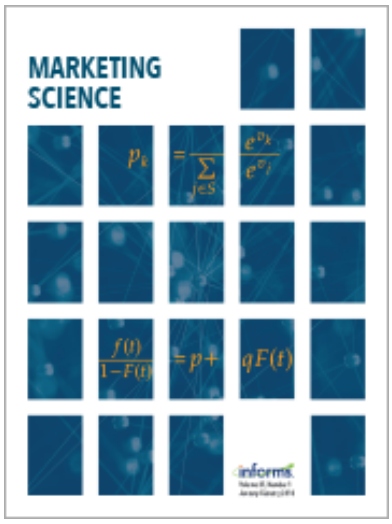

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Implications of Reduced Search Cost and Free Riding in E-Commerce

Dazhong Wu, Gautam Ray, Xianjun Geng, Andrew Whinston
Center for Research in Electronic Commerce, Department of Management Science and Information Systems,
The McCombs School of Business, University of Texas, Austin, Texas 78712
{dazhong.wu@mail.utexas.edu, gautam.ray@bus.utexas.edu, gengxj@mail.utexas.edu, abw@uts.cc.utexas.edu}

This paper examines a market where the provision of information service is costly, but information service has the characteristics of a public good. Consumers, on the other hand, can use the information service to make an informed purchase decision and derive higher utility from consuming their ideal product. However, after receiving the information service from an information service provider, consumers can easily free ride by purchasing at low-price sellers who do not provide any information service. The paper examines the competition where sellers compete by providing information service for horizontally differentiated products and where technology reduces consumers' search cost. It is found that in this market a seller needs to establish itself as an information service provider in order to make positive profits, even when there is free riding. A seller, however, cannot make positive profits by free riding all the time. Also, with an increase in competition in the information service market, sellers have reduced incentives to provide information service. It is also found that in this market a decrease in search cost may increase or decrease social welfare.

Key words: free riding; search cost; electronic markets; electronic commerce
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1. Introduction

It is argued that electronic markets reduce consumers' search costs and are therefore more efficient than physical markets. However, an important function of the market is to provide information service for consumers to assess their satisfaction from consuming a product, as well as provide information about how to use and maintain the product. For example, garden.com provides information service to determine the flowers and vegetables that could be grown in a garden depending on the features of the garden, and information about how to grow and maintain them. Similarly, amazon.com provides book reviews, tables of contents, and excerpts to enable users to assess their utility for a book. These information services are costly to provide. Therefore, if some firms provide these information services but do not make sales because of free riding by consumers and other sellers, it reduces a seller's incentive to provide these information services.

The free-riding problem was first examined by Telser (1960). He argued that competition might dissuade retailers from offering presale information service. A consumer may be convinced to purchase a product by the information service provided by the retailer. However, the consumer may buy the product from another retailer who charges a lower price. In this way, retailers who do not provide the information service free ride on those who do provide the service. Singley and Williams (1995) found that free-riding increases the price disparity between free-riding and nonfree-riding retailers, and drives consumers not currently free riding to free ride in the future. Free-riding also leads to a reduction in information service provided to consumers, and therefore to less demand for the product (Mittelstaedt 1986). Despite the free-riding problem, in physical markets information service providers still exist, as high search costs deter consumers from free riding. However, electronic markets reduce consumers' search costs. If the reduced search costs enable consumers to easily find lower prices, it is not clear if any seller would provide free information service.

In the search-cost literature (Varian 1980, Rob 1985, Stahl 1989, Zwick et al. 2003), consumers search for lower prices for homogeneous products; consumers do not need any information service. This literature therefore sidesteps the free-riding problem. Similarly, in markets where sellers sell differentiated products, sellers need not worry about free riding (Alba et al. 1997, Lal and Sarvary 1999, Lynch and Ariely 2000, Zettelmeyer 2000, Mehta et al. 2003, Wu and Rangaswamy 2003). The literature also suggests that lower search costs should make electronic

markets more efficient than comparable physical markets, and that the market price should go down to the competitive price (Brynjolfsson and Smith 2000, Clay et al. 2001). However, in markets where sellers sell the same set of horizontally differentiated products and consumers need information service to identify their ideal product, it is expected that a competitive price may eliminate sellers' incentive to provide free information service.

