Quantitative Marketing and Economics, 2, 233–255, 2004.

When Shopbots Meet Emails: Implications for Price Competition on the Internet

YUXIN CHEN
Stern School of Business, New York University, 44 W Fourth St, MEC 9-78, New York, NY 10012-1126, USA
E-mail: ychen@stern.nyu.edu

K. SUDHIR
Yale School of Management, 135 Prospect St, PO Box 208200, New Haven, CT 06520-8200, USA
E-mail: sk389@mail.som.yale.edu

Abstract. The Internet has dramatically reduced search costs for customers by using such technologies as *shopbots*. *Email* based targeting is relatively inexpensive; the targeting itself can be more precise because firms can better track individual purchase behavior on the Internet. In this paper we address the question: How does the convergence of *low search cost for consumers* and *better targeting ability for firms* affect price competition on the Internet? Current theoretical research suggests that both (1) lower search costs and (2) better targeting ability generally lead to more intense price competition. Taken individually, these results would lead us to expect that there will be greater price competition on the Internet due to lower search costs and better targeting. In this paper, we argue that targeting ability increases as search costs fall. Falling search costs can lead to improvements in targeting ability in the form of greater "targeting reach" (the ability to individually address consumers) and "precision" (the ability to distinguish consumers on the basis of their loyalty). We show that the interaction between consumer search and targeting ability *can reduce the intensity of competition and raise prices as consumer search and targeting become easier* on the Internet.

Key words. Internet, price competition, targeting, search costs, direct marketing

JEL Classification: M3, D4, L0

1. Introduction

A characteristic feature of the Internet is low consumer search costs. With a few clicks of the mouse, consumers can compare the offerings of a large number of competing sellers on the Internet. The business press has paid significant attention to this aspect of the Internet. For example, in his 1995 bestseller 'The Road Ahead', Bill Gates suggests that the Internet "will carry us into a new world of low-friction, low-overhead capitalism, in which market information will be plentiful and transaction costs low. It will be a shopper's heaven."

A second feature of the Internet is the relatively low cost with which firms can selectively target customers through email. According to the New York Times, "Email is a relatively inexpensive marketing tool, ranging from a penny to a quarter for each message, compared to \$1–\$2 for each piece of direct mail campaigns in the actual world. Moreover, email campaigns produce immediate results, no small factor in an industry, where speed is critical." (Stellin, 2001). Email marketing has been progressively increasing with Forrester Research and Emarketer forecasting growth in excess of 100% annually. Further, it is relatively easy to record a customer's search behavior and better categorize the customer into segments on the Internet. Online companies such as Amazon, Barnes and Noble and Wine.com routinely use purchase histories of customers to pepper them with offers (Stellin, New York Times, 2001). Thus, the Internet increases the ability of firms to target their customers.

In this paper we seek to address the question: How does the convergence of *low search cost for consumers* and *better targeting ability for firms* affect price competition on the Internet? A useful starting point in answering this question is to consider the predictions from the existing theoretical literature that analyzes the impact of search costs and targeted pricing separately.

We begin with the literature on search costs: Bakos (1997) argue that on the Internet, which is characterized by extremely low search costs, price competition will be very intense and profitability will be low. Varian and Shapiro (1997) come to a similar conclusion. A Business Week article tellingly titled, "A Market Too Perfect for Profits", (Kuttner, 1998) picked up the thread of this argument and stated colorfully: "The Internet is a nearly perfect market because information is instantaneous and buyers can compare the offerings of sellers worldwide. The result is fierce price competition, dwindling product differentiation, and vanishing brand loyalty."

Lal and Sarvary (1999) point out that the relationship between low search costs and intense price competition is not as simple: They classify goods as those with primarily digital attributes and non-digital attributes[1] and show that the Internet can reduce the intensity of competition for goods with non-digital attributes even when search costs fall. Others have treated the issue of low search costs as a problem that we need to circumvent. Zettelmeyer (2000) suggests that firms should strategically raise search costs for consumers by making it harder for consumers to judge comparability of products in order to improve profitability. Alba et al. (1997) and Ariely and Lynch (2000) suggest that the Internet can avoid the pitfalls of low profits by focusing on providing better fit to consumer needs and by removing the focus on price comparability. Smith (2001) offers another explanation for why some leading firms may be able to maintain high prices on the Internet despite the low search costs. He argues that since consumers search more among the dominant firms who they are aware of, the dominant firms find it optimal to tacitly cooperate and maintain high prices. In a recent paper, Iyer and Pazgal (2003) study the impact of Internet Shopping Agents (ISA) on the price competition. In their model, an ISA enables consumers to compare prices from multiple online retailers at no cost. Similar to Baye and Morgan (2001), they show that prices can rise when the numbers of retailers participating in the ISA increases and the reach of the ISA is independent of the number of participating retailers. However, Iyer and Pazgal (2003) also find that average prices consumers pay in the ISA decrease with the numbers of member retailers in the ISA if the reach of the ISA depends on the number of participating retailers. In a related paper, Chen et al. (2002) examine the role of Internet referral infomediaries in shaping firms' price competition. Referral infomediaries, such as Autobytel.com, lower search cost by providing consumers with online price quotes which may not necessary be the same as firms' offline offers. As shown in their paper, a referral

1 A digital attribute is one that can be communicated easily over the web. Non-digital attributes are things such as texture of clothes etc. which cannot be communicated over the web.

infomediary can become unviable as its reach to consumers increases, because it intensifies price competition among firms. In summary, the bottom line from this literature is that low search costs for products with primarily digital attributes (such as books, CDs, music, airline tickets etc.) will generally lead to lower profits when firms behave non-cooperatively.

The theoretical literature on targeting also paints a gloomy picture for the profitability of the Internet. Vives and Thisse (1988) and Shaffer and Zhang (1995) show that competition will become more intense as firms can target consumers. They make the assumption of perfect targetability. Chen et al. (2001) however show that when targeting is imperfect, increasing targeting may lead to a reduction in competition at low levels of precision in targeting but the opposite is true if the precision in targeting is high. Using a dynamic model of firms' behavior-based targeting, Villas-Boas (1999) further points out that firms are worse off under competitive targeted pricing if consumers anticipate future prices from firms and react strategically to targeted prices. To summarize, given that the Internet is widely touted to improve the efficiency and precision in targeting, the consensus in the existing theoretical literature on targeting suggests that the Internet is likely to intensify price competition and lower prices.

The logical question that follows, if these predictions about intense price competition and low prices are true, is asked in a Los Angeles Times article, "If the Internet offers the "lowest prices on Earth" just a mouse click away, . . . then who can make any money?" (Gaw, 1998). In this paper, we provide an argument for why in contrast to conventional wisdom and the existing theoretical literature, *competition may be reduced and prices may rise as firms compete non-cooperatively even when search cost is low and targeting is perfect*. The basic intuition for our argument is as follows: consider a market where consumers are heterogeneous in their loyalty as well as their cost per unit time to search. Suppose in one environment (as in the brick and mortar world), it takes consumers a very large amount of time to search across multiple stores. First, in such an environment very few customers will search in equilibrium because the gains from search will be relatively small compared to the cost of search. Firms in such a market will therefore not be able to distinguish if their customers bought from them due to their high loyalty to the stores or due to their unwillingness to search for low prices because of the high cost of search. Second, given that any customer is likely to visit fewer stores in a high search cost environment, the customer databases of any firm are likely to be smaller. These two factors limit the ability of the firm to effectively pursue a targeting strategy.

Now suppose in another environment (as in the online world), the amount of time to search across multiple stores is minimal (say zero). Now, irrespective of their opportunity cost of time, all consumers can search because the time to search is negligible. If, in spite of this, a consumer does not search, she is revealing that her loyalty to the store that she buys from is very high. By tracking the purchase behavior of the consumers, the stores can identify the levels of loyalty of their customers and thus segment the market in terms of customer's store loyalty. Thus a fall in search costs enable firms to more "precisely" segment consumers on the basis of their loyalty. Further, greater search implies that more consumers would be on firm databases on average, increasing the "reach" of a potential targeting strategy. Thus low search costs improve the "precision" and "reach" of targeting. If the stores can selectively target the segments with differential prices i.e., a high price to the store loyal segment and a low price to the price sensitive segment, then the increased competition due to price transparency caused by low search costs can be offset by the ability of stores to more precisely and completely price discriminate between their loyal price insensitive customers and their price sensitive customers. In fact, under certain circumstances, the extent of competition among stores can be reduced and their profits can rise.

