aggressive response from the other retailer.

Before we formally offer a rationale for this argument in terms of a simple, we briefly review the literature.

The free-riding problem among retailers has been studied and is well understood in standard economic literature (for example, Carlton and Perloff 2000; Carlton and Chevalier 2001). Telser (1960), and Signley and Williams (1995) suggest that free-riding increases the price disparity between service providing retailer and free-riding retailer. As a consequence, more consumers tend to free ride off one retailer's service and buy the product from another retailer who charges a lower price. Free-riding, hence, leads to dissuade retailers from offering sales service. On the other hand, Strauss (2002) and Wu et al (2004) found that service providing retailers could be still better off by service differentiation even in the presence of the free-riding problem. The key intuition is that both firms benefit from differentiation. However, it is not clear how this service differentiation could be sustained if consumers can substitute the benefit of the low price with the benefit of superior service. Moreover, they mainly focused on the service differentiation, not on the role of free-riding. They only regard free-riding as the pure cost and do not recognize any strategic value of free-riding while the current research mainly focuses on the strategic role of free-riding and considers the benefit of free-riding.

The effect of an online retailer on the price competition has been studied by several researchers in both economics and marketing. Bakos (1997) and Varian and Shapiro (1997) argue that price competition will be very intense and profitability will be low on the Internet because of low search costs. However, more recent research, such as by Lal and Sarvary (1999), Ariely and Lynch (2000), and Iyer and Pazgal (2003), points that the opposite conclusion is also possible. Lal and Sarvary's (1999) work is the first theoretical work which shows that the Internet can actually reduce the intensity of competition for goods with non-digital attributes even when search costs fall. Ariely and Lynch (2000) also found a similar result under online wine experiments where consumers focus on the quality more than price because of lower search costs not only for price but also for quality. Iyer and Pazgal (2003) also address the effect of an Internet Shopping Agent on the price competition. They show that prices can actually increase when the number of retailers participating in Internet Shopping Agents increases.

Finally, our work is related to the literature on the product differentiation, including recent work in marketing (Kuksov 2003; Desai 2001; Chu et al 1995; and Moorthy 1988). By differentiating their selling styles, the retailers avoid head to head competition. This is also related to a fairly lengthy literature on optimal differentiation between firms (for example, Bulow et al 1985; Ben Akiva et al. 1989; Anderson and Thisse 1992; and Ansari et al 1998). However, none of these works looks at how differentiation can be obtained when there is no *a prior* difference between retailers. By contrast, we focus on the way how the differentiation between retailers can be obtained.

The structure of this paper is as follows. In Section 2, a formal model of free -riding is presented and then analyzed. Section 3 presents the other implications and I conclude in Section 4.

2. Model

In order to develop a formal model, we now abstract from many of the real-world aspects of an economic relationship involving retailers and customers.

Consumers

Consumers are assumed to purchase one or zero units of the product. All the consumers get the same utility $v - p$ from consuming a product at price *p,* if the product is a good match with the consumer's situation. Otherwise, consumers get $\underline{v}$ utility. For simplicity, we set the utility $\underline{v}$ is equal to zero. Therefore, the utility a consumer gets is

$$U = \begin{cases} v & if \quad a \quad product \quad fits \\ 0 & if \quad not \end{cases}.$$

Where v is common and known to consumers, but consumers do not know whether the product fits their situation or their specific needs (Wernerfelt 1994).

There are two segments of consumers: *informed* and *uninformed* consumers. The total market size is normalized to one and α portion of consumers are informed while $(1-\alpha)$ are uninformed consumers. This relative size of segment is common knowledge to consumers and retailers.

The informed consumers are those who have sufficient knowledge about the product and know precisely whether the product fits their situation or their specific needs. On the other hand, the u*ninformed* consumers are those who are not sure about the matching between the product specification and their situation. These consumers need the retailer's sales advice service to resolve this matching uncertainty.

Also, consumers incur shopping costs when they visit the store. Within each segment, consumers are heterogeneous in terms of their shopping cost, $t \sim U[\underline{t}, \bar{t}]$, where $\underline{t} \geq 0$ and $\bar{t} = \underline{t} + 1$. The density is 1. These shopping costs are private information to consumers. We can think of this shopping cost as an opportunity cost for the time spent on shopping.

Retailers

We focus on a highly stylized situation in which two retailers indexed by $i \in \{1,2\}$ are competing with each other for the same consumers. Both retailers are selling the same product, *A*, at price p_1, p_2, respectively. Also, the unit cost of the product, $c > 0$, is the same for both retailers.

The product *A* is such that it is a good match with consumer's situation with probability *m* (<1). The matching probability *m* is the common knowledge to consumers and assumed to be strictly less than 1 to make the no-match case a non-empty event.

This one product setting can be easily extended to multiple products case – which is consistent with many real world situations where consumers do not know precisely what they want or need. The situation can be generalized as following: The retailers sell two products (*A* and *B*) in their assortments and may sell one of either or nothing. The unit cost of the product is c for both A and B, and the same for both retailers. Consumers may have a good match between their needs (situations) and the product (A or B), with probability η. The probability, η, is the same for both product A and B, and independent. Hence, there are four situations: (1) only product A, not with B is a good match (probability $\eta(1-\eta)$), (2)) only product B, not with A is a good match (probability $\eta(1-\eta)$), (3) both products A and B are good match (probability η^2), and (4) neither product A nor B is a good (probability $1-2\eta(1-\eta)-\eta^2$). η is common knowledge to consumer. Therefore, consumers have a prior of matching $m = 2\eta(1-\eta)+\eta^2 (<1)$ for $\forall \eta \in [0,1)$ [15].

Two crucial assumptions concern the function of selling effort and the asymmetry of the two retailers on service providing. First, we assume that uninformed consumers need to consult a service providing retailer if they want to resolve their matching uncertainty before they purchase.

We follow Wernefelt (1995) in consumers need to get expert service to precisely identify the best match between their situation and a product, or they need to physically inspect the product before they purchase a product.

A second assumption is that only one retailer (retailer 2) offers a sales service while the other does not offer any selling service (retailer 1). This implies that only one retailer who offers this service (retailer 2) incurs a selling cost equal to k per each customer who visits the store. The retailer that does not provide such sales service find itself in a lower

[15] The problem can therefore be simplified to the case where retailers sell only one product and the probability of matching for that product is m.

price position comparing with the retailer that provides ancillary services because of low selling costs (Shin 2004).

Game

We now describe the game that we consider to complete the model.

At stage 0, retailers decide the level of their prices and consumers know those prices. At stage 1, consumers decide which store to visit. When consumers visit the store, they all incur a shopping cost, t. Hence, consumers compare the expected utility of visiting each store, and visit the store which gives them bigger utility (as long as the expected utility is non-zero). Informed consumers have no uncertainty about matching, and they just visit the store which offers a product at lower price (which is retailer 1 in this case).

Expected utility for uninformed consumers when they visit the store 1 is,

$$EU_1 = m \cdot v - p_1 - t \tag{1}$$

When there is no sales service, consumers will make a purchase giving her v utility with probability m, with a payment p_1.[16]

Expected utility for uninformed consumers when they visit the store 2 is,

$$EU_2 = m \cdot \max\{v - p_1 - t, v - p_2\} - t \tag{2}$$

With the help of retailer's sales service (advice), uninformed consumers can realize whether the product fits them or not before they make a purchase decision.

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[16] for example, two products case, it would be $EU_1 = \frac{\eta}{2} v - p_1 - t$, because consumers will make a random choice giving her v utility with probability $\frac{\eta}{2}$, with a payment p_1. However, the results are exactly identical whether we use $\frac{\eta}{2}$ or m.

At stage 2, uninformed consumers who visit the store 2 now know whether a product fits or not. When it does not fit their situation, they simply decide not to buy. When it fits, then they have to make another decision where to buy (*depending on t*). Consumers can either purchase a product at store 2(staying) or switch to store 1 (free-riding) depending on their shopping costs.

All consumers who visit the store 1 at stage 1 purchase a product (otherwise, they would not have visited the store at stage 1).

Note that when uninformed consumers know that a product fits their needs or situations (it occurs with probability *m*), consumers with $t < \Delta p_L \, (\Leftrightarrow v - p_1 - 2t > v - p_2 - t)$ will switch to the store 1 to buy a product. Others will stay and purchase at the store 2.

We summarize the order of decisions for uninformed consumers in Figure 1.

••• Figure 1 •••

3. Analysis

3. 1. Free-riding pricing game

In order to calculate a consumer's visiting decision, we need to solve the problem backward.

At stage 2, we need to note that all *uninformed* consumers who visit the store 2 will

(1) always prefer to switch to store 1 at stage 2 (free-ride) *if and only if*

$t \le \Delta p = p_2 - p_1$,

(2) always prefer to purchase a product at store 2 *if and only if* $t > \Delta p = p_2 - p_1$

On the other hand, all *informed* consumers (who know precisely whether the product fits or not) will just visit the store 1 at stage 1 when it fits (even if both retailers charge the same prices, we assume that informed customers favor store 1 because there must be less waiting time or less hassle since there are no uninformed consumers, which mean less congested and no unnecessary service hassles).

Knowing consumers' purchase decisions, we can now calculate uninformed consumers' visiting decisions at stage 1.

(1) For all uninformed consumers with $t \le \Delta p$, they visit the store 2 if and only if their expected utility from visiting store 2 is bigger than that from visiting store 1.

$$EU_1 = m \cdot v - p_1 - t \le EU_2 = (1-m)\cdot(-t) + m\cdot(v - p_1 - 2t)$$

$$\therefore EU_2 \ge EU_1 \Leftrightarrow t \le \left(\frac{1-m}{m}\right) p_1 \tag{3}$$

Note that $\Delta p \le \left(\frac{1-m}{m}\right) p_1 \Leftrightarrow mp_2 \le p_1$. Hence, the condition $mp_2 \le p_1$ guarantees that all uninformed consumers such that $t \le \Delta p$ will visit the store 2.

(2) For all uninformed consumers with $t > \Delta p$, they also visit the store 2 if and only if their expected utility from visiting store 2 is bigger than that from visiting store 1.

$$EU_1 = m \cdot v - p_1 - t \le EU_2 = (1-m)\cdot(-t) + m\cdot(v - p_2 - t)$$

$$\therefore EU_2 \ge EU_1 \Leftrightarrow mp_2 \le p_1 \tag{4}$$

There are two cases that we need to consider: $mp_2 > p_1$ and $mp_2 \le p_1$.

Now suppose that $mp_2 > p_1$, then nobody visits retailer 2. Hence, the retailer 2 will lower the price to the point where $mp_2 \le p_1$, and get a positive demand. This may trigger the retailer 1 to reduce its price more such that all consumers would purchase at store 1. However, $mp_2 > p_1$ is not possible in equilibrium – the idea is that in the end, the retailer 2, who has a cost disadvantage because of service-providing, cannot lower its price below retailer 1's price. Thus, we assume that $mp_2 \le p_1$ for a while, and later check that it is indeed satisfied in equilibrium, and retailer 1 never wants to deviate by lowering its price.

The following assumption guarantees that $mp_2 > p_1$ never occurs in equilibrium.

Assumption 1 (Uncertainty Aversion).

$m \le m^*$, where $m^* = \dfrac{\alpha + 3(1-\alpha)c + (1-\alpha)(1-\underline{t})}{\alpha + 3(1-\alpha)c + (1-\alpha)(2+\underline{t})}$, $0 < m^* < 1 \quad \forall \alpha \in (0,1)$. Furthermore, m satisfies that following relationship such that $(\dfrac{m}{1-m})k \le c \Leftrightarrow m(c+k) \le c$.

With Assumption 1 and inequalities (3) and (4), we know that all uninformed consumers always visit the store 2.

Also, we make the following assumption for the moment:

Assumption 2 (Big Market). $\bar{t} \ge 2\underline{t}$.

This assumption says, roughly, that the amount of consumer heterogeneity is sufficient for what follows. We also make another assumption,

Assumption 3 (Individual Participation): $mv \ge \dfrac{2\alpha}{3(1-\alpha)} - \dfrac{2(2\bar{t}-\underline{t})}{3} + c$.

Assumption 3 ensures that in the price equilibrium all informed consumers buy a product if and only if the product fits their needs. In other words, v is sufficiently large so that every consumer wants to participate in the transaction when the product fits their situations.

The profit functions for retailers 1 and 2 are,

$$\begin{aligned}\pi^1 &= m\cdot[\alpha+(1-\alpha)(\Delta p-\underline{t})]\cdot(p_1-c),\\ \pi^2 &= m\cdot(1-\alpha)\cdot[\bar{t}-\Delta p]\cdot(p_2-c),-k\cdot(1-\alpha).\end{aligned} \tag{5}$$

From the first order condition,

$$\tfrac{\partial\pi^1}{\partial p_1}=\alpha+(1-\alpha)[p_2-2p_1+c-\underline{t}]=0,\ \tfrac{\partial\pi^2}{\partial p_2}=\bar{t}-2p_2+p_1+c=0,$$

$$\therefore p_1=\frac{p_2+c-\underline{t}}{2}+\frac{\alpha}{2(1-\alpha)},\quad p_2=\frac{\bar{t}+p_1+c}{2}.$$

Hence, we get the following equilibrium prices,

$$\begin{aligned}p_1{*} &= \frac{2\alpha}{3(1-\alpha)}+c+\frac{(\bar{t}-2\underline{t})}{3},\\ p_2{*} &= \frac{\alpha}{3(1-\alpha)}+c+\frac{(2\bar{t}-\underline{t})}{3}.\end{aligned} \tag{6}$$

Also, $\Delta p=\frac{(\bar{t}+\underline{t})}{3}-\frac{\alpha}{3(1-\alpha)}$, and $mp_2\le p_1$ for $\forall m\le m{*}$, where $m{*}=\frac{\alpha+3(1-\alpha)c+(1-\alpha)(1-\underline{t})}{\alpha+3(1-\alpha)c+(1-\alpha)(2+\underline{t})}$.