In the model presented in this paper, we examine a market where information service is valuable to consumers, and retailers compete to sell a set of horizontally differentiated products. In particular, we examine the incentives of sellers to provide free information service when consumers' search costs are reduced. It is found that as long as a certain proportion of consumers have a positive search cost, some sellers do provide free information service. Even in the presence of free riding, sellers are better off incurring the costs of providing free information service and having the reputation as sellers who provide information service, as against sellers who always free ride. It is also found that as the competition in the market increases, fewer sellers provide free information service.

In this market a decrease in search cost has a direct and an indirect impact on the social welfare. The direct impact is that a decrease in search cost increases social welfare by decreasing the cost of each search. The indirect impact is that it reduces social welfare by reducing sellers' incentives to provide information service, which in turn increases the amount of search required by consumers. The net impact of reduced search cost on social welfare depends on which effect is stronger. This suggests that if free riding is also considered, a decrease in search cost may increase or decrease social welfare. The rest of the paper is organized as follows. The model and its assumptions are described in §2, the equilibrium is presented in §3, and §4 examines the managerial and welfare implications of the equilibrium. We conclude in §5 with future extensions.

2. The Model

There is a continuum[1] of risk-neutral sellers, with mass S. A retailer sells different categories or classes [2] of products. In this model, sellers are electronic retailers who compete by selling N ($N \geq 2$) horizontally differentiated products for a product category. The paper examines the case of a specific product category. Sellers are of two types. A proportion α ($0 < \alpha < 1$) of the sellers, called Type-1 sellers, have the reputation for and the capability to provide free presale information service. The rest of the sellers, called Type-2 sellers, do not provide any information service. The main difference between the two types of sellers is that Type-1 sellers can choose whether to provide information service for a specific product category, while Type-2 sellers do not have the ability to provide any information service.[3] It is assumed that the sellers' ability to provide information service is independent of the model; i.e., α is exogenous.

The objective of providing the information service for a specific category is to help consumers identify their ideal product and to provide information about how to use and maintain the product.[4] It may be noted that information service serves more than one purpose. First, it helps consumers in identifying the product that fits them best. Second, information service is useful to consumers because it provides information about how to use and maintain a product. Therefore, the information service for a specific category helps consumers receive the maximum utility from consuming their ideal product. Every consumer who visits a Type-1 store can access the information service if the Type-1 seller provides information service for that category, regardless of whether she purchases at that store. All sellers procure products at constant marginal cost, which is normalized to zero without loss of generality. However, Type-1 sellers incur a cost of $V > 0$ if they provide information service for a specific product category. This cost is independent of the number of consumers who visit the electronic store to access the information service.

There is a continuum of risk-neutral unit demand consumers with mass B. A consumer in the model is interested in the specific product category under consideration. However, each consumer has one ideal product (i.e., 1 out of N in that product category) that maximizes her utility and she derives a utility of $R > 0$ from consuming this product. However, if a consumer purchases a product at random, she receives

[1] This implies that the number of sellers is very large and can be regarded as infinite. This assumption is widely used in the search-cost literature (Burdett and Judd 1983, Rob 1985, and Benabou 1993).

[2] A book retailer sells books, and books on game theory may be considered a product category. Similarly, an electronic goods' store sells consumer durables, and projection TVs may be considered as a product category.

[3] Type-2 sellers cannot provide information service, as sellers need to first incur a significant sunk cost to build the infrastructure for providing information service. For example, providing information service requires a significant investment in technological capabilities and domain expertise that may be beyond the Type-2 seller's capacity. It is also an enduring reality of electronic markets that there exist sellers who never provide information service.

[4] It is assumed that the information service is objective. The consumers may also believe that the retailers provide an unbiased description of the products, and they are more likely to trust the information service provided by the retailers compared to the information service provided by the manufacturers.

an expected utility of $r > 0$ where $r < R$. It is assumed that each product matches B/N consumers and that each consumer needs the information service to identify her ideal product. It is also assumed that there are two types of consumers. A proportion β $(0 < \beta < 1)$ of the consumers have zero search cost. These consumers enjoy the process of visiting stores and evaluating different products. Hence, they are referred to as shoppers (Stahl 1989, Banks and Moorthy 1999). The remaining consumers have a positive search cost K $(K > 0)$. These consumers are referred to as nonshoppers. Therefore, the impact of electronic markets on consumers' search costs can be interpreted as decreasing K. As is common in this literature, it is also assumed that consumers have perfect recall; i.e., they can return to any seller they have previously visited without any additional cost. It is also assumed that $r > K$; i.e., the product category is important to consumers so that they will always make a purchase.