The key argument is that as search becomes cheap for everyone, then *lack of search* indicates loyalty and thus can be more effectively used as a proxy to segment the market. However when search is costly, the resulting lack of search may either indicate high value for time or high loyalty and thus cannot be used to segment the market. Further on average, each firm's database would have fewer customers leading to a less complete targeting strategy. The resulting inability to segment the market makes the market appear more homogeneous than it really is and therefore leads to greater competition for the entire market.

Critical to the applicability of this argument is that we should be able to track the individual customer's behavior over time so that the store can classify the customer into a loyal or price sensitive customer. On the Internet, it is relatively easy to record a customer's search behavior and categorize the customer into segments. Further, after the segmentation, the store should be able to selectively offer a lower price to the price sensitive customer relative to the loyal consumer. Companies such as Amazon, Barnes and Noble and Wine.com routinely use purchase histories of customers to pepper them with offers (Stellin, New York Times, 2000). On the Internet, the segmented pricing strategy can be implemented by selectively delivering email coupons to price sensitive customers (because firms have access to email addresses of consumers), while the loyal customers pay the higher posted prices. This is also effective because the emails can be delivered instantaneously and the responses are also relatively fast relative to the offline world. With such segmentation, we show that the Internet may have higher prices and lower competition than offline stores. In fact, we find that *the effect of price discrimination may be so strong that under certain circumstances the profitability of stores can be higher when there is zero search cost than when there is infinite search cost*.

Both consumers and firms are increasingly taking online privacy seriously. We also take this important issue into account in our model and study the impact of consumer "opt-in" on firms' prices and profits.[2] Our modeling indicates that "opt-in" is a critical variable because it affects the "reach" of any targeting strategy. At low levels of "opt-in", only posted prices are effective and competition is similar to the offline market where lower search costs intensify competition. As "opt-in" increases, the market segmentation and price discrimination become more effective and store profitability increases as search costs fall. In fact beyond a critical level of "opt-in," the posted price will become so large, that only the loyal segment of the market will buy the product and the price-sensitive but privacy conscious customer who opts out will not find it worthwhile to buy the product. Thus we find that as consumers gain confidence in the technologies that help guard privacy

2 Customers can choose to "opt-out" (where customers by default receive emails, but can choose not to participate) or "opt-in" (where customers will not be included by default in mailings, but will need to explicitly sign in) for mailings from firms. Opt-in or opt-out policies, of course limit the ability of firms to operationalize the segmentation of the market and thus reduce the "reach" of a targeting strategy. From a modeling viewpoint, we do not distinguish between opt-in or opt-out policies and use the term "opt-in" to include both.

and "opt-in" increases, firms' prices and profits are more likely to increase with more consumer search but the remaining privacy conscious customers may be left out of the market.

In recent empirical research, there appears to be some apparent divergence in the average levels of posted prices at Internet stores. While Bailey (1998) found that average levels of prices for books and CDs were higher online between 1996–1997, Brynjolfsson and Smith (2000) found that the average levels of prices for books and CDs were lower online in 1999. Clay et al. (2001) however find that the average prices for books have been increasing online between mid 1999 to January 2000 (they may be still lower than offline prices; but Clay et al. do not check this). If all of these results were indeed consistent, then online prices should have fallen between 1997 and 1999 and then risen during 2000. While current theoretical research cannot explain this pattern of changes in prices, we show that this pattern is consistent with our model where the level of search costs on the Internet continues to decline steadily.

The rest of the paper is organized as follows: In Section 2, we introduce the basic model. Section 3 contains the analysis and the main results of the paper. In Section 4, we discuss extensions of the basic model. Section 5 concludes.

2. Model

Consider two competing firms in a product category selling through the Internet. The marginal production cost of each firm is assumed to be zero without loss of any generality. Each firm i has two segments of customers: a "strong loyal segment", s_i, and a "weak loyal segment", w_i. As shown in Smith and Brynjolfsson (2001), store loyalty is an important determinant of consumer choice even for retailers offering homogeneous products online since consumers use brand as a proxy for retailer credibility. Moreover, technologies such as "one click purchase" by Amazon.com can create significant switching costs for some consumers to keep them loyal to a particular online retailer.

The size of each of the four segments (two weak loyal and two strong loyal segments) is assumed to be equal to 1. Consumers in the strong loyal segment, s_i, have a reservation price r_s for firm i's product and they will never switch to buy from firm j ($j = 3 - i$). However, consumers in the weak loyal segment, w_i, have a reservation price r_w for firm i's product and a reservation price $r_w - L$ for firm j's product. Therefore, firm i's weak loyal consumers will switch to buy from firm j if the price difference between two firms is larger than L, i.e. if $p_i - p_j > L$, and $p_j \leq r_w$. We assume that $r_w < r_s$, implying that consumers in the strong loyal segment have higher willingness to pay than those in the weak loyal segment. The strong loyal segments in our model are similar to the loyal segments in the model used by Narasimhan (1988) and the weak loyal segments in our model are similar to the consumer segments in the model used by Raju, Srinivasan and Lal (1990). Each consumer makes a purchase decision to maximize her consumer surplus and buys at most one unit from the product category. If a consumer is indifferent between buying from a firm and making no purchase at all, we assume that she will make the purchase. Without loss of any generality to our results, we further assume that $r_w = 1$ and $r_s = r$.

Given the consumer segmentation, it is obvious that consumers in the strong loyal segments have no incentive to search for the price information of the competing firms in the market. Price comparison has no value to those consumers because their shopping decisions will not be affected by the price comparison. However, consumers in the weak loyal segment have incentives to search for price information, because it is optimal for them to switch from the firm they are weakly loyal to if the price at the other firm is low enough. Thus, due to the heterogeneity in consumers' à priori preferences (loyalty) for the two firms, even consumers with the same search cost may have different observed search behavior. Empirically, using supermarket scanner panel data, Mehta et al. (2003) find that consumers with higher price sensitivity search more than consumers with lower price sensitivity. However some consumers are extremely loyal and do not search even when it is relatively costless as on the Internet. Johnson et al. (2003) find that a significant fraction of consumers do not search for commodity-type of products, such as books, CDs and travel sites. Note that the size of each loyal segment is exogenously given in our model. Baye and Morgan (2001) and Iyer and Pazgal (2003) also make a similar assumption in studying consumer search and the impact of shopbots on price competition.

Denote β to be the proportion of consumers in either firm's weak loyal segment who search firms' prices. The Internet enables those consumers to compare prices across multiple competing firms at one shot through tools such as shopbots, or Internet Shopping Agents (Iyer and Pazgal, 2003), at very low cost. These "price searchers" may switch firms if the price difference between two firms is larger than L. The remaining consumers, who do not search, shop at the firm they are loyal to. We should expect that the size of "price searchers", β, increases when search cost decreases.[3]

While the Internet enables consumers to compare prices easily due to low search cost, it also enables firms to contact consumers directly with targeted email offerings such as electronic coupons. Importantly, a firm's targeting ability is highly related to the consumer's level of search. As we discussed in the introduction, when consumers search more firms can also target *more consumers* with *more precisely targeted prices*. Consider the following example: Without consumer search, a consumer in Firm 2's weak loyal segment, w_2, will never search and always buy from Firm 2. Consequently, Firm 1 will have no information about consumers in w_2 unless it buys such information from external data vendors. However, if β proportion of w_2 consumers searches both firms' prices, they may visit and purchase from Firm 1. Consequently, Firm 1 will be able to record information about them and potentially target them with emailed coupons.[4] Furthermore, because the Internet enables

3 Here we assume that β is exogenously given and interpret it to be monotonically inversely related to the average search costs in the market. Alternative, we can let β to be endogenously determined by the distribution of consumer search costs and their expected gains from search. Similar results to those shown in this paper are found in the case where β is endogenous. The detailed derivations are provided in an early working paper version of this paper, which is available upon request from the authors.