The following equilibrium profits for both retailers are

$$\begin{aligned}\pi_1{*} &= \frac{m}{1-\alpha}\cdot\left[\alpha\cdot\frac{2}{3}+(1-\alpha)\cdot\left(\frac{\bar{t}-2\underline{t}}{3}\right)\right]^2,\\ \pi_2{*} &= \frac{m}{1-\alpha}\cdot\left[\alpha\cdot\frac{1}{3}+(1-\alpha)\cdot\left(\frac{2\bar{t}-\underline{t}}{3}\right)\right]^2-k\cdot(1-\alpha).\end{aligned} \tag{7}$$

Consider the (IR) constraint of the retailer 2.

$$\frac{m}{1-\alpha}\left[\alpha\cdot\frac{1}{3}+(1-\alpha)\cdot\left(\frac{2\bar{t}-\underline{t}}{3}\right)\right]^2-k(1-\alpha)\geq 0 \Leftrightarrow \left[\alpha\cdot\frac{1}{3}+(1-\alpha)\cdot\left(\frac{2\bar{t}-\underline{t}}{3}\right)\right]^2\geq k\frac{(1-\alpha)^2}{m} \quad (8)$$

$$\Leftrightarrow \frac{m\cdot\left[\alpha+(1-\alpha)\cdot(2\bar{t}-\underline{t})\right]^2}{9(1-\alpha)^2}\geq k$$

Let $k^{IR}=\dfrac{m\cdot\left[\alpha+(1-\alpha)\cdot(2\bar{t}-\underline{t})\right]^2}{9(1-\alpha)^2}$, then retailer 2 also gets positive profits as long as the selling cost is less than $k\leq k^{IR}$.

Also, note that by Assumption 2, it follows that $p_i > c$ for all α and thus, the (IR) constraint of the retailer 1 is satisfied.

Before I derive the equilibrium condition, it is important to show that there is no hold-up problem such that retailer 2, who promised to offer a sales service, does not offer sales service and hold up uninformed customers under this equilibrium strategy. This hold-up strategy is particularly tempting in two ways. First, it enables the retailer 2 to save the selling costs. Second, it could actually increase the demand by $1-m$ since customers who realize that a product is not a good match would have decided not to buy now can have a positive expected utility and purchase.

Proposition 1 (No service hold-up).

Suppose that $\dfrac{1}{5(1-\alpha)}<\bar{t}$.

If the matching probability m is sufficiently low $m<\frac{1}{v}\left(\frac{\alpha}{3(1-\alpha)}+c+\frac{(2\bar{t}-\underline{t})}{3}\right)$*), then, the retailer 2 will not hold up consumers who already incur their shopping costs by not offering any service.*

Proof. See Appendix.

When the matching probability is sufficiently low, all the customers who visit the retailer 2 now find that it is better not to purchase a product when they cannot resolve the matching uncertainty. The condition $\frac{1}{5(1-\alpha)} < \bar{t}$ guarantees the existence of such a low matching probability which satisfies the Assumption 3 at the same time (so that all the informed customers still find it better to purchase a product)

Now, we need to check that any deviation strategy is not profitable for retailers. First, we check that retailers do not deviate by charging higher price so that any of consumers may choose not to purchase. Second, we check that neither retailer would want to deviate by having a strictly lower price than the competitor (non-local deviation). Hence, the following equilibrium conditions must be satisfied.

$$\pi_1^* \geq \pi_1^d = \max_p \pi_1(p \mid p \leq p_2^* - \bar{t}) \qquad (IC-1)$$

$$\pi_2^* \geq \pi_2^d = \max_p \pi_2(p \mid p \leq p_1^*) \qquad (IC-H)$$

This implies that the retailers must not want to capture the entire two markets at the same time. Note that small deviations in a neighborhood of p_i^* are always dominated by p_i^* from the first order condition – the only possible deviation is non-local deviation by the significant change of demand due to the reverse of the order of two prices. In the following proposition, we formally state the equilibrium condition for free-riding pricing game.

Proposition 2 (Free-riding pricing game equilibrium).

Suppose that $k \leq k^{IR}$, $\frac{1}{5(1-\alpha)} < \bar{t}$. If the matching probability is sufficiently small (small m), and if there exist non-zero portion of uninformed consumers ($\alpha < 1$), there exists a *unique pure-strategy Nash equilibrium to the free-riding pricing game in which both retailers charge prices, p_1*, p_2*. The retailer 1's profit is π_1* and retailer 2's profit is π_2*.*

Proof. See Appendix.

The proof in the appendix verifies that several possible including the possible non-local deviation do not increase a firm's profits. In particular, Lemma A in the Appendix shows that competition between two retailers makes it unprofitable to charge a price high enough that some customers decide not to buy. In that case, customers always switch to the other competitor (the competitor has the incentive to attract them) and, therefore, a retailer's ability to charge a high price or hold up is limited.

The most interesting, and plausible case is the no-local deviation. The intuition behind the proposition is that when the retailer 1 tries to steal uninformed consumers from the retailer 2, the retailer 1 must lower its price sufficiently large enough so that even the highest shopping cost customer can be compensated for her switching cost (additional shopping costs, $\bar{t} = \underline{t} + 1$). Otherwise, retailer 1 would have charged the equilibrium price. However, when there are sufficiently large number of informed consumers (large α), the retailer 1's gains from the increased demand ($\bar{t} - \Delta p$) is more than offset by the loss from the reduced unit-price for the informed consumers ($p_1 * - p_1^d = \frac{\alpha}{3(1-\alpha)} + \frac{2\bar{t}-\underline{t}}{3}$, see Appendix). As shown in Figure 2, area A is the increased demand by deviation. Moreover, this demand increase is a probabilistic even (area $A \times m$)

while the cost for reduced price is a sure sacrifice. Hence, it is not profitable for retailer 1 to deviate especially when α is large.

••• **Figure 2** •••

The retailer 2 also must reduce its price lower than the equilibrium price level of retailer 1 if the retailer 2 deviates. Otherwise, retailer 2 would have charged the equilibrium price (again, remember that the only possible deviation is non-local deviation). Note that $p_2^d = p_1*$ (see Appendix), which implies that the retailer 2 has to sacrifice profit margin by $\Delta p\,(= p_1* - p_2^d)$.

On the one hand, it can draw more people than in equilibrium (area B+C in Figure 3). Hence, it may increase the sales of a product (matching case: $m\times$Area (B+C)). On the other hand, this draws some unwanted people from whom the retailer has to incur unintended extra selling costs by serving them without earning a profit (no match case: area $(B+C)\times(1-m)$). Hence, if a matching probability is low (low m), the increased demand from the reduced price becomes very marginal. This is so because the cost for increasing the demand is a sure sacrifice of its profit margin while the effect of this cost is a probabilistic event. Hence, it is not profitable for the retailer 2 to deviate especially when m is small.

••• **Figure 3** •••

3. 2. Benchmark models

We will compare the result of the above section with a benchmark scenario in order to illustrate the role of free-riding. The benchmark case that we will consider is that only one retailer provides a service but free-riding is prohibited by not allowing consumers to visit a different store at stage 2 (hence, service and product is not separable).

The assumption that consumers can not switch a store after they visit one store is a device to rule out free-riding situation under duopoly competition. This will demonstrate the pure impact of free-riding. In practice, some retailers provide a service only after the actual purchase occurs in order to bundle their service with the actual product sales, for example, by sending their mechanics to the customer's house to set up their customized audio system.

We summarize the order of decisions made in the benchmark model in Figure 4.

••• Figure 4 •••

Before we actually calculate a consumer's strategy, we need to note an important property of retailers' prices.

Lemma 1. *In equilibrium,* p_1, p_2 *must satisfy the following relationship such that*

$mp_2 \le p_1 \le p_2$.

Proof. See Appendix.

Using this lemma, let us now analyze the game. At stage 0, retailers charge prices and consumers know these prices. Like free-riding pricing game, consumers decide whether to visit the store and which to visit at stage 1.

First, all informed consumers (α) who find a good match with a product (*m*) visit the store 1 (assume that v is sufficiently large so that all consumers get positive utility, i.e., $v - p_1 \geq \bar{t}$). The number of consumers who visit the store 1 is,

$$\begin{cases} \alpha m & \text{if} \quad p_1 \leq v - \bar{t}, \\ \alpha m(v - p_1 - \underline{t}) & \text{if} \quad p_1 > v - \bar{t}. \end{cases} \tag{9}$$

On the other hand, uninformed consumers ($1-\alpha$) always find it better to visit the store 2 because of Lemma 1. This is so because $mp_2 \leq p_1$ implies that $EU_1 = m \cdot v - p_1 - t \leq EU_2 = m \cdot (v - p_2) - t$. Therefore, consumers visit the store 2 *if and only if* their expected utility from visiting store 2 is bigger than zero.

$$EU_2 = (1-m) \cdot (-t) + m \cdot (v - p - t) \geq 0 \Leftrightarrow t \leq m(v-p).$$

Hence, uninformed consumers who visit the store 2 is,

$$(1-\alpha) \cdot \{m(v - p_2) - \underline{t}\} \tag{10}$$

(assume that *m* is sufficiently low such that $m(v - p_2) - \bar{t} \leq 0$).

At stage 2, consumers decide whether to buy or not. All informed consumers who visit the store purchase while uninformed consumers purchase only if it is a good match. Therefore, the profit functions for each store are,

$$\pi_1 = \begin{cases} \alpha m(p_1 - c), & \text{if} \quad p_1 \leq v - \bar{t} \\ \alpha m\{v - p_1 - \underline{t}\}(p_1 - c), & \text{if} \quad p_1 > v - \bar{t} \end{cases} \tag{11}$$

$$\pi_2 = (1-\alpha)\{m(v - p_2) - \underline{t}\}] \cdot (p_2 - c - k).$$

$$\text{s.t.} \ mp_2 \leq p_1 \leq p_2.$$

First, suppose that $p_1 > v-\bar{t},$ then from the first order condition p_1 is $\frac{v-t+c}{2}$, which implies that $2\bar{t}-\underline{t} > v-c$ (since $\frac{v-t+c}{2} > v-\bar{t}$). However, Assumption 3 implies that v is sufficiently large such that $2\bar{t}-\underline{t}+c < v$. Hence, p_1 must be $p_1 \le v-\bar{t}$.

Furthermore, it is easy to show that $v-\bar{t} \ge \frac{v+c+k}{2m} - \frac{t}{2m}$ under Assumption 3.

Hence, we get the following optimizing prices and profits,

$$p_1^{NF} = p_2^{NF} = \frac{v+c+k}{2} - \frac{\underline{t}}{2m}. \tag{12}$$

$$\begin{aligned} \pi_1^{NF} &= \alpha m\left(\frac{v-c+k}{2} - \frac{\underline{t}}{2m}\right), \\ \pi_2^{NF} &= \frac{(1-\alpha)}{4m}\{m(v-c-k)-\underline{t}\}^2. \end{aligned} \tag{13}$$

However, this does not constitute equilibrium. Unlike the case of free-riding pricing game, retailer 2 always find it profitable to lower its price slightly below p_1^{NF}, which increase its profits by stealing all the informed consumers' demand without sacrificing much. Also, the retailer 1 can increase its profits by lowering its price slightly by ε. Hence, we have Bertrand competition results that $p_1 = k+c-\varepsilon,\ p_2 = k+c,$ which satisfies that Lemma 1.

Proposition 3. *In equilibrium of no-free-riding game, retailers charge $p_1 = p_2 = c+k,$ and get to Bertrand competition result in which retailer 2 get zero profit.*

The proposition suggests an important point that the benefit of differentiation comes not from simply providing service but from allowing free-riding of consumers. It is well known result that differentiation is a way to avoid self-destructive Bertrand competition.

Also, service-providing is a source of store differentiation in spite of its potential costs of free-riding (Strauss 2001; Wu et. Al. 2004). The above result together with Proposition 1 suggests that the benefit from service differentiation cannot be fulfilled without free-riding.

The intuition behind this interesting result (the retailers can be better off not because of differentiation but because of free-riding) is that by allowing free-riding, retailer 2 induces a softer action from its competitor who now enjoy free-riding. The retailer 1 (free-rider) has less incentive to compete with the retailer 2 in price to attract more consumers because many consumers will eventually switch to them due to free-riding. This induced soft strategic response enables the retailer 2 to charge a higher price than its cost and enjoy the strictly positive profits which otherwise would have been wiped away by the head to head price competition. Therefore, allowing free-riding can be regarded as a strategic investment which prevents an aggressive response from the other retailer.

3. 3. Who is going to provide a service?