3. Market Equilibrium

Each seller takes as given the consumers' equilibrium behavior and the strategy of the different types of sellers, and chooses its strategy to maximize expected profits. For a specific product category, sellers choose their information service and pricing strategy. First, the Type-1 sellers determine whether to provide information service for that product category. If a Type-1 seller provides information service for a specific product category, it is refereed to as a Type-1a seller for that product category. If a Type-1 seller does not provide information service for a specific product category, it is referred to as a Type-1b seller for that product category. Therefore, for each product category, there are three types of sellers, Type-1a, Type-1b, and Type-2. Of course, as stated above, Type-2 sellers do not provide information service for any product category. It is to be noted that for a given product category, all the sellers sell all the N products.

We focus on the symmetric equilibrium (as in Varian 1980 and Stahl 1989), where Type-1 sellers choose to provide information service for a specific product category with the same probability and sellers set prices according to the price distribution function of their type. Let θ be the probability that a Type-1 seller provides information service for the product category under consideration, and $f_g(\cdot)$, $F_g(\cdot)$, $h_g(l_g)$ $(g \in \{1a, 1b, 2\})$ denote the density, cumulative distribution, and the highest (lowest) price charged by type-g sellers for this product category. Given that all the products in the category have the same expected demand, it is assumed that a Type-1 seller charges the same price for all the products in the category.[5] It is clear that there is no pure-strategy equilibrium where all Type-1 sellers provide information service for a specific product category.[6]

Consumers need the information service to identify their ideal product. The value of information service is the difference in utility from buying their ideal product after receiving the information service, R, and the utility of buying a product at random, r. Consumers know who has the ability to provide information service; i.e., they know who is a Type-1 seller and who is a Type-2 seller.[7] However, consumers do not know if a Type-1 seller provides information service for their category of interest unless they visit the Type-1 seller. Therefore, a consumer will search for information service if the value of the information service, $R - r$, is greater than the expected cost of finding the information service. However, if the value of the information service is lower than the expected cost of finding the information service, a consumer may not search for information service and may buy a product at random. In this paper we focus on the case in which the value of information service, $R - r$, is greater than the expected cost of finding the information service, so that consumers search for information service. Later, the case in which the cost of finding the information service is greater than its value is briefly discussed.

If the value of information service, $R - r$, is greater than its expected cost, consumers will search for information service to identify their ideal product. After having identified their ideal product, a consumer may search for a lower price among Type-2 sellers. In other words, a consumer's search strategy is divided into two stages. In Stage 1, if she decides to search for information service, she will search amongst Type-1 sellers for information service. In each visit to a Type-1 seller, she will learn the prices charged for the N products in that category, and assess the information service if the seller provides information service for that category. In Stage 2, she will search for a lower price. Because she knows that, on average, a Type-2 seller charges a lower price (as some Type-1 sellers incur a cost to provide information service),

[5] This assumption is stronger than necessary. The results hold as long as the difference between the utility from consuming the ideal product and a nonideal product is greater than the search cost K. The assumption of equal prices is just used to simplify the exposition.

[6] If all Type-1 sellers provide information service for a specific product category, then each Type-1 seller has an incentive to not provide information service for that product category and to charge a slightly reduced price.

[7] For example, consumers know that amazon.com and barnesandnoble.com provide information service. Therefore, consumers visit one or more of such stores to identify their ideal product in the product category of interest. On the other hand, consumers are sure that some online stores never provide information service for any product.

in Stage 2 she will search only among Type-2 sellers. As stated earlier, shoppers have zero search cost and nonshoppers have a positive search cost K, where K is the cost of visiting an electronic store for a specific product category and learning the prices charged. For each visit in Stage 1, the nonshoppers incur an additional cost to check if the seller provides information service. If this seller provides information service, the nonshoppers incur an additional cost to read this information. It is assumed that compared to K, the cost of checking for and reading the information is ignorable.[8]

A shopper has zero search cost. Therefore, in Stage 2 a shopper will search the whole market to find the lowest price. On the other hand, a nonshopper's decision to search in Stage 2 is contingent upon whether the expected gain from an additional search outweighs her search cost K. That is, if q is the lowest price a nonshopper has observed in Stage 1 and q satisfies

$$\int_0^q (q-p) f_2(p)\,dp = \int_0^q F_2(p)\,dp \le K, \tag{1}$$

she will stop and purchase at the Type-1 seller charging q. Otherwise, she will visit Type-2 sellers until she finds a seller whose price q satisfies Equation (1).