4 Retailers routinely maintain consumer purchase information both online and offline on databases. Online retailers identify customers through a number of techniques such as "cookies," user authentication, credit card information etc. Offline retailers use their loyalty program identification numbers to identify customers and relate them to past consumer transactions. More detailed description of the database technology used by firms for targeting purposes can be found in Acquisti and Varian (2003).

firms to observe competitors' prices easily (with technology similar to shopbots, that have been dubbed "pricebots"[5]), firms will be able to identify the type of consumers in their database if there are price variations in the market and consumers stay in the market for a sufficiently long time. For instance, from Firm 1's perspective, consumers who purchased at $1 < p_1 \leq r$ must be its strong loyal customers; consumers who never purchased at $p_1 > 1$ but purchased at $p_1 \leq 1$ and $p_1 - p_2 > L$ must be its weak loyal customers who do not search; consumers who only purchased at $p_1 \leq 1$ and $p_1 - p_2 < -L$ must be its competitor's weak loyal customers who search, and the remaining consumers must be its weak loyal customers who search.

To operationalize the above discussion on the interaction between consumer price search behavior and firms' email targeting ability, we assume that each firm has a database with individual level information on consumers in (1) its strong loyal segment, s_i, (2) the proportion of its weak loyal segment that do not search, $w_{i(1-\beta)}$, (3) the proportion of its weak loyal segment that search, $w_{i\beta}$, and (4) the proportion of its competitor's weak loyal segment that search, $w_{j\beta}$. Firms can identify each consumer in its database in terms of her membership in the segments of $s_i, w_{i(1-\beta)}$, $w_{i\beta}$, and $w_{j\beta}$, and can potentially target them with different prices through promotional offers such as electronic coupons.[6]

Because of the time constraints in reading emails and the growing concerns about online privacy, some consumers may not read or want to be targeted by emails. Typically firms give consumers the option to either "opt out" of an email list or "opt in" to an email list. As discussed earlier, we do not distinguish between opt-in and opt-out policies and will use the term "opt-in" throughout the rest of the paper. Actually, we will use the term "opt-in" in an even broader sense in the paper by treating consumers who receive targeting emails but do not open or read them as if they have not "opted in".

As long as the cost of checking an email is nonzero, a firm's strong loyal consumers and weak loyal consumers who do not search (i.e. consumers in s_i, and $w_{i(1-\beta)}$) have no incentive to opt in. A firm sending email to such a consumer will optimally set the targeting price equal to her reservation price because there is no competition from the other firm for the consumer. Therefore, the consumer will have no gain from reading the email, but incur a non-zero cost to check it. As a result, the expected utility gain from reading a target email is negative for a consumer in segments s_i, and $w_{i(1-\beta)}$. Hence consumers who do not search will have no incentive to opt-in and therefore cannot be targeted by firms. This further illustrates the strong correlation between consumers' search behavior and firms' targeting ability.

However, consumers who search for prices have incentive to receive and read emails because firms have incentive to compete for them with prices lower than posted prices on their websites. We assume that θ proportion of consumers who search for prices are potentially responsive to firms' email targeting, i.e. they have opted in. The remaining consumers either ignore targeting emails or choose not to receive emails because of time constraint or privacy concerns. θ can be interpreted either as a measure of consumer acceptance of targeting emails or their responsiveness to targeting emails.

5 Buy.com boasts that it offers "the lowest prices on earth" by regularly monitoring the competitive prices and updating its prices, using such technology.

6 Our results will not be changed even if firms cannot distinguish consumers from s_i, and $w_{i(1-\beta)}$.

Loyal	Search	Opt-in	Firm 1 Loyal	Firm 2 Loyal
Strong	-	-	1	1
Weak	No	-	$1-\beta$	$1-\beta$
Weak	Yes	No	$\beta(1-\theta)$	$\beta(1-\theta)$
Weak	Yes	Yes	$\beta\theta$	$\beta\theta$

Posted Prices: Monopoly

Posted Prices: Competition

Email Prices: Competition

Figure 1. The market.

The market can thus be represented as shown in Figure 1. The numbers within the cells represent the size of the segments. Firms 1 and 2 compete for the shaded market segments. Both the $\beta\theta$ weak loyal consumers of Firms 1 and 2 will be targeted by emails and will respond to competitive prices in the targeted email market. The $\beta(1-\theta)$ Firms 1 and 2 weak loyal consumers who search prices but do not opt in will look at both firms' prices and will buy from whichever firm offers the highest surplus. Both firms however have a monopoly on the unshaded segments loyal to their firms. Firm 1's strong loyal customers (of size 1) and $(1-\beta)$ weak loyal consumers who do not search (and do not find it optimal to opt in) will only look at Firm 1's posted prices and will buy only from Firm 1. Similarly, Firm 2's strong loyal customers and $(1-\beta)$ weak loyal consumers who do not search only look at Firm 2's posted prices and will buy only from Firm 2.

The marginal cost of sending a targeting email is assumed to be zero, consistent with the low cost of sending an email message relative to direct mail. Each firm simultaneously sets its posted price p_i to all consumers and email targeting prices $p_{ie}^{x}(x = w_{i\beta\theta}$ or $w_{j\beta\theta})$ to its own weak loyal consumers and its competitor's weak loyal consumers who opt in.

The model described in this section is parsimonious in nature but it captures the key economic effects resulting from the interaction between consumer search behavior and firms' targeting activities. There are only four parameters in the model: r reflects the degree of consumer heterogeneity; L reflects the intensity of competition in the market; β reflects the magnitude of consumer search; and θ reflects the extent of consumer acceptance of email targeting (opt-in). However, an important point to note in our model formulation is that the reach of targeting by firms in our model is driven not just by θ (opt-in), but also by β, (the extent of search). Thus the lowering of search costs not only increases search by consumers, but also increases the reach of targeting ($\beta\theta$). Further, as β increases due to reduction in search cost, it also enables firms to more cleanly separate out the "strong loyal" consumers from the "weak loyal" consumers. Thus reduction in search cost increases both the "reach" and "precision" of targeting. Our goal is to understand how this critical link between search cost and targeting ability affects the profitability of firms. This issue has hitherto been unexplored in the literature.

Before we proceed to the formal analysis of the model, we make three additional technical assumptions. First, we assume that $1 < r < 2$. This assumption guarantees that each firm will sell to both of its two consumer segments in the absence of consumer search. Second, we assume that $\frac{1}{6} < L < \frac{1}{3}$. This assumption makes it possible for weak loyal consumers to switch in equilibrium and ensures tractability for the model. Finally, we assume that consumers incur no cost to shop at the website of the firm they are loyal to. Thus, a consumer may still visit the website of the firm she is loyal to and buy from there even if she expects to be charged at her reservation price.[7]

3. Analysis

We start our analysis by examining firms' equilibrium decisions regarding email targeting. After receiving targeting emails from both firms, Firm 1's weak loyal consumers who search for prices and opt in (i.e. consumers in the $w_{1\beta\theta}$ segment) compare the two email offerings and buy at Firm 1 if and only if the price offered by Firm 1 is less than 1 and it is not higher than Firm 2's price by L or more. Therefore, competition for this segment results in Firm 1 charging L and Firm 2 charging 0 in equilibrium. Consequently, Firm 1 obtains a profit of $\beta\theta$L and Firm 2 obtains zero profit from this segment.[8] Similarly, in equilibrium Firm 1 charges 0 and Firm 2 charges L for Firm 2's weak loyal consumers who search and opt in (the $w_{2\beta\theta}$ segment). Firm 1 obtains zero profit and Firm 2 obtains a profit of $\beta\theta$L from this segment. Overall, each firm obtains a total profit of $\beta\theta$L from the consumers targeted by emails.