The model does not predict which of the two identical retailers provides a costly sales service. However, if firms enter the market sequentially, the first entrant (say firm 1) would decide whether to offer or not, fully anticipating the effect of its service choice on the follower (say firm 2). If the firm 1 would choose to offer a service, then the firm 2 would find taking the role of free rider more profitable than taking the role of another service provider, and vice versa. The logic is that the firm 2 always wants to position itself such that it can differentiate itself from the firm 1 in order to avoid the undifferentiated head to head price competition. Thus, both firms benefit from differentiation. This result is formally stated in the following proposition.

Proposition 4. *The firm 1 who enter the market first would choose to provide a service and the firm 2 would choose not to, if the selling cost is sufficiently small such that*

$$k \le k^*, \text{ where } k^* = \frac{m \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2}.$$

Otherwise, the firm 1 would not provide a service and the firm 2 would provide a service.

Proof. See Appendix.

It is easy to show that the participation constraint for a service providing retailer is satisfied, $k^{IR} \ge k^*$, because

$$\frac{m\left[(1-\alpha) \cdot (2\bar{t} - \underline{t}) + \alpha \right]^2}{9(1-\alpha)^2} \ge \frac{m\left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2} \Leftrightarrow \left((1-\alpha) \cdot \bar{t} + 1 \right)^2 \ge \left(2(1-\alpha)\bar{t} - 1 \right)$$

for all $\alpha \in [0,1]$ and $\bar{t} > 1$ ($\bar{t} = 1 + \underline{t}$).

The proposition suggests that the firm 1 chooses its store style depending on the level of selling cost (cost for providing service). One important implication of this result is that a retailer sometimes offers a service even if it fully recognizes the potential costs of free-riding by the competitor because the retailer is still better off incurring the selling costs for all consumers who may or may not purchase than being a free-rider. In other word, $\pi_2^* \ge \pi_1^*$ when $k \le k^*$ where $k^* = \frac{m \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2}$.

Moreover, the threshold level of selling cost (k^*) increases as the average consumer shopping cost increases ($\frac{\partial k^*}{\partial (\bar{t} + \underline{t})} > 0$). However, the threshold level only increases with respect to he matching probability (m) and the size of the informed consumers (α), only if the average consumer shopping cost is relatively large or there are many uninformed consumers in the market ($(1+\bar{t}+\underline{t})\cdot(1-\alpha)\geq 2$).

Corollary 1.

The threshold level of selling cost (k^*) monotonically increases,

$$\frac{\partial k^*}{\partial(\tilde{t})}>0, \qquad \text{for all } \tilde{t}>0, \qquad \text{where } \tilde{t}=\tfrac{\bar{t}+\underline{t}}{2}.$$

Also, it has a different sign w.r.t. the size of the informed consumers (α), and the matching probability depending on the range of $(1+\bar{t}+\underline{t})(1-\alpha)$,

$$\frac{\partial k^*}{\partial \alpha}>0, \quad \frac{\partial k^*}{\partial m}>0, \quad \textit{if} \quad (1+\bar{t}+\underline{t})(1-\alpha)\geq 2,$$

$$\frac{\partial k^*}{\partial \alpha}<0, \quad \frac{\partial k^*}{\partial m}>0, \quad \textit{if} \quad 1\leq(1+\bar{t}+\underline{t})(1-\alpha)<2,$$

$$\frac{\partial k^*}{\partial \alpha}<0, \quad \frac{\partial k^*}{\partial m}<0, \quad \textit{if} \quad (1+\bar{t}+\underline{t})(1-\alpha)<1.$$

This Corollary suggests that when the market condition is such that $(1+\bar{t}+\underline{t})\cdot(1-\alpha)\geq 2$, the firm 1 tends to offer a service if a product is standardized product which appeals to the largest number of customers (high m) or the product is well known to consumers (the size of informed consumers is large: large α). The intuition is that the service providing retailer can benefit from the increased demand of consumers from the increased matching probability, when the market condition is favorable for the service provider because of the high average shopping cost of consumers. It appears counter-intuitive that large α benefit the service providing retailer. The reason is that the market condition ($(1+\bar{t}+\underline{t})\cdot(1-\alpha)\geq 2$) imposes a restriction on the average shopping cost such that it must also get larger as α gets large. Hence, as long as the condition holds, the increased α implies the increased average shopping cost and, thus the former argument applies here.

On the other hand, when market condition is different, for example, $(1+\bar{t}+\underline{t})\cdot(1-\alpha)<1$, the firm 1 tends to offer a service if a product is a specialized product targeting the niche market (small *m*) or the product is quite new product (small α).

4. Conclusion

Free-riding can occur when all the pre-sales activities needed to sell a product can be conducted separately from the actual sale of the product itself. In those circumstances, revenues from the sale of the product have to cover the selling costs of providing this sale and service effort. Retailers that do not provide such sales service find themselves in a lower cost position from retailers that have to incur selling costs of providing the ancillary services. Selling costs are costs that a retailer incurs to serve a consumer who may or may not purchase a product. An important feature of selling costs is that they are a function of the number of consumers who visit the store, including consumers who free-ride off their service. These selling costs together with free-riding, therefore, may eliminate retailer's incentive to provide sales service. However, many free service providing retailers still exists despite the free riding problem and high selling costs.

Intuitively, we expect that retailers' free-riding off each other would harm retailers who provide those services. In a sense, free-riding is analogous to a theft of services. Consumer uses one retailer's resources, but all the revenues accrue to the retailer that makes the actual sale. As a consequence, it is difficult to see how the retailer providing services could benefit from free-riding. Nonetheless, we find that the retailer providing services does benefit from free-riding. The intuition is that allowing free-riding makes the competitor much softer in reaction to its pricing strategy. This induced soft strategic response enables the service provider to charge a higher price than its cost and enjoy the strictly positive profits which otherwise would have been wiped away by the head to head price competition.

There are many examples of potential free-riding situation besides sales assistance in the store. For example, suppose one retailer heavily advertises a particular product that is also carried by another retailer. The first retailer may create a demand for the product that benefits both retailers, but the second retailer incurs no costs for attracting consumers. A more subtle form of free-riding involves certification (Strauss 2002). For example, certain department stores (e.g., Saks Fifth Avenue, Barney's New York) are viewed as fashion trend setters. They achieved this reputation by investing in highly qualified buyers and developing purchase operations that select high quality, trendy items. Only the larges, most prestigious department store chains invest in sending their employees to Europe to view the current fashion shows. Competing retailers that carry the same items stocked by a "certifying" fashion store can reap a benefit without incurring a comparable cost.

Furthermore, as consumers increasingly purchase products from their home through online retailers, consumers' ability to judge the quality of products they buy is significantly reduced. In such environments, free-riding problem becomes substantive issue of traditional brick and mortar stores.

One possible extension that we have not done, but can be easily conducted is to look at the asymmetric shopping cost situation. By setting the shopping cost for visiting one retailer lower than the cost for visiting the other, we can gain further insight of the real world situation. In particular, it seems that the shopping cost is always low for online retailers. When two retailers have different shopping costs, the above results need further exploration. This will shed light on the issue of channel conflicts between offline and online channels.

Appendix

Proposition 1 (No service hold-up).

Suppose that $\frac{1}{5(1-\alpha)} < \bar{t}$. *If the matching probability m is sufficiently low* $m < \frac{1}{v}\left(\frac{\alpha}{3(1-\alpha)} + c + \frac{(2\bar{t}-\underline{t})}{3}\right)$*), then, the retailer 2 will not hold up consumers who already incur their shopping costs by not offering any service.*

Proof. Suppose that the retailer 2 decides not to offer any service after uninformed customers visit the store in order to save the selling cost. Uninformed customers who visit the store then have an expected utility $mv - p_2$ from purchasing at the store 2. However, by condition $m < \frac{1}{v}\left(\frac{\alpha}{3(1-\alpha)} + c + \frac{(2\bar{t}-\underline{t})}{3}\right)$, the uninformed customers' expected utility is $mv - p_2 = mv - \left\{\frac{\alpha}{3(1-\alpha)} + c + \frac{(2\bar{t}-\underline{t})}{3}\right\} < 0$. Hence, no body decides to purchase. This condition, hence, prevents the retailer 2 from holding up customers' shopping costs by not offering any service.

Furthermore, $\frac{1}{5(1-\alpha)} < \bar{t}$ guarantees the existence of such a low matching probability which satisfies the Assumption 3 at the same time (so that all the informed customers still find it better to purchase a product). This is so because $\frac{2\alpha}{3(1-\alpha)} + c - \frac{2(2\bar{t}-\underline{t})}{3} \le mv$ (Assumption 3) $mv < \frac{\alpha}{3(1-\alpha)} + c + \frac{(2\bar{t}-\underline{t})}{3}$ (Proposition 1) can coexist if $\frac{2\alpha}{3(1-\alpha)} + c - \frac{2(2\bar{t}-\underline{t})}{3} < \frac{\alpha}{3(1-\alpha)} + c + \frac{(2\bar{t}-\underline{t})}{3}$ $\Leftrightarrow \frac{1}{(1-\alpha)} < 4\bar{t} + \underline{t}$. Using the fact that $\underline{t} + 1 = \bar{t}$, we get the result. **Q.E.D.**

Proposition 2 (Free-riding pricing game equilibrium).

When $k \leq k^{IR}$*, if the matching probability is sufficiently small (small m), and if there exist non-zero portion of uninformed consumers (*$\alpha < 1$*), there exists a unique pure-strategy Nash equilibrium to the free-riding pricing game in which both retailers charge prices,* $p_1{*}, p_2{*}$*. The retailer 1's profit is* $\pi_1{*}$ *and retailer 2's profit is* $\pi_2{*}$.

Proof. First, we show two lemmas. With these lemmas, we will complete the proof.

Lemma A. Retailers do not deviate by charging higher price so that any of consumers may choose not to purchase.

Proof. Retailer 1 charges p_1 such that only informed consumers with $t \leq v - p_1$ visit the store and the uninformed consumers with $t \leq \Delta p$ and $m(v - p_1 - t) - t \geq 0$ visit the store. There are two cases we need to consider

(i) Case 1: $\Delta p < \frac{m}{1+m}(v - p_1)$.

First, note that $\Delta p < \frac{m}{1+m}(v - p_1)$ implies that $p_2 - p_1 < m(v - p_2)$. In this case, there exists no free-riding consumer (since potential free-riding consumers find it is not worth while to visit the store itself). It is straightforward that

$p_1^d = \arg\max_p m[\alpha(v - p - \underline{t})] \cdot (p - c) = \frac{v - \underline{t} + c}{2}$, and

$p_2^d = \arg\max_p m[(1-\alpha)\{m(v - p) - \underline{t}\}] \cdot (p - c) = \frac{v + c}{2} - \frac{\underline{t}}{2m}$. Here the condition that $p_1 \leq p_2$ binds. Because of convexity of the profit function of retailer 1, he will always charge the corner solution as long as $p_2 < \frac{v - \underline{t} + c}{2}$. Then, we have a situation that

$v - p_1 - \bar{t} = \frac{v-c}{2} - \frac{\underline{t}+2m\bar{t}}{2m} > 0$ under Assumption 3. Hence, it contradicts (retailer 1 does not charge so high).

(ii) Case 2: $\Delta p \geq \frac{m}{1+m}(v - p_1)$.

The deviation pricing is straightforward from that

$p_1^d = \arg\max_p m[\alpha(v - p - \underline{t}) + (1-\alpha)\beta(v - p - \underline{t}] \cdot (p - c)$, and

$p_2^d = \arg\max_p m[(1-\alpha)\{\bar{t} - p + p_1^d\}] \cdot (p - c)$. where $\beta = \frac{m}{1+m}$, and $(1-\beta)p_1 + \beta v \leq p_2$ from the condition ($\Delta p \geq \frac{m}{1+m}(v - p_1)$). The optimizing price for the retailer 2 is $p_2{}' = \frac{\bar{t}+c}{2} + \frac{1}{2}p_1$. Also, this price must satisfy the following condition $p_2 > p_1 \Leftrightarrow \bar{t} + c > p_1$.