Proposition 1. *Let $E\pi_g(\cdot)$ $(g \in \{1a, 1b, 2\})$ be the expected profits of a type-g seller from a specific product category. In equilibrium,*

(a) *$E\pi_g(p) \le \pi_g^*$ for every price p, and $E\pi_g(p) = \pi_g^*$ for every price p in the support of $F_g(\cdot)$.*

(b) *$\pi_{1a}^* = \pi_{1b}^*$.*

For a specific product category, a Type-1 seller chooses to provide information service with probability θ, and each type-g seller sets a price according to $F_g(p)$. In equilibrium, all the sellers of one type have the same expected profits. Moreover, Type-1a and Type-1b sellers also have the same expected profits, otherwise θ is not the equilibrium probability. For example, if $\pi_{1a}^* < \pi_{1b}^*$, a Type-1a seller would be better off if it were to stop providing information service for that specific category.

In the equilibrium, each Type-1 seller charges a price that satisfies Equation (1). Otherwise, no consumer will purchase from that seller. As long as Equation (1) holds, no nonshopper has an incentive to search in Stage 2. Therefore, consumers' equilibrium search behavior is: (a) a nonshopper, as long as Equation (1) is satisfied, always stops her search in Stage 1 after visiting a Type-1a seller and purchases her ideal product from the Type-1 seller charging the lowest price that she has seen in her search sequence; (b) a shopper, after identifying her ideal product in Stage 1, will search the whole market in Stage 2 and purchase her ideal product from a Type-2 seller charging the lowest price for that product. Therefore, as in Stahl (1989), in equilibrium Type-2 sellers are only able to sell to shoppers at the competitive price ($p = 0$) and $F_2(p)$ degenerates to a point ($p = 0$). Note that when entering the market, the Type-2 sellers aim to make small positive profits, but competition forces them to charge the competitive price. On the other hand, Type-1 sellers charge positive prices and make strictly positive profits.[9] Finally, Equation (1) can be rewritten as

$$q \le K. \tag{2}$$

It is clear from the equilibrium behavior of sellers and consumers that no Type-1 seller charges the competitive price, and that all shoppers search and purchase in Stage 2 from Type-2 sellers at the competitive price. It is also clear that Type-1 sellers only sell to nonshoppers. A nonshopper searches a sequence of Type-1 sellers until she finds information service (i.e., finds a Type-1a seller). After receiving the information service, she purchases her ideal product from the seller charging the lowest price in the sequence of Type-1 sellers she has visited. Of course, if a nonshopper visits a Type-1a seller as the first seller she visits, she will purchase her ideal product from this Type-1a seller.

Proposition 2. *For a Type-1 seller charging p, its expected demand from a specific product category is*:

$$D_{1a}(p) = \frac{(1-\beta)B}{\alpha S}\,\frac{1}{1-(1-\theta)\bigl[1-F_{1b}(p)\bigr]}, \tag{3}$$

$$D_{1b}(p) = \frac{(1-\beta)B}{\alpha S}\,\frac{\theta\bigl[1-F_{1a}(p)\bigr]}{\bigl\{1-(1-\theta)\bigl[1-F_{1b}(p)\bigr]\bigr\}^2}. \tag{4}$$

The proof of this proposition is available from the *Marketing Science* Web site. A brief outline of the proof is in the appendix. The proofs of other propositions are omitted to conserve space; they are available from the authors. For a specific product category, a Type-1b seller never charges a price higher than or equal to h_{1a}; otherwise, no consumer will return to buy from this seller. It can also be shown that h_{1b} is infinitely close to h_{1a}, or, equivalently, the support of $F_{1b}(\cdot)$ is $[l_{1b}, h_{1a})$.

[8] The cost of checking for and reading the information is ignored here for simplicity. The results in this paper are not influenced by the cost of checking for and reading the information in Stage 1.

[9] Assume that Type-1 sellers make zero profits. Then Type-1a sellers should charge positive prices to recover V. If the lowest price that Type-1a sellers charge is $l_{1a} > 0$, a Type-1b seller can always make positive profits by charging $l_{1a} - \varepsilon > 0$; therefore, a contradiction to Proposition 1. In other words, Type-1 sellers always charge positive prices and make strictly positive profits.