Now consider the market for firms' posted prices. Denoting π_{io} and π_i as firm i's profit associated with its posted price and its total profit respectively, we have $\pi_i = \pi_{io} + \beta\theta L$ where

$$\pi_{io} = 0 \qquad \text{if } p_i > r, \tag{1}$$

$$\pi_{io} = p_i \qquad \text{if } 1 < p_i \leq r, \tag{2}$$

$$\pi_{io} = p_i + p_i(1-\beta) \qquad \text{if } p_i > p_j + L \text{ and } p_i \leq 1, \tag{3}$$

$$\pi_{io} = p_i + p_i(1-\beta) + p_i\beta(1-\theta) \qquad \text{if } p_j - L \leq p_i \leq p_j + L \text{ and } p_i \leq 1, \tag{4}$$

$$\pi_{io} = p_i + p_i(1-\beta) + 2p_i\beta(1-\theta) \qquad \text{if } p_i < p_j - L \text{ and } p_i \leq 1. \tag{5}$$

7 The assumption on L is similar to that made in Raju et al. (1990) (p. 291). We make no additional assumptions about the cost of shopping in stores that consumers are not loyal to. For a consumer in the strong loyal segments, the cost of shopping at the website she is not loyal is irrelevant. For a consumer in the weak loyal segment, her cost of shopping at the website she is not loyal to can be regarded as a part of L. Our conclusions are robust with respect to the relaxation of these technical assumptions. Details are available upon request.

8 If firms incur positive variable costs and/or fixed costs to send emails, both firms' equilibrium pricing decisions are in mixed strategies. Firm 2 has positive probability of not sending emails and it charges non-zero price. However, the resulting equilibrium profits are the same as in the case where emails are costless. Therefore, our analysis below is not affected.

In the above equations, p_i is Firm i's profit from its strong loyal segment when $p_i \leq r$ and $p_i(1-\beta)$ is Firm i's profit from its weak loyal consumers who do not search when $p_i \leq 1$. When $p_j - L \leq p_i \leq p_j + L$ and $p_i \leq 1$, Firm i gets its weak loyal consumers who search but do not opt in for email lists. Its profit from those consumers is $p_i\beta(1-\theta)$ as shown in (4). Finally, when $p_i < p_j - L$ and $p_i \leq 1$, Firm i gets both its own and the competitor's weak loyal consumers who search but do not opt in email lists. Its profit from them is $2p_i\beta(1-\theta)$ as shown in (5).

By the same logic as in Raju et al. (1990), firms' equilibrium posted prices may involve mixed strategies. Solving for firms' optimal decisions based on the profit functions given in equations (1)–(5), we can obtain firms' equilibrium posted prices (or expected posted prices, $E_i(p)$, in the case of mixed strategy equilibrium) and total profits as described in Lemma 1 below.

Lemma 1. *The competition in posted prices among firms results in an equilibrium in one of five exhaustive and mutually exclusive parameter regions. The regions, the expected posted prices, profits and the key comparative statics for prices and profits associated with these regions are summarized in Table* 1.

The proof for Lemma 1 can be found in the Appendix. Lemma 1 provides firms' equilibrium posted prices and profits under different regions of parameter values. An example of the equilibrium regions is shown in Figure 2 for $r = 1.8$ and $L = 0.25$.

The equilibrium is in pure strategies for Regions I, IV and V but is in mixed strategies for Regions II and III. Detailed results relating to the price distributions in mixed strategy equilibrium can be found in the Appendix.

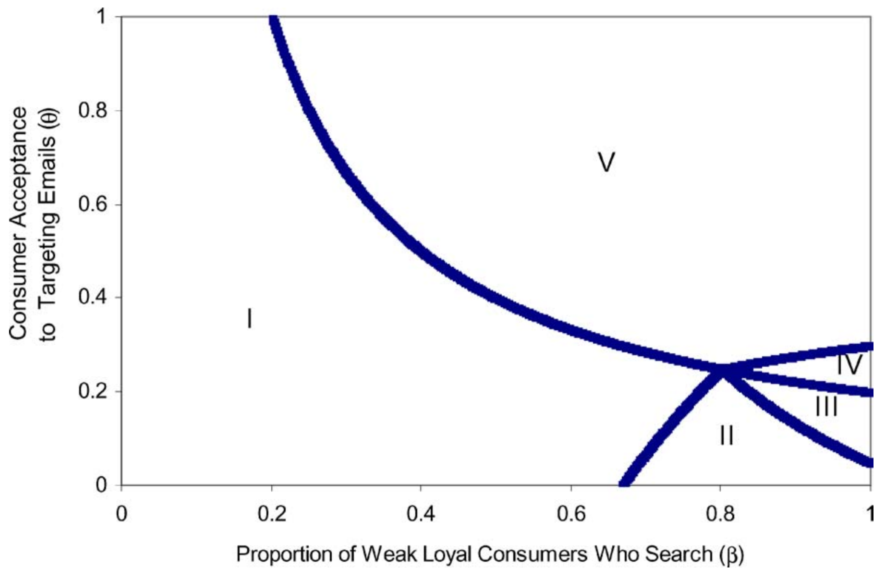


Figure 2. Equilibrium regions ($r = 1.8$, $L = 0.25$).

Table 1. Expected prices, expected profits and comparative statics in different regions.

Regions	Conditions	Expected posted prices (p)	Expected profits (π)	Key comparative statics
Region I: Symmetric pure strategies	$r < 2-\beta\theta$ $L \geq \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$	1	$2-\beta\theta(1-L)$	$\frac{\partial p}{\partial \beta}=0,\ \frac{\partial \pi}{\partial \beta}<0,$ $\frac{\partial p}{\partial \theta}=0,\ \frac{\partial \pi}{\partial \theta}<0$
Region II: Symmetric mixed strategies	$r < 2-\beta\theta$ $L < \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$ and $L \geq \frac{r}{2-\beta\theta} - \frac{2-\beta\theta}{2+\beta-2\beta\theta}$	$\frac{p_{n1}(2-\beta\theta)}{\beta(1-\theta)}$ $\left[\ln \frac{1-L}{p_{n1}(p_{n1}-L)} + L\left(1-\frac{1}{p_{n1}}+\frac{1}{p_{n1}-L}\right)\right.$ $\left. + p_{n1}\left(1-\frac{1}{p_{n1}-L}\right)+1\right] + p_{n1} - \frac{2-\beta\theta}{\beta(1-\theta)}$	$\frac{(2-\beta\theta)^2}{2+\beta-2\beta\theta}+2L$	$\frac{\partial E(p)}{\partial \beta}<0,\ \frac{\partial \pi}{\partial \beta}<0,$ $\frac{\partial E(p)}{\partial \theta}>0,\ \frac{\partial \pi}{\partial \theta}<0$
Region III: Symmetric mixed strategies	$r < 2-\beta\theta$ $L < \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$ and $L < \frac{r}{2-\beta\theta} - \frac{2-\beta\theta}{2+\beta-2\beta\theta}$	$\frac{r}{\beta(1-\theta)}\left[\ln \frac{1-L}{p_{n2}(p_{n2}-L)}\right.$ $+ L\left(\frac{2}{p_{n2}-L}-\frac{1}{p_{n2}}-\frac{1}{1-L}\right)$ $\left. + \left(1-\frac{1}{p_{n2}-L}\right)+\frac{r}{1-L}\right] + 1 - L - \frac{(2-\beta\theta)r}{\beta(1-\theta)}$	$r+\beta\theta L$	$\frac{\partial E(p)}{\partial \beta}<0$ if θ is small, $\frac{\partial E(p)}{\partial \beta}>0$ otherwise. $\frac{\partial \pi}{\partial \beta}>0,\ \frac{\partial E(p)}{\partial \theta}>0,\ \frac{\partial \pi}{\partial \theta}>0$
Region IV: Asymmetric pure strategies	$r \geq 2-\beta\theta$ $L < 1-\frac{r}{2+\beta-2\beta\theta}$	$p_i = 1-L,\ p_j = r$	$\pi_i = [2+\beta(1-2\theta)]$ $-[2+\beta(1-3\theta)]\,L$ $\pi_j = r+\beta\theta L$	$\frac{\partial p}{\partial \beta}=0,\ \frac{\partial p}{\partial \theta}=0,\ \frac{\partial \pi_i}{\partial \theta}<0$ $\frac{\partial \pi_j}{\partial \theta}>0,\ \frac{\partial \pi_j}{\partial \beta}>0$
Region V: Symmetric pure strategies	$r \geq 2-\beta\theta$ $L \geq 1-\frac{r}{2+\beta-2\beta\theta}$	r	$r+\beta\theta L$	$\frac{\partial p}{\partial \beta}=0,\ \frac{\partial \pi}{\partial \beta}>0,$ $\frac{\partial p}{\partial \theta}=0,\ \frac{\partial \pi}{\partial \theta}>0$

Where $p_{n1} = \frac{2-\beta\theta}{2+\beta-2\beta\theta} + L$ and $p_{n2} = \frac{r}{2-\beta\theta}$.