Hence, in this case ($\Delta p \geq \frac{m}{1+m}(v - p_1)$), again, the retailer 1 will not charge too high price since those price is always dominated by charging the price $\bar{t} + c > p_1$. Hence, it is not profitable for retailer 1 to deviate to charge a price much higher that any consumer decides not to buy. This, in turn, makes the retailer not to charge too high since the retailer 2 also gets better profit by charging $p_2{}' = \frac{\bar{t}+c}{2} + \frac{1}{2}p_1$. This proves that the deviation to charge higher price such that any consumer decides not to buy is not profitable. ■

And now, we verifies that the possible non-local deviation does not increase a firm's profits. Remember small deviation in a neighborhood of $p_1{}^*$ is always dominated by $p_1{}^*$ from the first order condition – the only possible deviation is non-local deviation from the significant change of demand due to the reverse of the order of two prices. Let $p_1^d = \arg\max_p \pi_1^d\left(p \middle| p \leq p_2{}^* - \bar{t}\right), p_2^d = \arg\max_p \pi_2^d(p \mid p \leq p_1{}^*)$ denote the price that retailer 1 and 2 will charge in deviation, respectively. From equation (5), we know that $\pi_1^d = m\cdot(p_1 - c)$, and $\pi_2^d = m\cdot(1-\alpha)\cdot(p_2 - c) - k$. Hence, the maximum profits can be obtained when both retailers choose the corner solution, $p_1^d = p_2 * -\bar{t}$, $p_2^d = p_1 *$. Plug them into the profit function, we get $\pi_1^d = m\cdot\left[\frac{\alpha}{3(1-\alpha)} - \frac{\bar{t}+\underline{t}}{3}\right]$, and

$$\pi_2^d = m\cdot\left[\frac{2\alpha}{3(1-\alpha)} + \frac{2\bar{t}-\underline{t}}{3}\right] - k.$$

First, look at (IC-1), $\pi_1^d = m\cdot\left[\frac{\alpha}{3(1-\alpha)} - \frac{\bar{t}+\underline{t}}{3}\right] \le \frac{m}{1-\alpha}\cdot\left[\alpha\cdot\frac{2}{3} + (1-\alpha)\cdot\left(\frac{\bar{t}-2\underline{t}}{3}\right)\right] = \pi_1 *$.

$$\Leftrightarrow \left[\frac{\alpha}{3(1-\alpha)} - \frac{(\bar{t}+\underline{t})}{3}\right] \le \frac{1}{1-\alpha}\cdot\left[\alpha\cdot\frac{2}{3} + (1-\alpha)\cdot\left(\frac{\bar{t}-2\underline{t}}{3}\right)\right]^2.$$

The inequality is always satisfied if $\frac{\alpha}{3(1-\alpha)} < \frac{(\bar{t}+\underline{t})}{3} = \frac{1+2\underline{t}}{3}$. For any $\underline{t} > 0$, we can always find $\bar{\alpha} < 1$ such that for all $\alpha \ge \bar{\alpha}$, $\frac{\alpha}{3(1-\alpha)} < \frac{(\bar{t}+\underline{t})}{3}$. Hence, (IC-1) satisfies (note that LHS<0, and RHS>0 for $\forall \alpha \in (0,1)$).

Second, let us now consider (IC-2).

$$\pi_2^d = m\cdot\left[\frac{2\alpha}{3(1-\alpha)} + \frac{2\bar{t}-\underline{t}}{3}\right] - k \le \pi_2 * = \frac{m}{1-\alpha}\cdot\left[\alpha\cdot\frac{1}{3} + (1-\alpha)\cdot\left(\frac{2\bar{t}-\underline{t}}{3}\right)\right]^2 - k\cdot(1-\alpha).$$

After a few algebras, the inequality can be rewritten as

$$\left[6\alpha + 3(\bar{t}-2\underline{t})(1-\alpha)\right] - \left\{\alpha + (1-\alpha)(2\bar{t}-\underline{t})\right\}^2 \le \frac{9\alpha(1-\alpha)k}{m}.$$

For any given $\alpha, \underline{t}$, and *k*, RHS is an decreasing in *m*. Therefore, we can always find $\bar{m} > 0$ such for $\forall m \le \bar{m}$, it is satisfied that

$$\left[6\alpha + 3(\bar{t}-2\underline{t})(1-\alpha)\right] - \left\{\alpha + (1-\alpha)(2\bar{t}-\underline{t})\right\}^2 \le \tfrac{9\alpha(1-\alpha)k}{m}.$$

In sum, for any $\underline{t} > 0, k > 0$, we can find α which satisfies (IC-1). Furthermore, for this α, we can also find corresponding m such that $m \le \min\{m^*, \overline{m}\}$, which make (IC-2) satisfied. Together with Lemma 1, this completes the proof. ***Q.E.D.***

Proposition 4. *The first entrant would choose to provide a service and the follower would choose not to, if the selling cost is sufficiently small such that*

$$k \le k^*, \;\; \text{where } k^* = \frac{m \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2}.$$

Otherwise, the first entrant would not provide a service and the follower would provide a service.

Proof. This is a direct result of comparison between two retailers' profits at equation (7).

$$\pi_2^* \ge \pi_1^* \Leftrightarrow \frac{m}{1-\alpha}\left[\alpha \cdot \frac{1}{3} + (1-\alpha) \cdot \left(\frac{2\bar{t} - \underline{t}}{3} \right) \right]^2 - k(1-\alpha) \ge \frac{m}{1-\alpha}\left[\alpha \cdot \frac{2}{3} + (1-\alpha) \cdot \left(\frac{\bar{t} - 2\underline{t}}{3} \right) \right]^2$$

$$\Leftrightarrow \frac{m}{9(1-\alpha)^2} \cdot \left[\alpha \cdot + (1-\alpha) \cdot \left(2\bar{t} - \underline{t} \right) \right]^2 - \frac{m}{9(1-\alpha)^2} \cdot \left[2\alpha + (1-\alpha) \cdot \left(\bar{t} - 2\underline{t} \right) \right]^2 \ge k$$

$$\Leftrightarrow 3 \cdot \left[(1-\alpha)\left(\bar{t} - \underline{t} \right) + \alpha \right] \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right] \ge \frac{9(1-\alpha)^2}{m} k$$

$$\Leftrightarrow \frac{m \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2} \ge k.$$

Let $k^* = \frac{m \cdot \left[(1-\alpha) \cdot \left(\bar{t} + \underline{t} \right) - \alpha \right]}{3(1-\alpha)^2}$, then $\frac{\partial k^*}{\partial \alpha} < 0$ for $\alpha < \frac{1}{2}$ since $\bar{t} + \underline{t} > 1$. ***Q.E.D.***

Lemma 1. *In equilibrium,* p_1, p_2 *must satisfy the following relationship such that* $mp_2 \le p_1 \le p_2$.

Proof. I show the $mp_2 \le p_1$ first. This is so because consumers decide their visiting decision based on their expected utility: $EU_1 = m \cdot v - p_1 - t, EU_2 = m \cdot (v - p_2) - t$. All uninformed consumers would visit the store 1 *if and only if* $m \cdot v - p_1 - t \ge m \cdot (v - p_2) - t \Leftrightarrow mp_2 \ge p_1$. This implies that if the condition that $mp_2 \le p_1$ does not hold, the retailer 2 does not have any demand. Hence, the retailer must charge low enough price such that $mp_2 \le p_1$.■

Next, I show that $p_1 \le p_2$. Suppose not ($p_1 > p_2$), all informed consumers will visit the store 2. The only possibility that retailer 1 can have non-zero demand is from uninformed consumers. However, uninformed consumers decide solely based on their expected utilities, and visiting the retailer 2 always gives a higher utility than visiting store 1 ($m \cdot v - p_1 - t \le m \cdot (v - p_2) - t \Leftrightarrow mp_2 \le p_1$). It directly follows that the retailer 1 does not have any demand. Hence, it must be that $p_1 \le p_2$.■

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Figure 1: Uninformed Customers' Decisions

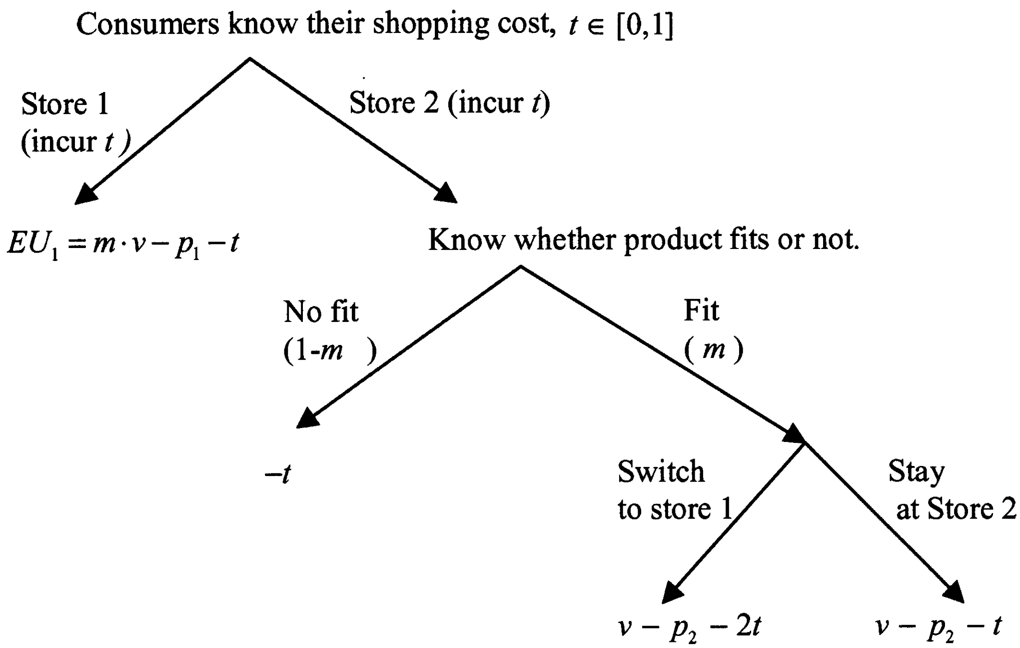
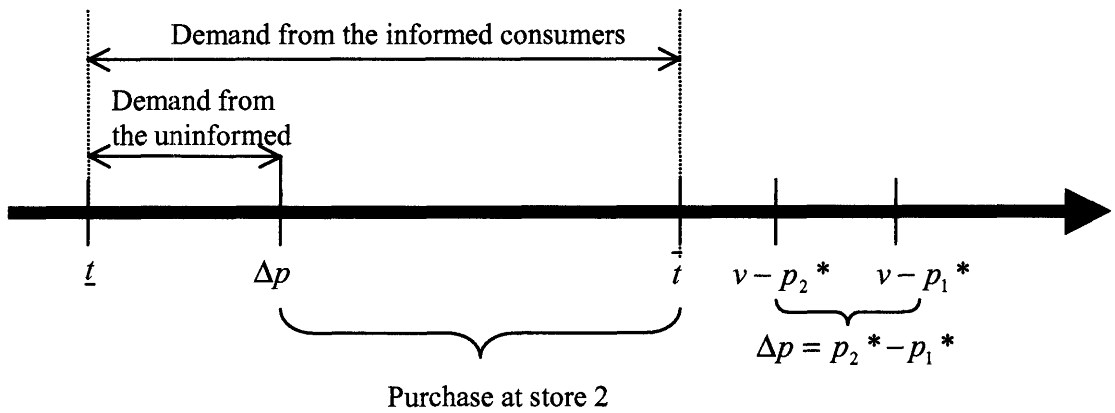


Figure 2. Demand for the retailer 1

(1) Equilibrium:



(2) Deviation:

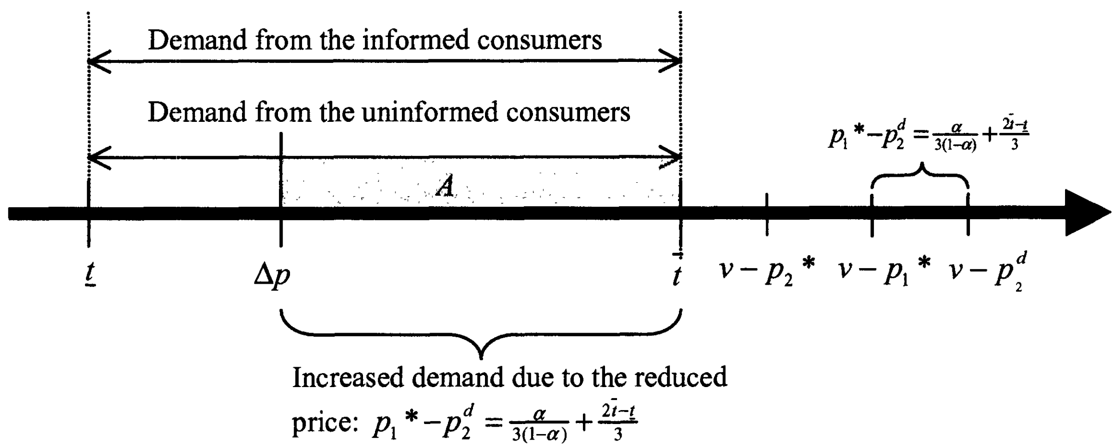
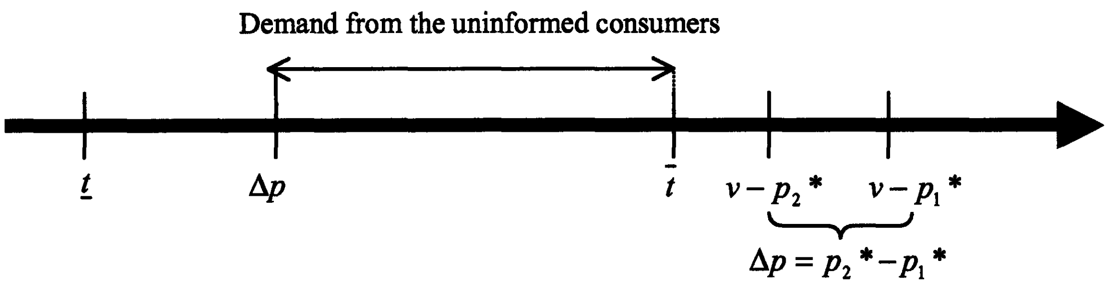


Figure 3. Demand for the retailer 2

(1) Equilibrium:



(2) Deviation:

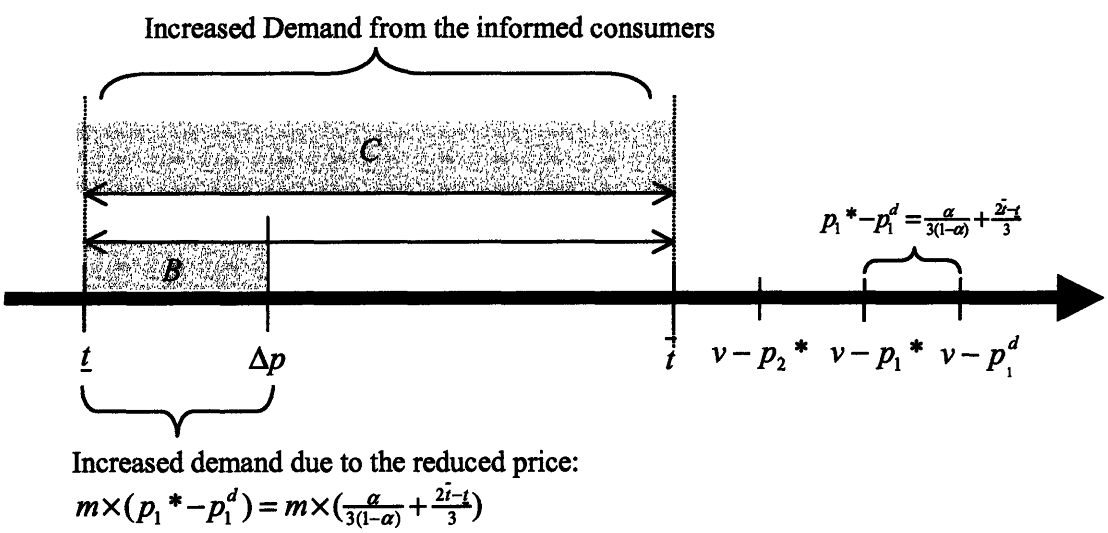
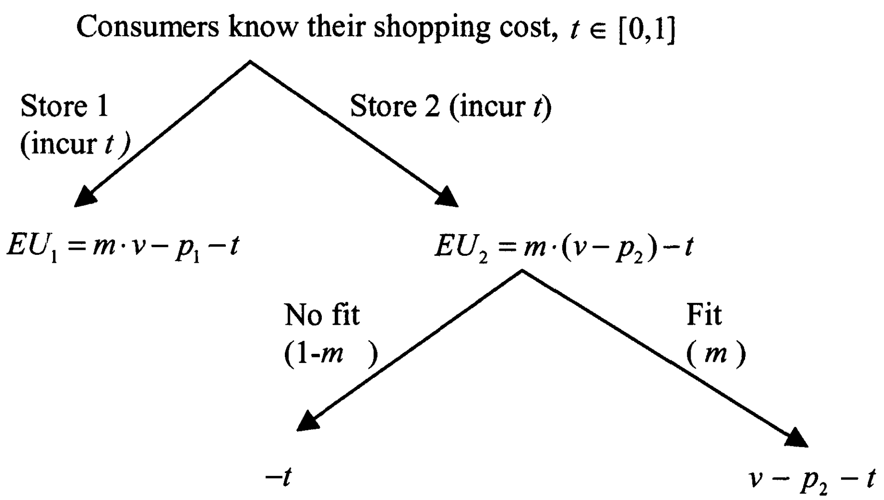


Figure 4: Customers' Decisions Tree (without free-riding)



Chapter 3:

Keeping Doors Open: The Effect of Unavailability on Incentives to Keep Options Viable

This paper is based on joint work with Dan Ariely.

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Keeping Doors Open:

The Effect of Unavailability on Incentives to Keep Options Viable

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Abstract

Many of the options available to decision makers, such as college majors and romantic partners, can become unavailable if sufficient effort is not invested in them (taking classes, sending flowers). The question asked in this work is whether a threat of disappearance changes the way such options are valued. In four experiments using "door games," we demonstrate that options that threaten to disappear cause decision makers to invest more effort and money in order to keep these options open, even when the options themselves seem to be of little interest. This general tendency is shown to be resilient to information about the outcomes, to increased experience, and to the saliency of the cost. The last experiment provides initial evidence that the mechanism underlying the tendency to keep doors open is a type of loss aversion rather than a desire for flexibility.

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1. Introduction

Imagine a student who is uncertain about whether he wants to become a computer programmer or a poet. If he wants to keep both options available, he has to keep taking classes in both majors. On the other hand, keeping both options open has its own cost. Double majoring implies that the student has to divide his time and effort, taking classes in both fields – leading him to become proficient in both, but an expert in neither. Along similar lines, consider a person pursuing two potential relationships. As long as our romantic decision maker spends sufficient time with each of her potential romantic partners, she can keep them both as viable future relationships. However, once she starts spending more time with one and neglecting the other, the neglected party is likely to move on and become unavailable. Given the possible loss of the second romantic option, our enthusiastic dater might try to spend at least some of her time with her less preferred partner, largely to maintain the viability of the relationship. However, much like the student in the above example, "keeping doors open" has its costs, drawing valuable time and energy away from the more promising relationship.

Double majoring and dating are just two examples of cases where one must invest extra time and effort in order to keep options available. The main questions asked here are whether the threat of future unavailability makes less desirable options seem more appealing and whether this causes individuals to over-invest in these options. In other words, do doors that threaten to close loom more attractive than doors that remain open? And if so, will individuals over-invest just to keep these doors open?

From a naive, rational perspective, one could expect that the value of an option (having the ability to make a choice) would be based solely on the expected utility of the outcomes it represents. From a psychological perspective, however, there are two primary reasons why the subjective value of an option can exceed its expected value: a desire for flexibility and loss aversion.

Initial evidence for the value of flexibility was proposed by Brehm (1956), who showed that people are willing to sacrifice consumption pleasure in order to increase freedom of choice (see also Simonson, 1990; Gilbert and Ebert, 2002). The desire for flexibility is not limited to humans, having been exhibited even in pigeons, which were willing to expend effort in order to have the flexibility of a future choice (Catania, 1975). Such preference for flexibility implies that individuals can get utility (pleasure) from simply "having the right to choose" (keeping options open) prior to making a final choice.

The evidence for loss-aversion dates back to Kahneman and Tversky (1979). The most relevant application of the loss aversion is the case of endowment effect (Kahneman, Knetsch, and Thaler, 1990; Kahneman, Knetsch, and Thaler, 1991; Bar-Hillel and Neter, 1996; Carmon and Ariely, 2000), showing that ownership, or even deliberation (Carmon, Wertenbroch, and Zeelenberg, 2003), can increase attachment and hence valuations. Earlier evidence for loss aversion was also provided in the context of risky choice, in particular the rejection of pair of mixed gamles (Markowitz, 1952; Williams, 1966). Although options for items are very different from the items themselves -- for example, the possibility of dating a person is a very different experience from actually dating that person -- and although it is not possible to own an option in the same way as to own an item, losing an option (opportunity loss) is closely related to the loss of an item. Namely, the loss of an option also implies the loss of the item. Based on this similarity in terms of loss and the large influence of loss on decision making (Tversky and Kahneman 1991), it can be argued that individuals will also experience loss aversion and a pseudo-endowment effect for options. Loss aversion implies that the utility that individuals get from simply "having the right to choose"(keeping options open) is not a utility, but rather disutility or pain that can accompany the loss of options.

In summary, the current work asks two questions: the first is whether the threat of unavailability increases the perceived value of an option. And if so, whether the higher valuation comes from a desire for flexibility or from loss aversion. The next four experiments were designed to provide initial answers to these questions.

2. The Experiments: General

Because all the experiments employ the same basic design, it is simpler to first describe the overall paradigm (the "game") and provide more details about specific differences as they pertain to the individual experiments. The general structure of the game involved a sequential search task (Camerer, 1995; Ratchford and Srinivasan, 1993; Zwick, Weg, and Rapoport, 2000), in which respondents are faced with multiple alternatives, each associated with a different payoff distribution. Respondents playing the game face a dilemma similar to many real life search tasks: they want to maximize their earnings by finding the best alternative (payoff in this game is based solely on performance), yet search is costly. Thus, respondents have to tradeoff the possible value of additional searching against its cost in order to determine their stopping rule (Saad and Russo, 1996).

As a metaphor for "keeping options open," we created a computer game with three doors to three rooms (for a schematic illustration of the game see Figure 1). One door was red, another blue, and the third, green. By clicking with the mouse on one of the doors (door-click) respondents opened that door and entered the room. Once in the room, respondents could either click in that room (room-click) or click on a door to a different room (door-click). Each room-click resulted in a payoff gain sampled randomly from that room's distribution, and each door-click transferred the respondent to that room (without a payoff). Respondents were given a click budget to use on door - and room-clicks as they wished. Once respondents used up all their clicks, the game was over and they were paid the sum of their door-click payoffs. Note that charging the respondent a click to switch rooms created switching cost. The total number of clicks was indicated clearly on the screen, both in terms of how many clicks the respondent had used and in terms of how many clicks they had left until the end of the experiment.

The main manipulation of interest was the relationship between the actions of the player and door availability (**option-availability**), which was varied on two levels: constant-availability and decreased-availability. In the **constant-availability** conditions, all three rooms remained as viable options throughout the experiment, irrespective of the action of the respondent. In the **decreased-availability** conditions, availability depended on the action of the respondent. Every time a respondent clicked either on a door or within a room, the doors to the <u>other</u> two rooms were reduced in size by 1/15 of their original width. A <u>single</u> door-click on a shrinking door revitalized it to its original size and the process continued. Once the size of a door reached 0, it was eliminated for the rest of the game. With this shrinking factor, an option (room) that was not clicked on within 15 clicks was eliminated and was no longer visible or available.[18]

In sum, at each point, our respondents had to decide whether to remain with their current choice or whether to continue searching while incurring switching costs. In addition, respondents in the decreased-availability condition also had to decide whether to invest in options that threaten to disappear in order to maintain their viability.

The analogy between the experimental game and the examples presented earlier should be clear. The three doors represent different academic or romantic options. In the decreased-availability conditions, the viability of an option is threatened when there is no investment in, or attention to, that option. Moreover, after a certain amount of neglect, options become unavailable, a state that is irreversible.

••• Figure 1 •••

3. Experiment 1: Effect of Decreased Availability

Experiment 1 was designed to determine whether the mere fact that options could become unavailable would influence decision makers' behavior. Our hypothesis was that the decreasing-availability condition would cause respondents to invest in keeping options viable. By providing an initial answer to the question, whether people switch rooms more often when there is a threat of disappearance, Experiment 1 will serve as a starting point for examining the possible motivation to invest in keeping options open.

[18] For a robustness test, we manipulated this visual saliency of the disappearance of the doors in a separate experiment. The results showed that there was no observable impact on player's actions, suggesting that the effect of availability was not due to the visual saliency that was used in our game.

Method

Respondents: One hundred and fifty-seven respondents were recruited by advertisements around campus and from within the computer lab where the experiment took place. The experiment lasted about 15 minutes. Respondents were randomly assigned to one of the two option-availability conditions (constant and decreased availability).

Design: The overall structure of the game was as described in the general description of the game. For this experiment, the expected value of each room-click was 3¢, but the three rooms were associated with three different distributions (Table 1). Door 1 was highly concentrated around mean 3 (normal with variance 0.64); door 2 was symmetric around the same mean, but much more diffused (normal with variance 2.25); and door 3 was highly skewed toward high numbers (chi square with 3 degrees of freedom). The payoff distributions across these three rooms ranged from -2¢ to 14¢, with the lower numbers being more frequent than the higher numbers (so that the mean value was 3¢). Respondents were given a total of 100 clicks in the experiment, which they could allocate as they saw fit between switching rooms (door-clicks) and getting payoffs within a room (room-clicks).

••• Table 1 •••

Procedure: Upon arrival to the lab, respondents were seated individually and given instructions for the game. All respondents received instructions that emphasized that their goal in the experiment was to make as much money as possible, and that the amount they made would be paid to them at the end of the experiment. In the decreased-availability condition, respondents were also given the description of the rules governing the shrinking, revitalizing, and disappearance of the doors. The instructions did not include any information about the different payoffs distributions of the three doors; respondents had to learn about the distributions while playing the game.

Results and Discussion

First, we compared how door-switching behavior varied across the two conditions. A comparison of the average number of room switches (door-clicks) revealed that switching was more likely to occur in the decreased-availability condition ($M = 16.70$) than in the constant-availability condition [$M = 7.47$; $t(156) = 7.82$, $p < 0.001$].

Next, we examined how the tendency to switch rooms in the two option-availability conditions changed as a function of the total number of clicks used ("click number"). Note that the click number is a measure of both the learning and the expected value of keeping options open, both reducing the motivation for switching. First, as the click number increase, respondents have more experience, better estimation of the distributions, and thus have a reduced need to explore the different options. Second, the expected benefit of exploring different options is reduced with the click number because the time horizon during which this information can be used is reduced. To analyze the effect of the click number, clicks were divided into 10 blocks of 10 clicks each. An overall 2 (option-availability) by 10 (block) ANOVA revealed a significant main effect for option-availability [$F(1, 1550) = 306.27$, $p < 0.0001$]; a significant main effect for block [$F(9, 1550) = 5.61$, $p < 0.0001$]; and a significant interaction effect between option-availability and block [$F(9, 1550) = 3.82$, $p = 0.0001$]. As can be seen in Figure 2, there was a decreased tendency to switch rooms later in the game. However, even in the last block of 10 clicks, more switching occurred in the decreased-availability condition (M = 1.27) than in the constant availability condition (M=0.75: $F(1, 155) = 8.23$, $p = 0.0047$). More importantly, there were interesting differences in how the tendency to open other doors changed as a function of block in the two conditions, as indicated by the interaction. In particular, while respondents in the constant-availability condition switched the most during the first block, respondents in the decreased-availability condition switched the most during the second block – which was the first time they encountered a threat of options elimination.