PROPOSITION 3. *All Type-1a sellers charge the same price for all the products in a product category; i.e.,* $l_{1a} = h_{1a} = K$.

The equilibrium price distribution of Type 1b and l_{1b} and h_{1a} are as shown below.

$$F_{1b}(p) = 1 - \frac{1}{1-\theta}\left(1 - \sqrt{\frac{p}{h_{1a}}}\right) \quad p \in [l_{1b}, h_{1a}), \tag{5}$$

$$l_{1b} = \theta^2 h_{1a}, \qquad h_{1a} = \frac{\alpha S}{(1-\beta)B}\frac{V}{(1-\theta)}. \tag{6}$$

From Equation (6) and Proposition 3,

$$\theta^* = 1 - \frac{V}{K}\frac{\alpha S}{(1-\beta)B}. \tag{7}$$

The above analysis assumes that nonshoppers search until they find information service; i.e., they search until they visit a Type-1a seller. In other words, if the value of information service, $R - r$, is greater than its expected cost, K/θ, a nonshopper will search until she finds information service. To see this, assume that a nonshopper has visited several Type-1b sellers and has not yet found a service provider. If the lowest price that she has observed so far is q, she will continue to search for information service if the expected value from another search is greater than her search cost, i.e., if $\theta(R - r) + (1 - \theta)\int_{l_{1b}}^{q} F_{1b}(p)\,dp > K$. However, as long as $R - r > K/\theta$, $\theta(R - r) + (1 - \theta)\int_{l_{1b}}^{q} F_{1b}(p)\,dp$ is always greater than K. As a result, nonshoppers will always search until they find information service, and all the results discussed above hold. On the other hand, if $R - r < K/\theta$, some nonshoppers may purchase without receiving information service. In this paper we are interested in examining the incentives of sellers to provide free information service when information service is valuable for consumers to identify their ideal product. The case when $R - r < K/\theta$ is not discussed further, as information service is not very important in these markets.

4. Equilibrium Analysis and Implications

We first examine the impact of the proportion of Type-1 sellers (α), proportion of shoppers (β), and search cost (K) on the competition and the Type-1 sellers' incentive to provide free information service (θ^*) for a specific product category. The impact of α, β, and K on social welfare is analyzed subsequently.

4.1. Managerial Implications

RESULT 1. (a) There is no equilibrium where all Type-1 sellers provide information service for a specific product category; i.e., $\theta < 1$; (b) θ decreases with α and increases with B.

A manager needs to investigate both market-related (α and B) and search-cost-related parameters (K and β) to arrive at the firm's information service and pricing strategy. First, as long as nonshoppers search for information service, Type-1 sellers make positive profits, whereas Type-2 sellers make zero profits. The reason is that nonshoppers purchase from Type-1 sellers at positive prices, whereas shoppers purchase at Type-2 sellers at the competitive price. The point is that the price competition among Type-2 sellers competing for zero-search-cost consumers drives their prices down to the competitive level. The analysis in this paper suggests that in markets where information service is valuable to consumers, sellers who do not provide any information service will find it difficult to make positive profits.

In this model, profits are the economic rents of the reputation for and the capability to provide free information service. From a managerial perspective, if consumers value information service, sellers need to establish themselves in the information service market in order to make positive profits. This is true even if some sellers and consumers free ride. Intuitively, nonshoppers visit a sequence of Type-1 sellers for information service. However, as nonshoppers cannot distinguish between Type-1a and Type-1b sellers, they may visit some Type-1b sellers before they visit a Type-1a seller in their search for information service. Therefore, if a nonshopper visits a few Type-1b sellers before visiting a Type-1a seller, after receiving the information service from a Type-1a seller, she may go back and purchase from a visited Type-1b seller charging a lower price. This enables Type-1b sellers to charge positive prices and make positive profits.