It is easy to verify that, across all regions, firms' equilibrium posted prices and total profits are non-decreasing as r increases and/or L increases. The intuition behind it is very obvious because an increase in r increases the overall willingness to pay of consumers in the market and an increase in L reduces competition between firms.

Our main interest in this paper is to understand the joint impact of consumer search and firms' targeting activities on market competition. Based on the comparative statics shown in Table 1, we summarize the impact of consumer price search on firms' posted prices and total profits in the following proposition.

Proposition 1 (Impact of Consumer Price Search). *If opt-in* (θ) *is small, firms' equilibrium posted prices are non-increasing and their equilibrium profits decrease as more consumers search for prices from competing firms* (*i.e. as* β *increases*). *However, if opt-in* (θ) *is sufficiently large, both firms' equilibrium posted prices and their equilibrium profits can increase as more consumers search for prices from competing firms.*

Proposition 1 can be proved using the results of Lemma 1. If opt-in (θ) is small, the equilibrium is in Region I when the size of the search segment (β) is small or is in Region II when β is large. From Table 1, firms' posted prices are non-increasing and profits are decreasing with respect to β in both regions. Moreover, both equilibrium posted prices and profits decrease when the equilibrium shifts from Region I to Region II. This proves the first part of Proposition 1. If θ is sufficiently large, as illustrated in Figure 2, the equilibrium will lie in Region III, IV or V when β is large. Based on Table 1, firms' equilibrium posted prices and profits can both increase with β in those regions. This proves the second part of Proposition 1.

Intuitively speaking, Proposition 1 is the result of two opposing effects of consumer search on price competition. Obviously, there is a competition effect: an increase in consumer price search intensifies competition between firms. As more consumers search prices across competing firms, firms are more likely to undercut each other's posted prices. In addition, more consumers will be targeted by emails with even lower prices. This effect of consumer price search has a negative impact on firms' prices and profits, which is consistent with conventional wisdom.

However, there is also a price discrimination effect due to a better ability to segment the market on the basis of the customer's store loyalty. An increase in consumer price search activities provides firms greater information to separate consumers who are loyal to the store and those who are "price searchers." As a result, an increase in consumer search enables firms to better price discriminate between their strong loyal consumers and weak loyal consumers. Consequently, it can lead to higher posted prices and profits. This effect becomes stronger as the opt-in (θ) increases. When θ is sufficiently large, the price discrimination effect will dominate the competition effect. Hence, firm's posted prices and total profits can both increase.

It is critical to note that firms' ability to price discriminate is a result of the interaction between consumer search and targeted pricing. Price discrimination cannot be efficiently implemented without the targeted communication online made possible by email. More importantly, it is the low online search cost that induces consumers to reveal their loyalty types (strong or weak) through their search and purchase behaviors; and this provide the basis for the firms' segmentation and price discrimination strategy.

The first part of Proposition 1 confirms the conventional wisdom regarding the impact of consumer search on firms' prices and profits. However, the second part of Proposition 1 contradicts conventional wisdom and shows that, in the presence of email targeting, an increase in consumer search activities in a market can indeed increase firms' prices and profits. This result suggests that lower online search cost may lead to either lower or higher observed online prices depending on the level of opt-in. *The fact that greater search endogenously improves the* ***precision and reach*** *of targeting in our model, is critical to the reversal of conventional wisdom in our analysis*.

The Internet has drastically reduced consumer search costs for prices. Therefore, it will be interesting to compare firms' prices and profits under extreme values of β, which correspond to big differences in consumer search costs. We have the following corollary.

Corollary 1. *If both opt-in* (θ) *and consumer heterogeneity in willingness to pay* (r) *are sufficiently large*, *firms' posted prices and profits are higher in the case where a sufficiently large proportion of consumers search for prices* ($\beta \to 1$) *than in the case where no consumer searches for prices* ($\beta = 0$).

Corollary 1 is easy to verify. As shown in Table 1, the equilibrium falls in Region I at $\beta = 0$. The corresponding posted prices and profits are $p_i^I = 1$ and $\pi_i^I = 2$. At $\beta \to 1$ and $\theta \to 1$, however, the equilibrium falls in Region V with corresponding posted prices and profits $p_i^V = r$ and $\pi_i^V = r + \beta\theta L$. Therefore, we have $p_i^V > p_i^I$ and $\pi_i^V(\beta \to 1, \theta \to 1) \to r + L > 2 = \pi_i^I$ as $r \to 2$. The same results can be obtained by comparing posted prices and profits in Region III or IV to Region I. Actually, as demonstrated in Figure 2, θ need not be very high for the equilibrium to be in Region III, IV or V. Therefore, Corollary 1 holds for a large range of parameter values of θ. Corollary 1 extends the conclusion in Proposition 1 by indicating that with the presence of email targeting, firms' prices and profits can increase not only with a marginal decrease but also with a dramatic decrease in consumer search cost.

Proposition 1 and Corollary 1 reveal the impact of consumer search on equilibrium outcomes with different levels of opt-in. We now look at the impact of opt-in (θ) on firms' posted prices and total profits. The results are given in Proposition 2 below.

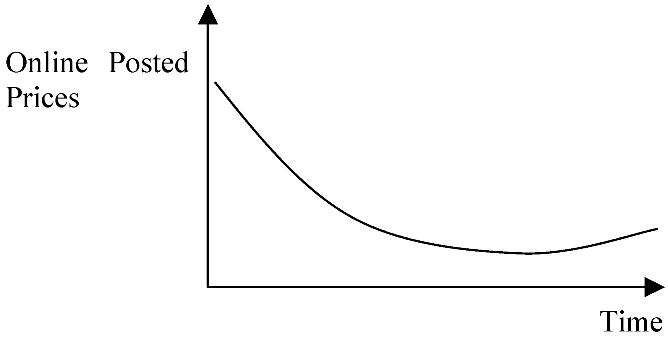
Proposition 2 (impact of opt-in)**.** *If the proportion of consumers searching prices* (β) *is small*, *firms' equilibrium posted prices are non-decreasing and their equilibrium profits decrease as opt-in increases* (*i.e. as* θ *increases*). *However*, *if the proportion of consumers searching prices* (β) *is sufficiently large*, *both firms' equilibrium posted prices and their equilibrium profits can increase as opt-in increases.*

Similar to Proposition 1, Proposition 2 can be proved using the results of Lemma 1. If β is sufficiently small, the equilibrium is either in Region I for all θ or in Region I then Region II as θ increases. In both cases, firms' posted prices are non-decreasing and profits are decreasing with respect to θ. If β is sufficiently large, the equilibrium will fall in Region III, IV or V when θ is large. From Table 1, firms' equilibrium posted prices can increase in those regions as θ increases and their values can be higher than those in the cases where θ is small (i.e. in Region I or II). Also from Table 1, firms' equilibrium profits in those regions increase with θ as well.

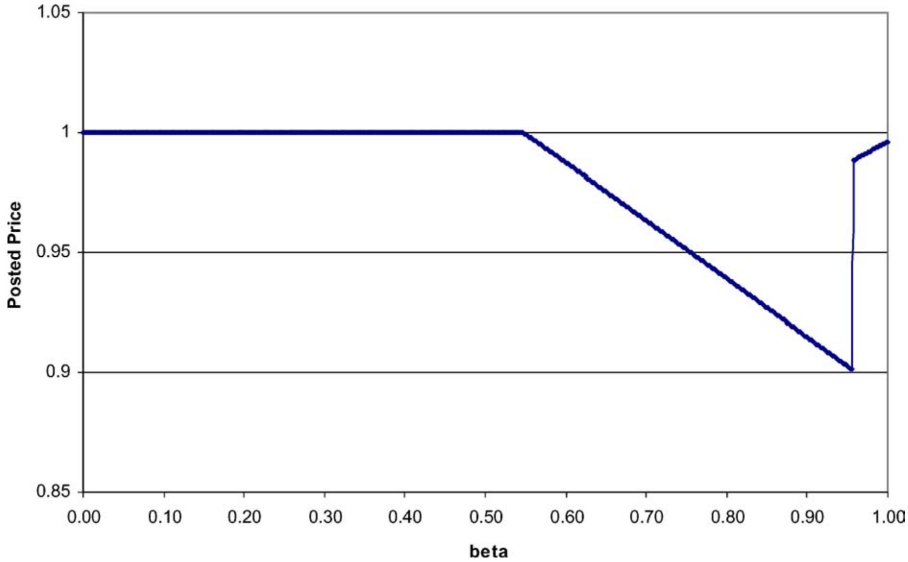
The intuition behind Proposition 2 is similar to that for Proposition 1. First, there is a competition effect. An increase in opt-in (θ) intensifies competition between firms because the email targeting market is more competitive than the posted prices market. Obviously, this effect has a negative impact on firms' total profits. Second, there is also a price discrimination effect. An increase in targeting coverage due to higher opt-in further separates "price searchers" from strong loyal consumers and thus enables firms to better price discriminate between them. This price discrimination effect has a positive impact on firms' posted prices and profits. When search cost is high (β is small) consumer types cannot be identified due to limited search activity, therefore the competition effect dominates the price discrimination effect. But when β is large, the price discrimination effect dominates the competition effect because of the improved reach and precision of targeting.