It is worth contrasting the behavior of our respondents to an optimal strategy benchmark, which in this experiment was to select a single room and remain there during the entire game, which would have earned the highest possible payoff due to the implicit opportunity cost of 3¢ for each room switch (door-click). Relative to this standard, the respondents in Experiment 1 gave up 11% of their profits as a consequence of switching rooms (Constant availability condition = 8%, Decreased availability condition = 14%), which occurred on the average of 12 times per respondent. Note that in this experiment, respondents had to discover the underlying payment distribution based on experience, and therefore, had to switch in order to learn about the doors, i.e., payoffs. Accordingly, the reduction in payment cannot be taken as evidence of any irrational behavior. Experiment 2 will more carefully examine normative expected behavior in such cases·

In summary, experiment 1 showed a main effect for option-availability. Decision makers' interests in alternative options seemed to increase when they were threatened by their unavailability. In order to generalize the results to cases where the distributions do not have the same expected value, we conducted another experiment (N=35), in which the three distributions were normal with variance of 1.25 and means of 2.5, 3, and 3.5. Replicating the results of Experiment 1, respondents in the decreased-availability condition switched significantly more ($M = 10.13$) than respondents in the constant-availability condition [$M = 4.26$, $t(33) = 3.17$, $p < 0.001$]. Together, these results suggest that the mere fact that options could have been lost promotes more frequent room-switches.

This was done to test whether respondents in Experiment 1 might have expended efforts to keep all options open simply because they had no clear reason to keep one and discard the others (Kahneman, Knetsch and Thaler, 1991; Shafir, Simonson, and Tversky, 1993; Inman and Zeelenberg, 2002). In this new experiment, where all options were not equal, respondents could more easily find a reason to make decisions, and thus could justify less switching than in Experiment 1, where all options were created equal and, therefore, it was difficult to find a reason to make decisions.

••• Figure 2 •••

4. Experiment 2: Effects of Knowledge on the Desire to Keep Doors Open

Although the results of Experiment 1 suggest that our respondents were willing to invest to keep their options open, it remains unclear as to whether this investment can be classified as an over-investment. It is possible, for example, that in the face of uncertainty, the optimal strategy is to keep options open until sufficient information about distribution accumulates. Experiment 2 manipulates the level of knowledge respondents have about the distributions, the logic being that if the reason for keeping options available is lack of knowledge, providing respondents with more information about payoff distributions should eliminate, or at least substantially decrease, the difference in switching between the decreased- and constant- availability conditions. On the other hand, if the tendency to keep options open was caused by mechanisms such as preference for flexibility or loss aversion, providing additional information should not influence the effects of option-availability on room switching.

Method

Respondents: One hundred and five respondents were recruited by advertisements around campus and from within the computer lab where the experiment took palace. Respondents were randomly assigned to one of the six conditions.

Design and Procedure: The main manipulation in Experiment 2 was a manipulation of **information**, which was varied on three levels: **no-prior-information, practice-information**, and **descriptive-information,** which was crossed with the manipulation of option availability. The distributions of the three rooms had the same mean value of 6¢ (Table 1), and respondents were allocated 50 clicks rather than 100 clicks as their clicking budget. The no-prior-information conditions were a basic replication of Experiment 1. In these two conditions (constant and decreased availability), respondents did not get any prior information about the distributions. They were simply given the opportunity to play the game. In the practice-information condition, respondents played the same game twice, first for 50 practice trials without getting paid, and then for 50 real trials. Respondents were clearly informed that the distributions associated with each room were the same in the practice and real parts, thus increasing their knowledge about these distributions for the real part of the experiment (the part for which they got paid). Respondents in the descriptive-information condition were told that the averages of the distributions of all three rooms were identical. They were also shown a graph in which the means, skewnesses, and variance of each distribution were depicted. Although the respondents in the descriptive-information condition knew the three distributions, they did not know which room corresponded to which distribution. Thus, if they were not satisfied with the equal expected value across the three rooms, they could have searched the three rooms for their preferred distribution.

Results and Discussion

As in Experiment 1, the main dependent measure was the frequency of room switches across the different conditions, analyzed in a 2 (option-availability) by 3 (information) between subjects ANOVA. The overall ANOVA (Figure 3a) revealed a main effect for option-availability [$F(1, 99) = 56.66$, $p < 0.001$], replicating the main results of Experiment 1. The overall ANOVA also revealed an effect for information [$F(2, 99) = 6.99$, $p < 0.001$], showing that the no-prior-information conditions induced more switching than did the other two conditions [$F(1,101) = 12.78$, $p < 0.001$], which were not different from each other [$F(1,61) = 1.85$, $p = 0.18$]. Finally, the analysis showed a non-significant interaction between option-availability and information [$F(2, 99) = 1.32$, $p = 0.27$], demonstrating that the addition of information did not change the effect of option-availability on switching behavior, i.e., respondents with no prior information about the distributions exhibited the same reaction to the threat of disappearance as respondents who had more information (either descriptive or practice) about these distributions.

While these results demonstrate that additional information does not reduce the effect of option availability, they do not rule out rational explanations for the observed effect. For example, had respondents needed 15 clicks per room to learn its payoff distribution, respondents in the decreased-availability conditions would have had to switch rooms at least 6 times, while respondents in the constant-availability conditions would have had to switch only twice. In order to examine more carefully such possible explanations, we constructed three other measures: **pecking, elimination point**, and **click investment**.

First, we examined "**pecking,**" the number of times that respondents switched to another room, clicked in that room once, and switched back. The result remains the same if we define pecking as switching to another room and switching back without clicking inside the room, or as a combined measure. From the perspective of gaining information about the payoffs, we could consider such pecking behavior as an irrational over-investment in keeping options open because it provides little information (one more sample) at a high cost (3 clicks – one for switching away, one for sampling the payoffs, and one for switching back). ANOVA analysis revealed that pecking behavior was more frequent in the decreased-availability condition ($M = 0.36$) than in the constant-availability condition [$M = 0.07$; $F(1, 99) = 5.97$, $p = 0.016$], suggesting that in the face of a threat that options could become unavailable, respondents showed "irrational" behavior more often. More importantly, the effect of information on pecking was not significant [$F(2, 99) = 0.682$, $p = 0.508$], nor was the interaction between option-availability and information [$F(2, 99) = 0.435$, $p = 0.649$], suggesting that the different amounts of information had no effect on respondents' over-investment in keeping options open.

In a second attempt to examine the irrational aspect of keeping doors open, the number of clicks from the start of the experiment in which each respondent stopped visiting **each** of the three rooms was computed and compared across the different conditions. For each respondent, the smallest number of the three was the first time he/she eliminated a door from his/her consideration – which we termed the **elimination point**. We reasoned that the comparison of this elimination point could demonstrate the amount of investment in learning across different conditions. If respondents over-invested in options in order to keep them, then their elimination point would be higher. An overall ANOVA (Figure 3b) revealed a main effect for option-availability [$F(1, 99) = 44.67$, $p < 0.001$]; a non significant effect for information [$F(2, 99) = 0.322$, $p = 0.725$]; and a significant interaction effect between option-availability and information [$F(2, 99) = 4.76$, $p = 0.011$]. These results indicate that although respondents felt they did not need to revisit their least preferred room relatively early in the process (as indicated by the elimination-point in the constant-availability condition: M = 9.8), they kept the least preferred option viable for longer in the decreased-availability condition (M = 27.14). Moreover, the practice-information condition showed that the addition of practice-information actually increased the difference between the constant-availability and decreased-availability conditions as the interaction suggested (Figure 3b).

The third attempt to examine the irrational aspect of keeping doors open used the behavior of respondents in the constant-availability condition to create a normative standard from which to evaluate the behavior of the decreased-availability condition. This analysis assumes that clicks that took place early in the process are best viewed as an investment of search costs in order to accumulate enough information[19] to determine which door to stay in. Based on this idea, we computed **"click investment,"** which is the number of clicks participants invested before they settle down in one of three doors. This measure captures the amount of information that respondents felt they need in order to determine which option to pursue. This analysis is particularly useful as a test of whether the increased number of switching in the decreased-availability condition was due to rational information search, as illustrated in the example with 6 and 2 switches above. The overall ANOVA revealed a main effect for option availability [$F(1, 99) = 64.99$, $p<0.001$], showing that the decreasing-availability leads the higher click investment in options ($M = 10.07$), compared with the constant-availability condition ($M = 4.49$). Moreover, the results also showed a non-significant effect of information [$F(2, 99) = 0.33$, $p = 0.72$], suggesting that respondents over-invest in information search in the face of the possibility that the option would become unavailable, irrespective of their informational state. These results are also in accord with the results of the later trials in Experiment 1 (Figure 2), showing that even when participants had more information (in the last block of 10 clicks), the effect of option-availability was still pronounced.

In summary, the results of Experiment 2 replicated Experiment 1 by showing that decreased-availability increases the tendency to invest in keeping options open. More

[19] What kind of information people need depends on individual preference. For some, the mean might be sufficient, while others might need more information about the distribution.

importantly, Experiment 2 demonstrates that this effect could not simply be attributed to information. Providing respondents with more experience (in the practice-information condition) or telling them explicitly about the distributions (in the descriptive-information condition) decreased overall switching behavior, but it did not change the effect of decreased-availability on switching (the difference between the two option-availability conditions). Combined with the results of Experiment 1, these findings suggest that there is an inherent tendency to keep options open, even when doing so is costly. Experiment 2 also provides initial evidence that people are overzealous in their preference for keeping options open beyond the level that could be attributed to investment in learning (based on the analyses of pecking, elimination point, and click investment).

••• Figure 3 •••

5. Experiment 3: Effects of Cost Saliency on the Desire to Keep Options Open

Experiments 1 and 2 both demonstrated that the threat of option-disappearance causes decision makers to sacrifice payoffs in order to keep options viable. Moreover, Experiment 2 showed that this tendency remained even when it became more apparent that keeping these options open had no expected value (such as in the descriptive-information condition). It is possible, however, that while respondents understood that keeping options available had little value, they nonetheless did so because they did not understand the costs of keeping these options available. Specifically, the cost in

Experiments 1 and 2 was implemented as an opportunity cost, losing a click every time respondents switched to a different room. While we carefully explained to the respondents that they lost a click for every door-click, and presented them with an updated click-counter after every click, opportunity costs might have been less heavily weighted compared with out-of-pocket explicit costs (Thaler, 1980). Respondents may have simply failed to carefully consider the value of opportunity cost, leading them to frequent switching. Experiment 3 examined this issue by including a condition in which respondents paid explicitly for switching rooms. We reasoned that if the high level of switching in Experiments 1 and 2 were due to the low saliency of the cost, then making the cost explicit (and higher) would decrease switching, and eliminate the effect of option-availability. On the other hand, to the extent that room switching is not influenced by the cost, we would increase our confidence that individuals have the desire to keep options open.

Method

The basic design of Experiment 3 differs from Experiment 1 in two ways. First, all respondents engaged in 100 practice clicks before beginning with the 100 real clicks (as in the practice-information condition in Experiment 2, but with 100 clicks). Second, there were explicit penalties for door-clicks (room switching).

Respondents: Eighty-six respondents were recruited by advertisements around campus and from within the computer lab where the experiment took place. Respondents were randomly assigned to one of the four conditions.

Design and Procedure: Experiment 3 included the same option-availability manipulation as in Experiment 1, with an additional manipulation of **cost**, which was varied on two levels: **implicit-cost** and **explicit-cost,** crossed with option-availability. In the implicit-cost conditions, the cost of switching rooms was the loss of a click (as in experiments 1 and 2). In the explicit-cost conditions, the cost of switching rooms was loss of a click (implicit cost) and a loss of 3¢. The loss of 3¢ per switch was noted on the screen for every door-click in the same way that payoffs for each room-click were posted. We selected 3¢ as the explicit cost because it was the expected value of a room-click (Table 1), making the total cost of switching in the explicit conditions twice as much as in the implicit conditions.

Results and Discussion

An overall ANOVA of door-clicks indicated a significant main effect for option-availability [$F(1, 82) = 13.41$, $p < 0.001$]; a marginal effect for cost [$F(1, 82) = 3.48$, $p = 0.066$]; and a non-significant interaction between option-availability and cost [$F(1, 82) = 0.38$, $p = 0.539$]. As can be seen in Figure 4, the effect of option-availability replicated the previous experiments, showing that decreased-availability caused more switching behavior ($M = 13.26$) than constant-availability ($M = 5.36$). The effect of cost revealed that switching was more frequent, but only marginally so, in the implicit-cost condition ($M = 10.8$), compared with the explicit-cost condition ($M = 6.65$). Although the cost manipulation was marginally significant, the important aspect is that the magnitude of the cost effect (lambda = 3.48) was much lower than that of the option-availability effect (lambda = 13.41). Most importantly, the non-significant interaction between option-availability and cost illustrates that the desire to keep options open persisted even when the cost was more explicit and even when its magnitude was twice as large. Finally, the amount of experience in this experiment was higher (100 clicks instead of 50), which allowed us to look at trials in which respondents had more experience – the effects of availability and cost persisted throughout the 100 clicks.