Type-1a and Type-1b sellers make equal profits. This is explained as follows. A nonshopper, on visiting a Type-1b seller, may continue to search for information service among Type-1 sellers. However, a consumer may not purchase from a Type-1b seller if she later visits another Type-1b seller charging a lower price. On the other hand, if a consumer visits a Type-1a seller as the first seller she visits, she always stops her search and purchases from this Type-1a seller. This is because a Type-1a seller's price makes another search unprofitable for a nonshopper. Therefore, in equilibrium the savings of a Type-1b seller from not providing information service for a specific category are equal to the expected loss from consumers continuing to search for information service. The nature of the mixed-strategy equilibrium is such that it makes a Type-1 seller indifferent between being a Type-1a or a Type-1b seller. In this way, Type-1 sellers make equal profits and are indifferent to free-riding. The key point is that in equilibrium no seller can profitably (i.e., make more profits than Type-1a

sellers) free-ride on other sellers by charging a lower price.

It is clear that the incentive of Type-1 sellers to provide free information service (θ) decreases with the increase in the proportion of Type-1 sellers (α). In other words, the higher the proportion of Type-1 sellers, fewer Type-1 sellers provide information service for a product category. It is interesting that in a market where information service is valuable to consumers, if there is an increase in the number of sellers with the capability to provide information service—i.e., if the market becomes more competitive—a smaller proportion of Type-1 sellers provide information service. This is because the profits of each Type-1 seller decrease with the increase in competition (an increase in the proportion of Type-1 sellers) as the profits from selling to nonshoppers are shared among a larger number of Type-1 sellers. However, the profits of Type-1a sellers decrease more than the profits of Type-1b sellers, causing some Type-1a sellers to switch to becoming Type-1b sellers, resulting in a lower θ.[10] It is also apparent that as the demand (B) for a product category increases, the probability that a Type-1 seller will provide information service for that category increases.

Result 2. (a) θ increases with K and decreases with β; (b) there exists a $K' > 0$, and $\beta' > 0$, such that when $K \le K'$, or $\beta > \beta'$, no seller provides information service, i.e., there is no market with sellers providing free information service.

It is clear that the incentive to provide information service generally decreases with a decrease in the search cost, and with an increase in the proportion of shoppers. Given other parameters, if the search cost is very low, or the proportion of shoppers is very high, a manager should decide not to provide free information service, as the firm would not be able to recover the cost of providing this service. It is said that high search cost may lead to market failures (Bakos 1997). However, this research suggests that low search cost may also lead to market failure, as consumers may not have access to information service to identify their ideal product. This suggests that when search cost is very low, firms should provide information service only when they are able to charge for the service. This fee can be implemented in different ways. For instance, some sellers ask consumers to pay for the information service, and in some electronic stores consumers need to register by providing biographical information before they can receive the information service. Therefore, there are circumstances where increased search costs not only increase sellers' profits, but also benefit consumers by increasing sellers' incentive to provide information service.

[10] It can be easily shown that $E\pi_{1a} = (1-\beta)BK/(\alpha S) - V$ and $E\pi_{1b} = \theta(1-\beta)BK/(\alpha S)$. It is clear that $|\partial E\pi_{1a}/\partial\alpha| \ge |\partial E\pi_{1b}/\partial\alpha| = \theta|\partial E\pi_{1a}/\partial\alpha|$.

4.2. Social Welfare Analysis

This section examines the impact of α, β, and K on social welfare. Let BTS and STS be the consumers' and sellers' total surplus. Consumers' total surplus BTS is equal to $B \cdot R - TP - TSC$, where TP is the consumers' total payment, and TSC is the consumers' total search cost. It is straightforward that each consumer, on average, visits $1/\theta$ Type-1 sellers. Because the cost of visiting a Type-1 seller for a nonshopper is K, the total search cost is $(1-\beta)BK/\theta$. Sellers' total surplus is $STS = TP - S\alpha\theta V$. Therefore, social welfare W is

$$W = B \cdot R - (1-\beta)B\frac{K}{\theta} - S\alpha\theta V. \tag{8}$$

Therefore, $\partial W/\partial\theta = (1-\beta)BK/\theta^2 - S\alpha V$. From Equation (7), it is clear that $(1-\beta)BK > S\alpha V$, so $\partial W/\partial\theta > 0$. The intuition is that an increase in θ has two effects: (i) it increases social welfare by lowering consumers' total search cost for information service, as there are a higher number of Type-1a sellers, and (ii) it decreases social welfare by increasing sellers' cost of providing information service, as more Type-1a sellers incur the information service cost V. However, the first effect outweighs the second. Therefore, when more sellers provide information service, social welfare increases. The other parameters also influence social welfare. Equation (8) can be written as $W = w(\theta(\alpha, \beta, K), \alpha, \beta, K)$. In other words, each parameter has two effects on social welfare. First, it has a direct impact. Second, it also influences social welfare by influencing θ.