Propositions 1 and 2 indicate the importance of investigating the impact of consumer search and firm targeting behavior using an integrated approach. The interaction between consumer search and firms' email targeting is captured by $\beta\theta$ in our model. When this interaction is small (i.e. either β or θ is small), the results in the two propositions converge to similar conclusions as in the previous literature (Bakos, 1997; Thisse and Vives, 1988; Shaffer and Zhang, 1995). However, when this interaction is strong (i.e. both β and θ are large), the opposite is true. In the context of the Internet, the interaction between consumer price search and firms' email targeting tends to be strong. On the one hand, consumers empowered by Internet technologies can compare prices across several stores at one shot using a few "clicks". Consequently, their product preferences and price sensitivities are revealed to firms through their search activities and the resultant purchase decisions. On the other hand, firms equipped with emails servers and electronic databases can gather a large amount of consumer information online in real time and target consumers individually with negligible cost. This enables firms to price discriminate and helps mitigate (and even overcome) the competitive pressures on firm prices and profits. Therefore as suggested by Propositions 1 and 2, the implications of the reduced consumer search cost on price competition can be very different from the predictions made by current theory that do not consider the interactions between consumer search and email targeting in the context of the Internet.

As we mentioned in Introduction, recent empirical research has indicated an apparent divergence in the average levels of posted prices at Internet stores (Bailey, 1998; Brynjolfsson and Smith, 2000; Clay et al., 2001). If all of those empirical results were indeed consistent, then online prices should have fallen between 1997 and 1999 and then risen during 2000 as indicated in Figure 3(a). Current theoretical research cannot explain this pattern of changes in prices. In Figure 3(b), we show how the expected posted price changes as search costs fall (β increases). The pattern in Figure 3(b) is consistent with the pattern in Figure 3(a) in that prices may decline and then rise as search costs falls. Hence, if the level of search costs on the Internet has been declining over the period of 1997–2000 (a reasonable assumption), our results offer a plausible explanation for the seemingly divergent empirical findings regarding online retail prices. We present these findings with the caveat that a simpler explanation such as changes in the objectives of dot-com firms due to investor pressures to show profitability could have led to this pattern as well. For example, firms may have had



(a)



(b)

Figure 3. (a) Online posted price pattern reported in empirical studies. (b) Posted prices as a function of β in the model ($r = 1.5$, $L = 0.167; \theta = 0.33$).

market share goals and therefore lower prices early on and may have shifted to profitability goals leading to higher prices.

Another interesting aspect of our results is that we find that in some regions the equilibrium is in mixed strategies. Recent empirical research has documented substantial price dispersion in prices of firms that are unrelated to observable firm characteristics (Pan et al., 2003). Such dispersion would however be quite consistent with the mixed strategy equilibrium results of our model.

Before concluding our analysis in this section, we briefly discuss the welfare implications of consumer price search activities and firms' ability to target online. An interesting result is given in Corollary 2 below.

Corollary 2. *If a large number of consumers search prices and opt-in (i.e. both β and θ are large), some consumers who do not receive emails will not buy from either firm. Nevertheless, in this condition (i.e. when both β and θ are large), an increase in the number of consumers who search prices and/or opt-in (i.e. as β and/or θ increase) can increase both total consumer welfare and firms' profits.*

Corollary 2 is directly obtained from Lemma 1 and Proposition 1 and 2. If the equilibrium is in Region I or II, all consumers are served in the market. Thus, consumer welfare increases (decreases) as firms' profits decreases (increases) in those regions. However, if the equilibrium is in Region III, IV or V (where both β and θ are large enough), some weak loyal consumers who are not targeted may not buy from either firm because at least one firm sets its posted prices at r with nonzero probability. Therefore, there are losses in total social welfare. As β and/or θ increase in those regions, more consumers will be served through targeting and thus total social welfare increases. Consequently, it is possible for both firms and consumers to be better off when β and/or θ increase. For example, firms' profits increase with respect to β and θ in Region V. The total consumer welfare in this region is $W = 2(r + \beta\theta - \pi_i) = 2\beta\theta(1 - L)$. It increases with respect to β and θ as well.

Corollary 2 implies that consumers who do not search or do not opt-in can be left out of the market by high prices, and this results in a loss of social welfare. However, given high levels of consumer search and firms' targeting, any further increase in consumer price search and targeting may actually improve total consumer welfare and benefit firms simultaneously. It is interesting for Internet policy makers that consumers who are dissatisfied with online privacy and therefore refuse to opt in can be left out of the market when a large majority of the market is satisfied with the privacy standards and therefore opts in.

4. Extensions

In this section, we extend our model in several respects to obtain additional insights on the joint impact of consumer search and firms targeting on market competition. First, we relax the symmetry assumption of firms and discuss the competitive implications of consumer search and firms' email targeting in the context of asymmetric firms. Then in Section 4.2, we provide directional insights about how our results will be affected if consumers behave strategically by possibly signaling the wrong type to firms in order to obtain lower prices from targeted emails.

4.1. Asymmetric firms

So far, our discussion was limited to competition between symmetric firms. However, the main conclusions we derive from the basic model also apply to the case where the competing firms are asymmetric. To demonstrate this, we focus on the equilibrium corresponding to Region I and V in Lemma 1. Assume that the size of Firm 1's strong loyal segment is $\lambda_s > 1$, the size of its weak loyal segment is $\lambda_w > 1$, the reservation price of its strong loyal segment is $r_1 > r$ with $\lambda_s r_1 < \lambda_s + \lambda_w$, and the minimum price difference needed for its weak loyal consumers to switch is $L_1 > L$. Let Firm 2 be the same as in the basic model.

For the email targeting market, Firm 1 charges L_1 and Firm 2 charges 0 to Firm 1's weak loyal consumers in equilibrium. The resulting profits are $\lambda_w \beta\theta L_1$ for Firm 1 and 0 for Firm 2. Similarly, Firm 2 obtains a profit of $\beta\theta L$ and Firm 1 obtains no profit from Firm 2's weak loyal consumers in the email targeting market. If $\beta \to 0$, the equilibrium for the posted prices is $p_1^I = p_2^I = 1$, which corresponds to Region I in the basic model. Firms' total equilibrium profits in this case are $\pi_1^I = \lambda_s + \lambda_w[(1-\beta\theta(1-L)]$ and $\pi_2^I = 2-\beta\theta(1-L)$. Both profits decrease with respect to β and θ, which are similar to our results from the basic model.

However, if $\beta \to 1$ and $\theta \to 1$, the equilibrium posted prices are $p_1^V = r_1$ and $p_2^V = r$, which corresponds to Region V in the basic model. Firms' total equilibrium profits in this case are $\pi_1^V = r_1\lambda_s + \lambda_w \beta\theta L_1$ and $\pi_2^V = r + \beta\theta L$. Both profits increase with respect to β and θ and p_i^V is higher than p_i^I. These results are similar to those in Proposition 1 and 2. Also, it is obvious that π_i^V can be higher than π_i^I when r_1 or r is sufficiently large, leading to the same conclusion as Corollary 1.