In summary, Experiment 3 suggests that the tendency to "keep options open" in our experiments still persists under the different saliency of the cost (explicit vs. implicit). While explicit cost increases the amount of attention people pay to it and thus slightly reduces switching, this cost does not prevent decision makers from having increased interests in alternatives when there is a possibility that these alternatives will be eliminated.

••• Figure 4 •••

6. Experiment 4: Loss Aversion vs. Flexibility

The previous three experiments demonstrated that a threat to availability has a strong influence on the desire to keep options open. Both Experiments 2 and 3 demonstrated that neither information nor saliency of cost can account for the effect of option-availability. Experiment 4 examines two possible psychological mechanisms that could provide an explanation for respondents' tendency to keep doors open: the desire to keep or increase flexibility in future choices, and the desire to protect against possible losses. In order to test these two hypotheses, a new manipulation of "**re-activation**" was added to the decreased-availability condition, allowing respondents to reactivate a door that had previously disappeared. To do so, respondents simply pressed a button, paid a known payment, which was varied (0¢, 6¢ or 30¢), and then the door would reappear and they would be in the room. By using this re-activation manipulation, options could disappear without changing future flexibility – disassociating desire for future flexibility from disappearance (loss) of an option. We argue that if the increased switching in the decreased-availability conditions is caused by the desire for future flexibility, adding the possibility of re-activation should decrease or eliminate the effect of option-availability. On the other hand, if the increased switching in the decreased-availability conditions is caused by loss aversion, re-activation should not influence the effect of option-availability. The argument here is that reactivation following the disappearance of a door can revitalize it, but it does not eliminate its disappearance (loss). Returning to our initial dating example, the re-activation is analogous to a case where our romantic decision maker knows that even if a potential romantic partner becomes unavailable, this unavailability could always be reversed at a known cost, such as a gift, flowers, or jewelry.

Method

Respondents: Ninety-one respondents were recruited by advertisements around campus and from within the computer lab where the experiment took place. Respondents were randomly assigned to one of the five experimental conditions.

Design and Procedure: Experiment 4 had five conditions, all of which offered respondents 100 clicks. The first two conditions were constant-availability and decreased-availability (as in Experiment 1). The novel conditions in Experiment 4 introduced the re-activation mechanism, which guaranteed the future flexibility of the doors in the decreased-availability settings. In the re-activation conditions, once a door disappeared, a small box appeared above the location of the door. By clicking on this box, the respondents reactivated the door and entered the room (door-click was embedded), and the cost of reactivation was deducted from the payoff. The cost of reactivation was varied: 0¢, 6¢ or 30¢.

The expected pattern of results depended on whether switching behavior was motivated by the desire to keep, or increase, flexibility in future choices, or by protection against possible losses. If the flexibility account is correct, it would be expected that respondents would expend a similar level of effort in the three re-activation conditions as in the constant-availability condition, while a higher level of effort would be expected to keep options open in the basic decreased-availability condition. Furthermore, within the re-activation conditions, it would be expected that the level of effort would depend on the cost of exercising the re-activation. On the other hand, if the tendency to keep options open largely relates to a general aversion to losses, the re-activation manipulation should have no influence on the effect to keep options open, since re-activation does not prevent the disappearance (loss) of the doors. In terms of the cost of reactivation, the loss aversion account suggests that since the main motivation is to eliminate loss, there will be a low sensitivity to the magnitude of the cost (since the cost of reactivation matters only after losing some options). Thus, to the extent that the loss aversion account is correct, room switching should be the same in the all four decreased-availability conditions, irrespective of re-activation.

There is another way to look at these conditions: Based on the future flexibility account, there is only one condition where the future flexibility is not guaranteed (decreased-availability condition), while in other four conditions (constant-availability, and the three re-activation conditions), the future flexibility remains the same. In contrast, from the perspective of the loss aversion account, there is only one condition without a threat of availability (constant-availability condition), while in the other four conditions, availability is threatened (decreased-availability condition and the three re-activation conditions).

A final prediction that is based on loss aversion, relates to the difference in switching between the 0¢ re-activation and the constant-availability condition. Note that these two conditions are identical from the perspective of a rational agent, but that they differ in terms of framing, such that the 0¢ re-activation condition can involve the loss aversion mechanism.

Another advantage of Experiment 4 was that it introduced a case in which the expected payoffs of the different doors were not the same (Table 1). This was done to replicate the results of the experiment in the later discussion of Experiment 1.

test whether respondents in the previous three experiments might have expended efforts to keep all options open simply because they had no clear reason to keep one and discard the others (Kahneman, Knetsch and Thaler, 1991; Shafir, Simonson, and Tversky, 1993; Inman and Zeelenberg, 2002). In Experiment 4, where all options were not equal, respondents could more easily find a reason to make decisions, and thus could justify less switching than in Experiment 1, where all options were created equal and, therefore, it was difficult to find a reason to make decisions.[20] The distributions were normal with variance 1.25, and means of 2.5, 3, and 3.5.

[20] We are indebted to an anonymous reviewer for guiding us to this point.

Results and Discussion

There were five conditions in Experiment 4, two of which were a replication of the main option-availability manipulation (constant-availability and decreased-availability), and three of which were re-activation-related decreased-availability conditions with reappearance cost of 0¢, 6¢ and 30¢. An overall ANOVA of the switching behavior revealed a main effect for option-availability [$F(4, 90) = 2.73$, $p = 0.034$].

First, we examine whether these results replicate the previous experiments. As can be seen in left two columns of Figure 5, the main result was replicated – switching in the constant-availability condition ($M = 6.06$) was lower than the switching in the decreased-availability condition [$M = 12.76$; $t(31) = 2.83$, $p < 0.01$]. These results also show that the same pattern of results emerges when using distributions of different means. To further support this idea, we compared the constant and decreased-availability conditions in Experiment 1 and 4 using 2 (Experiment: equal/unequal distributions) by 2 (option-availability) between subjects ANOVA. The results revealed an effect of availability [$F(1, 186) = 32.52$, $p < 0.0001$], confirming our previous finding of the effect of option-availability. The results also showed a marginally significant effect of Experiment, where respondents switched more in Experiment 1 ($M = 12.11$) than in Experiment 4 [$M = 9.52$; $F(1, 186) = 3.66$, $p = 0.057$]. Although marginally significant, this result is consistent with the idea that the different means provided the respondents with reasons to switch less. Furthermore, the interaction between experiment and option-availability was not significant, demonstrating that unequal distributions did not change the effect of option-availability on the desire to keep options open.

With the knowledge that Experiment 4 replicated the previous experiments, we next examined which of the two theories (future flexibility of choices and loss aversion) is better supported. Recall that we are interested in the relationship between the re-activation conditions as a whole to the constant and decreased availability conditions, particularly in the comparison between these conditions and the 0¢ re-activation condition.

First, in comparing the re-activation conditions with the constant and decreased availability conditions, we asked whether the three re-activation conditions would be similar to the constant-availability condition, thus supporting the future flexibility explanation, or whether they will be similar to the decreased-availability condition, thereby supporting the loss aversion explanation. As can be seen in Figure 5, the switching behaviors in the three re-activation conditions ($M = 11.58$) were not different from each other [$F(2, 55) = 0.74$, $p= 0.484$], and they were also not statistically different from the decreased-availability condition [$M = 12.76$; $F(1, 73) = 0.32$, $p = 0.5735$]. The three re-activation conditions, however, were significantly different than the constant-availability condition [$M= 6.06$; $F(1, 72) = 9.34$, $p < 0.001$]. These results provide support for loss aversion over future flexibility as the driving force underlying the desire to keep doors open.

Next, in comparing the 0¢ re-activation condition with the constant and decreased availability conditions, we asked whether the 0¢ re-activation condition would exhibit similar switching to the constant-availability (to which it was logically equivalent) or to the decreased availability, which could be the case if loss aversion is the force that causes individuals to switch more in the face of the threat of options disappearance. This results

(Figure 5) indicates that the switching behavior in the 0¢ re-activation condition (M = 10.38) is more similar to that of decreased-availability condition [t(40) = 0.72, p = 0.475] than that of constant-availability condition [t(40) = 2.50, p= 0.016], suggesting that in our set-up, loss aversion plays a larger role than flexibility. These results can also provide a hint as to whether the effort to keeping doors open is driven by the utility (or pleasure from having more options) or disutility (or pain from having options disappear). The higher switching in the re-activation conditions (in particular, the 0¢ re-activation condition) compared with the constant–availability condition suggest that it is the disutility of having options disappear that is the driving force.

It is also interesting to examine the effect of the magnitude of the deductible penalty on switching behavior. The lowest amount of switching occurred in the zero re-activation condition (M = 10.38), followed by the 30¢ re-activation condition (M = 12.12), and the 6¢ re-activation condition (M = 13). But there was no statistical difference between these conditions [F(2, 55) = 0.74, p = 0.484]. This lack of sensitivity to the magnitude of the cost can be taken as another indication that the tendency to keep doors open is not due to a rational cost-benefit analysis.

In sum, the different ways of looking at the results of Experiment 4 all point to the same conclusion – that the threat of availability of options is aversive and hence, respondents are willing to invest in order to reduce the possible experience of loss. This effect can be termed disappearance aversion, similar in some ways to the general ideas of loss aversion.

••• Figure 5 •••

7. General Discussion

The current work attempts to capture a general aspect of human behavior that extends from interpersonal relationships to abstract monetary options – valuations of options. The experiments presented here tested how individual decision makers evaluate options compared with these expected value of options by manipulating the threat of options disappearance. Experiment 1 demonstrated that the possibility that the options will become unavailable in the future increases investments in them in order to keep them from disappearing. Experiment 2 tested whether this effect can be due to information, and, in addition, added three more fine-grained measures (pecking, click investment, and elimination point) to test whether the effort respondents expanded to maintain options open can be rationally explain – it cannot. Experiment 3 tested whether the distinction between implicit and explicit cost is the reason that our respondents over-invested in keeping doors open – it was not. Finally, Experiment 4 contrasted two psychological theories — flexibility and loss aversion — as possible mechanisms for the overinvestment in keeping options open. The results from this experiment point to loss aversion as being the more powerful of the two (at least in our setup). In a further test of loss aversion, we created a new measure aiming at examining whether the room that respondents "gave up on" first (elimination-point) was one for which they had more or less information about compared with the one they "gave up on" second (second elimination-point). We argue that from an informational point of view, subjects should abandon a room they have more information about, since the amount of information indicates their certainty in the quality of the room. On the other hand, from a loss aversion perspective, a room that had attracted more clicks might also have a higher attachment associated with it, thus leading to a lower tendency to abandon such room. Analyzing this measure in Experiment 2 revealed that the respondents were four times more likely to first abandon doors they have less information about, thus supporting the attachment and loss aversion ideas. Also, the increased effect of availability in the practice-information condition in Experiment 2 strongly supports the loss-aversion explanation (Figure 3). The experience of actual feeling of the losses of the options during the practice trials seems to cause respondents to be even more resistant to experiencing more losses during the actual trial[21].

In summary, the experimental evidence presented suggests that individuals value options in a way that is different from the expected value of these options, and, in particular, that decision makers overvalue their options and that they are willing to over-invest in order to keep these options from disappearing. Based on the results of Experiment 4, we believe that the desirability of keeping options open is a kind of disutility from loss rather than utility from "having more options from to choose."

In a world where maintaining options has no cost, such tendency would have been non consequential. However, we believe that in most day-to-day cases, there is substantial cost to keeping options open, which would lead to erroneous behavior. There are many situations in which decision makers encounter tradeoffs between the future availability of options and their maintenance costs. We have already mentioned dating, and choosing a major in college. Other examples include tradeoffs between focusing on one's current work and looking for new employment elsewhere; whether to specialize in

[21] We are also indebted to an anonymous reviewer for pointing out this point.

a way that suits one's current employer or instead to invest in skills that are valued by other potential employers. These results might also shed light on one of life's greater mysteries: why do some people channel surf rather than, for example, enjoy a single movie? The answer might be the fear of losing other options.

These results might also be generalized to one-shot cases. For example, when buying a new computer, consumers face the dilemma of deciding whether to buy a system that suits their current needs or purchase an expandable system (e.g., more slots for cards, and more memory) that could better fit their uncertain future needs. In this case, the main source of the dilemma is the uncertainty as to whether future expansion will be needed, or if the option to expand is worth the cost at the present. Our computer buyer is faced with a situation that is analogous to the door game one click before a door disappears. She can take a costly action at the purchasing time to ensure that the expansion option remains available to her, whether she subsequently decides to expand or not.

Other examples in which consumers face the "disappearing" options are deciding whether to purchase an extended warranty when buying new electronic product, and deciding whether to buy pictures of oneself from a third party such as on a white water rafting trip. In such cases, consumers are given the opportunity to act on the options (the warranty or the pictures), while realizing this will be their only opportunity to take this action, and that not acting on the options will cause the "pain" of losing these options. We suspect that the effectiveness of such tactics is based on the option's non-availability in the future – causing these options to be perceived more favorably and to be acted on more frequently.