The impact of a decrease in K on social welfare is examined first. The direct impact of a decrease in K is that social welfare increases as consumers' cost of each search is reduced. The indirect impact of a decrease in K is that it decreases social welfare as a decrease in K decreases a seller's incentive to provide information service (θ). The total impact of a decrease in K is determined by the sum of the direct and the indirect impacts and can either increase or decrease social welfare. It is straightforward that $\partial^2 W/\partial K^2 < 0$. That is, as K decreases (so θ also decreases), the direct impact dominates the indirect impact as long as θ is sufficiently high. In other words, when there are a large number of Type-1a sellers, a decrease in K increases social welfare by reducing consumers' search cost, as there are still enough service providers in the market. However, below a certain value of θ, a decrease in K causes the indirect impact to dominate the direct impact. In other words, when there is a small number of Type-1a sellers to begin with, a decrease in K reduces social welfare by reducing Type-1 sellers'

incentive to provide information service, and as a result consumers have to search a much larger number of Type-1 sellers to find information service, even though the cost of each search is reduced. The impact of an increase in the proportion of shoppers (β) on social welfare is analogous to the impact of a decrease in K. This analysis suggests that depending on the value of θ, a decrease in search cost (K) or an increase in the proportion of shoppers (β) may increase or decrease social welfare.

Next, the impact of the proportion of Type-1 sellers (α) is examined. The direct impact of an increase in α is a decrease in social welfare as it increases society's cost of information service. The indirect impact of an increase in α is a decrease in social welfare as it reduces a seller's incentive to provide information service. Therefore, an increase in α unambiguously reduces social welfare.

5. Conclusion

The model presented here examines a market where information service is costly to provide but has the characteristics of a public good. Consumers, on the other hand, use the information service to identify their ideal product. However, after receiving the information service, consumers may search for a lower price. The paper examines the competition in horizontally differentiated markets where information service is valuable to consumers to identify their ideal product and where technology reduces consumers' search cost. The analysis suggests that in this setting a seller needs to develop the capability of and reputation for service provision to make positive profits. Otherwise, no nonshopper will visit them for service and purchase from them. This is true even though there are sellers and consumers who free ride. The analysis also suggests that a seller cannot make positive profits by free-riding all the time. It is interesting to note that when the competition in the market for information provision increases, fewer sellers provide information service. In the market examined in this paper, increased competition amongst information service providers is not in the interests of the incumbent firms, as well as the society at large. Obviously, incumbents do not prefer increased competition, as it reduces their profits. Similarly, from a social welfare perspective, an increase in competition reduces social welfare. It is also clear that if the search cost is too low, or if the proportion of shoppers is very high, no seller will provide any free information service.

The model also provides another interesting social welfare result. A decrease in search cost may increase or decrease social welfare. When a large proportion of sellers provide information service, a decrease in search cost increases social welfare by decreasing the cost of each search. On the other hand, if the proportion of sellers providing information service is low, a decrease in search cost reduces social welfare by reducing sellers' incentive to provide information service, which in turn increases the amount of search required by consumers. This suggests that if free riding is also considered, a decrease in search cost may increase or decrease social welfare. As indicated earlier, all these results apply to horizontally differentiated markets where information service is valuable for consumers to identify their ideal product. If the expected utility of buying a product at random is not very different from searching for information service to identify one's ideal product, the above results need further exploration.

Appendix

Outline of the Proof for Proposition 2. Because no shopper purchases from Type-1 sellers, the expected demand of Type-1 sellers is derived from nonshoppers. Each nonshopper keeps on searching Type-1 sellers until she finds a Type-1a seller. The demand of a Type-1a seller comes from two kinds of nonshoppers: (i) those who visit this Type-1a seller as the first Type-1 seller they visit, as they will stop and purchase at this seller; (ii) those who visit one or more Type-1b sellers before visiting this seller; each of these consumers will purchase from this seller if it charges a price lower than the Type-1b sellers she has already visited. The expected demand of a Type-1b seller is derived from consumers who visit this Type-1b seller before receiving information service from a Type-1a seller, and then return and purchase from this Type-1b seller when this seller's price is the lowest in the sequence of Type-1 sellers visited. □

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