Comparing changes of firms' profits at $\beta = \theta = 1$ to $\beta = 0$, we have that

$$\begin{aligned} \Delta &= \left(\pi_1^V\big|_{\beta=\theta=1} - \pi_1^I\big|_{\beta=0}\right) - \left(\pi_2^V\big|_{\beta=\theta=1} - \pi_2^I\big|_{\beta=0}\right) \\ &= (r_1 - 1)\lambda_s - (r-1) - \lambda_w(1-L_1) + (1-L) \end{aligned} \quad (6)$$

It is easy to see that Δ increases with r_1, λ_s and L_1 but decreases with λ_w. The reason behind this result is as follows. Firm 1's gain from the price discrimination effect increases when r_1 or λ_s increases and its profit from email targeting increases with respect to L_1 as a larger L_1 leads to less competition. However, an increase in λ_w puts more consumers into the more competitive email targeting market and therefore reduces the firm's profit. Thus, the firm with a stronger market position (larger L) and a larger number of strong loyal consumers with higher willingness to pay will benefit more as consumer search cost drastically reduces and firms' targeting ability increases in the online world. However, a firm with only more weak loyal consumers will benefit less than its competitor or could be even worse off in this new competitive environment.

This result indicates that the value of loyalty is great in the online world and offers some support for online firms trying very hard to build a large customer base in the hopes of future competitive advantage. Our result however is particularly insightful as a warning that it is can be a disadvantage to have a large customer base if the customer base lacks strong loyalty. A larger customer base can be a competitive advantage only if it comes with a superior product or service that inspires high loyalty.

4.2. Strategic consumers

Our basic model in Section 2 is static in nature. An implicit assumption there is that consumers do not take the surplus of future periods into consideration when making search and purchase decisions. In other words, consumers are completely myopic (discount rate for future surplus is 0) in the basic model. However, as shown in our analysis, consumers receive lower prices from email targeting than from posted prices. Given this fact, if the discount rate for future gains is large enough, in order to receive lower targeted prices, consumers who do not mind to opt in will have incentive to signal to firms that they are the weak loyal consumers who search. By doing so, consumers may incur initial loss from searching and buying from the firm they are not loyal to but they gain in future periods if the firm they are loyal to perceives them to be price sensitive and targets them with low price.

Recently, researchers have started paying attention to the strategic behavior of consumers facing targeted prices. Two-period models (Acquisti and Varian, 2001; Fudenberg and Tirole, 2000) and overlapping-generation models where each consumer survives for two periods (Villas-Boas, 1999, 2003) have been developed. Explicitly examining strategic behavior of consumers in the framework of our model is beyond the scope of this study due to tractability considerations. This is because a dynamic model setup will be needed, where each consumer has to be in the market for more than two periods as it may require multiple transactions for firms to learn the type of a consumer.

Nevertheless, we can still obtain some insights about the implications of this strategic behavior for our results from the basic model by considering the extreme case where the discount rate for future surplus is 1. In this case, consumers do not discount future gains at all. If there are sufficient periods in the future, regardless of the cost of search (as long as the search cost is finite), all consumers who do not mind opting in will search and pretend to be the weak loyal consumers of both firms. Hence firms do not find targeting to be an effective mechanism for price discrimination, no matter what the level of search cost is. However as search costs fall, firms will compete more aggressively in the posted price market, and therefore prices and profits decline. Thus as argued in our earlier discussion, without the link between consumer search and firms' targeting ability, more consumer search always lowers firms' prices and profits as in the existing literature.

Therefore, we should be cautious in generalizing our results from the basic model to the case of strategic consumers. If consumers are strategic, our results are likely to hold if they heavily discount the future. Otherwise, with strategic consumers, more consumer search will lead to lower prices and lower profits as suggested by the theoretical analysis when search costs are analyzed separately as in Bakos (1997).

5. Conclusion

The Internet has drastically reduced consumer search costs and improved firms' targeting ability. We therefore investigated the impact of these two effects on online price competition. A key insight in this paper is that increased search due to a reduction in search cost can lead to improvements in the "reach" and "precision" of firms' targeting ability. A moderating effect on the effectiveness of targeting is the level of consumer opt-in for email targeting. In this paper, we investigated the impact of changes in search cost and opt-in on price competition and profits. Unlike extant research which suggests that a decline in search costs and improvements in targeting ability will cause prices and profits to decline, the key result of this paper is that a reduction in search cost can reduce price competition and raise profits due to its ability to increase the targeting ability of firms. This critical link between search and targeting has hitherto been unexplored in the literature.

Our analysis offers interesting strategic insights for managers about how to address the competitive problems associated with low search costs on the Internet:

(1) It suggests that firms should invest in better technologies for personalization and targeted pricing so as to prevent the Internet from becoming a competitive minefield that destroys firm profitability. In fact we suggest that low search costs can facilitate better price personalization and lead to higher profits.
(2) The analysis also offers guidelines on online customer acquisition efforts. The critical issue for competitive advantage is not in increasing market share per se, but in increasing the loyalty of the customers. While a larger share of very loyal customers reduces competitive intensity, surprisingly a larger share of customers who are not very loyal can be a competitive disadvantage. In order for customer acquisition to be profitable, it should be accompanied by a superior product or service that can ensure high loyalty.
(3) Investing in online privacy initiatives that assures consumers that their private information will not be abused other than to offer them "deals" is worthwhile. Such assurances will encourage consumers to opt into firm mailing lists. This facilitates successful targeting which in turn ameliorates the competitive threats posed by low search costs on the Internet.
(4) When the overwhelming majority of customers are satisfied with online privacy, the remaining privacy conscious customers who are not willing to pay a higher price to maintain their privacy will be forced out of the market. This may be of some concern to privacy advocates.

This research however is only a first step towards understanding the competitive implications of the interactions between search and targeting on the Internet. By design, we have focused on communication of only price information to control for other effects. Previous research however has indicated that communicating product-related information over the Internet can increase the perceived differentiation among products and thus reduce competitive intensity (Zettelmeyer, 2000). Moreover, Lal and Sarvary (1999) distinguish between products with primarily digital and non-digital attributes and show that competition may be reduced on the Internet for products with non-digital attributes. We have also shown that our results are not likely to hold if consumers behave strategically and do not discount future gains at all. Such consumers can stifle the ability of firms to learn their true types (by searching initially and pretending they are weakly loyal) and break the link between targeting and search that we provide in the paper. Future research therefore needs to evaluate the robustness of our insights by incorporating such finer aspects of consumer search.

Appendix: Proofs of Lemma 1 and Propositions 1 and 2

If $r < 2 - \beta\theta$ and $L \geq \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$ (Region I), then $p_i = 1$ in equilibrium with $\pi_{io} = 2 - \beta\theta$. This is because neither firm would like to set $p_i = r$ as $r < 2 - \beta\theta$. Also, neither firm has incentive to undercut its competitor's price to get its $w_{\beta(1-\theta)}$ segment because the profit of doing so is $[2 - \beta\theta + \beta(1-\theta)](1-L)$, which is less than $2 - \beta\theta$ for $L \geq \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$.

If $r < 2 - \beta\theta$ and $L < \frac{\beta(1-\theta)}{2+\beta-2\beta\theta}$, then each firm has incentive to undercut the other's price in order to get the $w_{\beta(1-\theta)}$ segment from its competitor. This is because $[2 - \beta\theta + \beta(1-\theta)](1-L) > 2 - \beta\theta$ now holds. This scenario is similar to the model discussed in Raju et al. (1990). The equilibrium involves mixed strategy because Firm i has incentive to undercut Firm j's price by L if p_j is high enough but has incentive to increase its price if p_j is low enough. The mixed equilibrium is derived below. The logic of the proof follows Raju et al. (1990).

First, let p_{n1} be the lowest price of Firm j that Firm i is willing to undercut. $p_{n1} > 1 - L$ must hold because $(1 - 2L)[2 - \beta\theta + \beta(1 - \theta)] < 2 - \beta\theta$ always holds as $L > \frac{1}{6}$ by assumption. This implies that rather than undercut $p_j = 1 - L$ by setting p_i below $1 - 2L$, Firm i is better off by setting $p_i = 1$ to secure its own $w_{\beta(1-\theta)}$ segment and obtain $\pi_{io} = 2 - \beta\theta$. Since $p_{n1} > 1 - L$, it can be solved from $(p_{n1} - L)[2 - \beta\theta + \beta(1 - \theta)] = 2 - \beta\theta$. This leads to $p_{n1} = \frac{2-\beta\theta}{2+\beta-2\beta\theta} + L$.

Next, let p_{n2} be the lowest price Firm i will charge if such price does not undercut Firm j's price by L. Because Firm i can at least obtain $\pi_{io} = r$ by setting $p_i = r$, we have $p_{n2}(2 - \beta\theta) = r$. Thus, $p_{n2} = \frac{r}{2-\beta\theta}$.

Now consider the case where $p_n = \max(p_{n1}, p_{n2}) = p_{n1}$, i.e. $\frac{r}{2-\beta\theta} - \frac{2-\beta\theta}{2+\beta-2\beta\theta} \leq L$. This is corresponding to Region II in Lemma 1. In this case, Firm i's price support is $p_i \in [p_n, 1] \cup (p_n - L, 1 - L)$ because (1) neither firm would undercut price lower than p_n by L and (2) for any $p_j \leq 1 - L$, Firm i would like to secure its own $w_{\beta(1-\theta)}$ segment by setting $p_i = p_j + L$ rather than undercut p_j by setting p_i below $p_j - L$. No probability mass can exist at $1 - L$ because Firm i can undercut $p_j = 1$ to obtain the $w_{j\beta(1-\theta)}$ segment only at p_i *below* $1 - L$. Also, probability mass cannot exist at $p_n - L$ because Firm i will set $p_i = 1$ rather than $p_n - L$ if $p_j = p_n$. Denoting $H_i(p) = \Pr(p_i \geq p)$, we have the following equations from the profit-invariant nature of mixed strategy equilibrium.

$$\pi_{io} = p_i[(2 - \beta) + \beta(1 - \theta)H_j(p_i - L)], \quad \text{if } p_n \leq p_i \leq 1 \tag{A1}$$

$$\pi_{io} = p_i\{(2 - \beta) + 2\beta(1 - \theta)H_j(p_i + L) + \beta(1 - \theta)[1 - H_j(p_i + L)]\}, \quad \text{if } p_n - L < p_i < 1 - L \tag{A2}$$

$$\pi_{io} = p_i(2 - \beta\theta) \quad \text{if } p_i = p_n \tag{A3}$$

Thus, the equilibrium profit and price distribution for Firm i are $\pi_{io} = p_i(2 - \beta\theta)$ and

$$H_i(p) = \frac{\pi_{io}}{\beta(1 - \theta)(p - L)} - \frac{2 - \beta}{\beta(1 - \theta)} - 1, \quad \text{if } p_n \leq p_i \leq 1; \tag{A4}$$

$$H_i(p) = \frac{\pi_{io}}{\beta(1 - \theta)(p + L)} - \frac{2 - \beta}{\beta(1 - \theta)}, \quad \text{if } p_n - L < p_i < 1 - L. \tag{A5}$$

The probability mass at 1 is given by $q_1 = H_i(1)$ and the probability mass at p_n is given by $q_n = H_i(1 - L) - H_i(p_n)$. The expected equilibrium price of each firm can then be derived from its definition:

$$E_i(p) = \int_{p_n - L}^{1-L} -\frac{\partial H_i(p)}{\partial p} p\,dp + \int_{p_n}^{1} -\frac{\partial H_i(p)}{\partial p} p\,dp + q_n p_n + q_1.$$

The result is as provided in Lemma 1.

If $p_n = \max(p_{n1}, p_{n2}) = p_{n2}$, i.e. $L < \frac{r}{2-\beta\theta} - \frac{2-\beta\theta}{2+\beta-2\beta\theta}$, we have the Region III in Lemma 1. In this case, Firm i's price support is $p_i \in \{r\} \cup (p_n, 1] \cup (p_n - L, 1 - L]$.

Comparing to Region II, r is on the price support but there is no probability mass at p_n. This is because instead of setting $p_i = p_n$ Firm i will be better off setting $p_i = r$ in this case. There can be a probability mass at $1 - L$ because Firm i can now charge $p_i = 1 - L$ in order to get the $w_{j\beta(1-\theta)}$ segment not served by Firm j when $p_j = r$. (A1)–(A5) still hold in this region by replacing (A3) with $\pi_{io} = p_i$ if $p_i = r$. Therefore, $\pi_{io} = r$ in equilibrium and the probability mass at $1 - L$ is given by $q_{1-L} = H_i(1 - L) - H_i(p_n)$. In addition, we have that

$$\pi_{io} = p_i[(2 - \beta\theta) + \beta(1 - \theta)H_j(r)] \quad \text{if } p_i = 1 - L, \tag{A6}$$

which implies that $q_r = H_i(r) = \frac{\pi_{io}}{\beta(1-\theta)(1-L)} - \frac{2-\beta}{\beta(1-\theta)} - 1$. Since $H_i(r) = H_i$ (1) obtained from (A4), there is no probability mass at $p_i = 1$, i.e. the equilibrium price support is actually $p_i \in \{r\} \cup (p_n, 1) \cup (p_n - L, 1 - L]$ in this case. Similar to Region II, the expected equilibrium price of each firm can then be derived from its definition:

$$E_i(p) = \int_{p_n-L}^{1-L} -\frac{\partial H_i(p)}{\partial p} p dp + \int_{p_n}^{1} -\frac{\partial H_i(p)}{\partial p} p dp + q_{1-L}(1 - L) + q_r r,$$

which leads to the result reported in Lemma 1.

If $r \geq 2 - \beta\theta$, Firm i will never charge a price below r if it cannot undercut the other firm's price by L to get the $w_{j\beta(1-\theta)}$ segment. If $L < 1 - \frac{r}{2+\beta-2\beta\theta}$, i.e. in Region IV, Firm i has incentive to set price at $1 - L$ to get Firm j's $w_{\beta(1-\theta)}$ segment when $p_j = r$ because $(1 - L)[2 - \beta\theta + \beta(1 - \theta)] > r$. However, Firm j has no incentive to further undercut Firm i by setting $p_j = 1 - 2L$ because $(1 - 2L)[2 - \beta\theta + \beta(1 - \theta)] < r$ as $r \geq 2 - \beta\theta$ and $L > \frac{1}{6}$. Therefore, we have $p_i = 1 - L$, $p_j = r$, $\pi_{io} = [2 + \beta(1 - 2\theta)](1 - L)$ and $\pi_{jo} = r$ in the equilibrium.

Finally, we are in Region V if $r \geq 2 - \beta\theta$ and $L \geq 1 - \frac{r}{2+\beta-2\beta\theta}$. In this case neither firm has incentive to undercut the other firm for the $w_{j\beta(1-\theta)}$ segment by setting p_i below r because $(1 - L)[2 - \beta\theta + \beta(1 - \theta)] \leq r$. Therefore, $p_i = r$ and $\pi_{io} = r$ in the equilibrium.

Since the above regions are mutually exclusive and exhaust all possible values of parameters in the model, we have equilibrium results derived for the entire parameter space. The comparative statics of equilibrium profit w.r.t. the parameters in the model are easy to obtain by examining the signs of first order derivatives. So do the comparative statics of equilibrium price w.r.t. the parameters in the model for Region I, IV, and V. For Region II and III, the comparative statics of expected equilibrium price w.r.t. the parameters in the model are obtained by numerical examination because the expression of $E_i(p)$ given in Lemma 1 is very complicated. Since all parameters are confined to a closed range ($1 < r < 2, \frac{1}{6} < L < \frac{1}{3}, 0 \leq \beta \leq 1$, and $0 \leq \theta \leq 1$), the numerical analysis provides thorough results. The results regarding all such comparative statics are summarized in Propositions 1 and 2.

Acknowledgments

We thank participants at the 2001 NYU Annual Marketing Camp, the 2001 Marketing Science Conference in Weisbaden, Germany, the 2002 Stanford Institute of Theoretical

Economics (SITE) Conference on the Economics of the Internet, the Marketing Workshops at the University of Florida, Cornell, MIT and Yale for their comments. We thank Skander Essegaier and Subrata Sen for their comments. The usual disclaimer applies.

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