There remain numerous unanswered questions. For examples, what are the mechanisms that underlie the fear of losing options? What is the relationship between keeping options open and indecision, particularly when deciding means committing to one out of a multitude of other possibilities (see also Amir, 2002)? What is the impact of options' prospective lifetime and unavailability on their subjective value? What is the range of options people would like to keep? Faced with a large number of options, would decision makers still value options (Iyengar and Lepper, 2000)? Finally, under what conditions will individuals want to actively eliminate options? We keep these research opportunities open for the future.

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Figure captions

Figure 1: A schematic illustration of the "door game." Respondents first encountered three doors to three rooms. Clicking on any door opened that door, allowing the respondents to either click within that room or move to another room. Clicking in a room awarded the respondents a payoff randomly sampled from the distribution of that room. Moving to a different room cost the respondents a click. Respondents were given a total click budget and the experiment was completed when the click budget was depleted.

Figure 2: Average number of door switches for the decreased and constant availability conditions within each block of 10 clicks in Experiment 1.

Figure 3: The average number of door switches across the two option-availability and three information conditions in Experiment 2 (Panel (a)). Error bars are based on standard errors. The average Elimination Point in the two option-availability and three information conditions in Experiment 2 (Panel (b)). Error bars are based on standard errors.

Figure 4: Average number of door switches across the two option-availability and two cost conditions in Experiment 3. Error bars are based on standard errors

Figure 5: Average number of door switches in the two replication conditions (left), and the three re-activation conditions in Experiment 4. Error bars are based on standard errors.

Table 1: The distributions of payment in the three doors across the four experiments

Experiment # (clicks)	Manipulation		Door 1	Door 2	Door3 [22]
Experiment 1 (100)	Option - availability	Distribution	Normal	Normal	Chi-Square
		Average ¢/ Variance	3 / 2.25	3 / 0.64	3 / 10
		Min ¢/ Max ¢	0 / 7	1 / 5	- 2 / 10
Experiment 2 (50)	Information level	Distribution	Normal	Normal	Chi-Square
		Average ¢/ Variance	6 / 9	6 / 2.25	6 / 16
		Min ¢ / Max ¢	0 / 14	2 / 9	-4 / 19
Experiment 3 (100)	Saliency of the cost	Distribution	Normal	Normal	Chi-Square
		Average ¢/ Variance	10 / 9	10 / 2.25	10 / 20
		Min ¢/ Max ¢	4 / 18	6 / 13	0 / 20
Experiment (100)	Re-activation	Distribution	Normal	Normal	Normal
		Average ¢/ Variance	2.5 / 1.25	3 / 1.25	3.5 / 1.25
		Min ¢/ Max ¢	-0.6 / 5.9	0.1 / 6.9	1.2 / 8.1

[22] Door 3 was a Chi-square distribution with a degree of freedom, which is larger than the expected mean by 2¢. We subtracted 2 cents from the distribution in order to keep the same average, but encounter a few negative outcomes. For example, in Experiment 1, door 3 was a Chi-square distribution with 5 degrees of freedom, where we subtracted 2¢.

Figure 1:

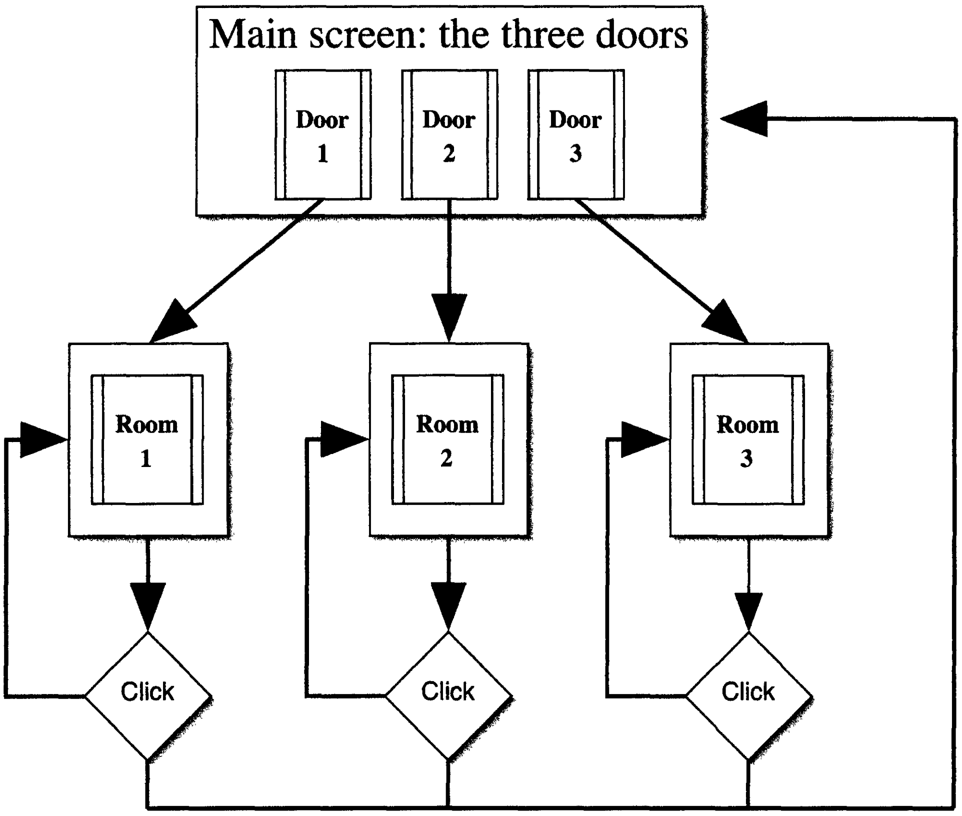


Figure 2:

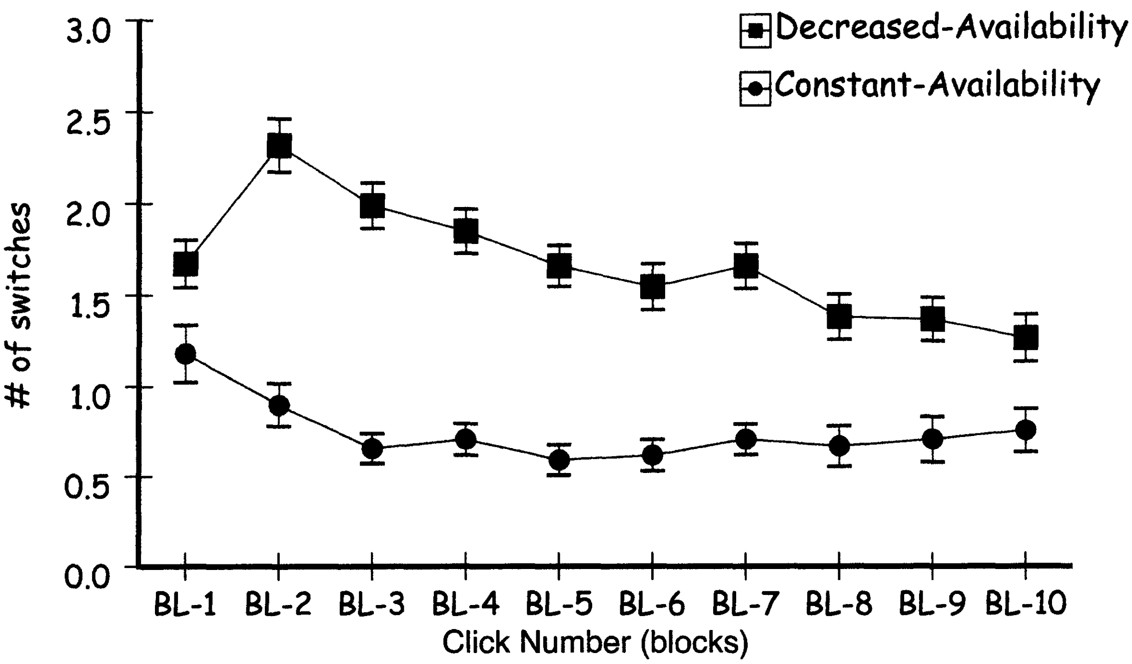
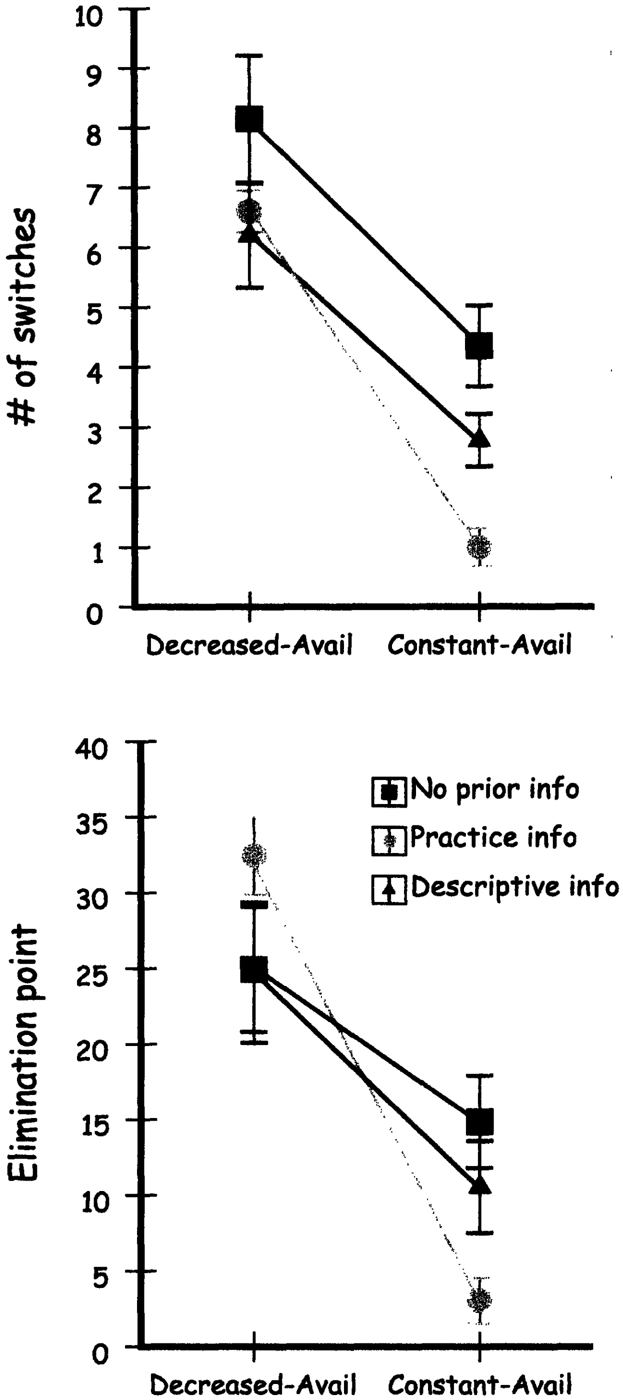


Figure 3[23]



[23] There were some respondents who wanted to get the fastest result without switching the room in all conditions. Thus these respondents drove the standard error higher for the case when the mean was higher, which is the decreased-availability condition.

Figure 4:

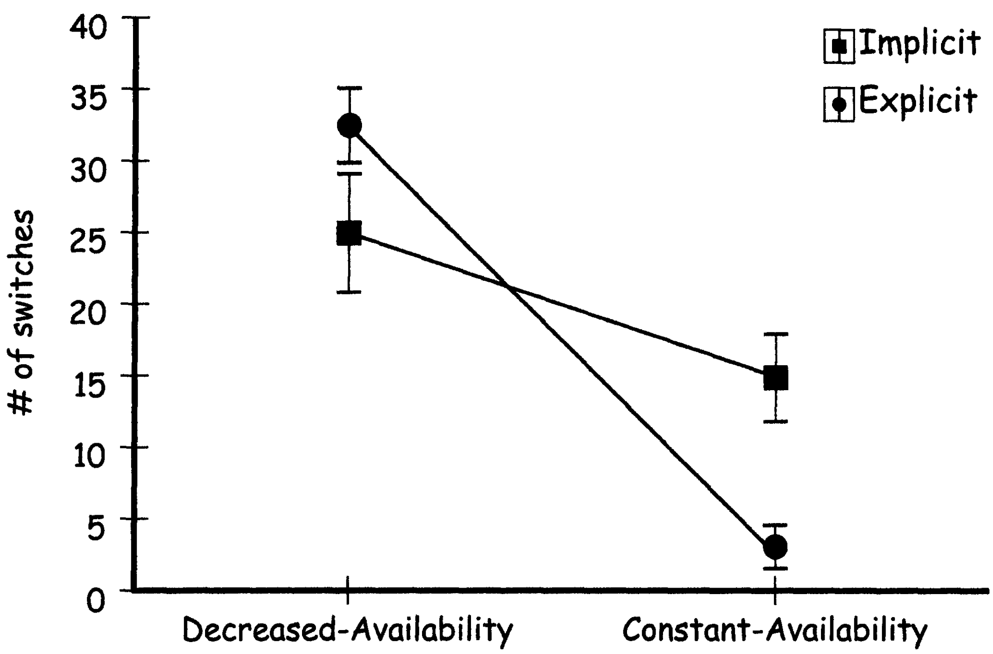


Figure 5: