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Reducing the Costs of Consumers' Information Exchange on the Internet: Implications for Electronic Commerce Marketplaces

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and
Andrew B. Whinston

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Abstract

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降低信息交流成本对电子商务市场的影响

论文摘要

在这篇论文中我们探讨了降低信息交流成本对电子商务市场的影响。消费者通过信息交流而获取产品信息的过程可以表示为一个 BAYESIAN 统计决策模型。我们发现：如果消费者进行个人搜寻，厂商制定的的最优产品价格将介于产品的实际价值和消费者所相信的价值之间，降低搜寻成本可以使产品价格接近实际价值，从而增加社会福利。我们也探讨了消费者组成一个“信息俱乐部”来进行共同搜寻的可能性。最后，我们证实一个从事搜寻和销售产品信息的中介机构也是有利可图的。

Reducing the Costs of Consumers' Information Exchange on the Internet: Implications for Electronic Commerce Marketplaces

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Abstract

In this paper we investigate the impacts of consumers' learning from each other about product benefits on the optimal strategies of the electronic commerce market players. A consumer' optimal search of others' experiences of a product is modeled as a Bayesian statistical decision problem based on his prior beliefs and the search costs. We find that the firm's optimal price lies between the consumers' beliefs of the product benefit and the true value of the benefit, and reducing the search costs will move the price closer to the true benefit. We demonstrate that the consumers have the incentive of forming an information club to reduce uncertainty about the product and hence enhance market efficiency. It may also be profitable for an independent third party intermediary to collect information and sell it to the consumers.

Key Words: Club, Search, Pricing

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1. Introduction

The rapid expansion of electronic commerce (abbreviated as EC in the rest of the paper) is redefining the business processes and recasting the roles of the market players. New communication technologies provide a new form of social interaction (such as chat rooms and inter-relay chat [IRC]) and knowledge sharing (such as newsgroups and File Transfer Programs) among EC consumers. Social interaction creates a sense of virtual community among the Cyberspace inhabitants and helps give rise to the concept of a “global village”. By using the global internet, people can communicate with others around the world at ever-decreasing costs and high speed. Virtual communities are rapidly becoming important information sources to their members. Word of mouth communication on the internet is playing a more and more important role in changing EC consumers' knowledge, even preferences. Online firms are also trying to take advantage of consumers' information exchange on the internet. The success story of Amazon.com is a good example of this practice.

While in a traditional marketplace the firm is mainly responsible for devising mechanisms to advertise and sell products, consumers are playing an unprecedentedly active role in testing and accepting new products in EC marketplaces with the help of word of mouth communication. Due to the unique characteristics of EC marketplaces, word of mouth communication among consumers is brought to a new level as an effective advertising lever. As commented by Jeff Bezos, Amazon.com′s founder and CEO, "The very best way to promote oneself online is by word of mouth. This is because one person can tell 5000 people something as easily as he can tell five people. This is what has happened with Amazon.com." [1]

We can anticipate that products offered on the internet which match the consumers' needs well will be accepted at a more rapid pace compared with traditional markets, and products with bad matches will disappear more quickly. Due to the low sunk costs of entering and exiting the markets, electronic marketplaces have witnessed a very high birth and death rate of companies[2].

Consumers′ search for product information on the internet is costly. On the one hand, they need to make an investment on the hardware and software to get connected to the internet, and they may also have to pay fees to gain access to suitable information sources such as online chat-rooms. On the other hand, the experience of surfing the internet may not be so pleasant due to the slow traffic of information flow and a huge amount of junk information. Obviously, consumers have the incentive of reducing the search costs of obtaining valuable information. From the society point of view, reducing the search costs also promotes efficiency and therefore is socially desirable.

In the physical world, information intermediaries such as consumer reports serve as effective channels of reducing consumers' uncertainty about products. Due to the easiness of communication on the internet (such as timeliness and being one click

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[1]"Amazon.com′s Amazing Allure", *Publishers Weekly*, November 4, 1996, Page 24--25

[2]Accroding to a research result of the Center for Research in Electronic Commerce of the Univerisity of Texas at Austin, one in three of the internet companies didn't exist before 1996 (for details, go to homepage "www.internetindicators.com" . In the meanwhile, perhaps nobody will feel surprised to hear news about small online firms going out of business.

away from enormous amounts of information), online intermediaries will play even more important roles in transmitting product information to the consumers.

This paper studies the implications on the market equilibria of consumers′ search for others' experiences of a product. In particular we look at the consumers′ incentive of reducing the search costs by forming an information club and its impact on the firm′s optimal pricing strategies. We also investigate the profitability of an independent third party intermediary who collects and sells product information.

While search models have been intensively investigated by economists, the focus of this line of research has been mainly on search goods[3]. For these goods, firms′ advertising and consumers′ search could bring the consumers information about the good′s existence, retail location, price and characteristics. Stigler (1961) and Diamond (1971) assume that consumers can learn about the prices being charged on the market by going out and sampling the suppliers. Salop and Stiglitz (1977) assume that the only way consumers can learn about prices is by buying a magazine which contains all the relevant information. In contrast, most of the digital products offered online are experience goods. Uncertainty about these products arises from the consumers' imperfect knowledge of the product′s quality or fit with their preferences. The goods are also durable, therefore repeat purchases play no role in the process of the consumers learning the product benefits. An important channel through which the consumers may learn some additional information about the products is word-of-mouth communication.

[3] The differences between search goods and experience goods are discussed in Tirole (1988), page 106.

Assuming consumers can costlessly observe others′ experiences, McFadden and Train (1996) examine the consumers′ tradeoffs between trying the product themselves and waiting to observe others′ experiences, and the impacts of consumers′ learning from each other on the product sales. We concentrate on the impacts of the search costs, which lends quite a different flavor to the analysis.

Our model is based on the one used by Tirole (1988) to analyze the firms' optimal intertemporal prices with consumers′ repeat purchases. Uncertainty about the product is assumed to be a dichotomous match. If a good match occurs the consumer will enjoy some positive benefits from the product and if a bad match occurs the benefits to the consumer are zero. We believe this characterization captures the salient features of a broad range of quality uncertainty problems on the EC marketplaces. An accurate online financial report about the stock market may lead a consumer to make the right move of selling or buying stocks and an inaccurate forecast may lead to a huge financial disaster. A right choice of computational software will satisfy a buyer's future needs perfectly and a wrong choice may simply waste money and turn out to be useless. While Tirole assumes the probability of a product match between the product and the consumers′ preferences to be common knowledge, we introduce uncertainties and consumers′ search into this simple model. The analyses focus on how the consumers can learn this parameter most efficiently. We also investigate the impacts of this learning process on the firm′ optimal pricing strategies.

The paper is organized as follows. In section 2, we model a consumer′s search for product information from observing others′ experiences as a Bayesian statistical decision problem. A consumer incurs a search cost which is an increasing function of the sampling size, and the value of information depends on the consumer′s beliefs about product benefit and on the product price. We have found that the consumers' optimal sampling size is a decreasing function of the search cost; but does not dependent on the real product benefit. The consumers search most extensively if the firm is charging their willingness to pay for the product. The firm′ optimal price lies between the real product benefit and the consumer's beliefs of the benefit. In section 3, we investigate the incentives of the consumers to form an information club to reduce the search costs and their impacts on the firm′s profit. We also investigate the profitability of an independent third party information intermediary to collect and sell the product information to the consumers. We show that the formation of information club and the existence of a for-profit third party information intermediary depend on the costs of collecting and selling information. In a broad scenario, the endogenously formed information club will reduce the search costs and hence enhance market efficiency. The paper ends with some concluding remarks.

2 Market Equilibrium from Consumers′ Individual Search

A consumer is considering whether to purchase an information product offered on the internet, the characteristics of which cannot be verified beforehand and a warranty cannot be issued. However the consumer could form prior beliefs on the product benefit through the firm′s advertisements such as an on-line multimedia demonstration of the product features. The consumer can either make the purchase decision based on his prior beliefs or wait to observe other consumers' experiences and make the purchase decision thereafter. In this section, we formalize the consumer′s search for others′ experiences of the product as a Bayesian statistical decision problem.

2.1 Modeling of consumers′ preferences

As Tirole (1988), we set up the following matching model. A consumer with taste θ has the following preferences for the good produced by the monopolist:

$$u = \begin{cases} \theta s - p & \text{if he buys at p} \\ 0 & \text{otherwise} \end{cases}, \tag{1}$$

where p is the product price and s denotes the quality to the consumer. There are two potential levels of quality: s=0 ("no match") and s=1 ("match"). Without losing the sense of generality, we assume that $\theta = 1$. The probability of a match (s = 1) between the consumer and the product is x^*, belonging to (0,1). Unlike Tirole (1988), we assume the true value of x^* is not known to the consumers. However each consumer has a prior belief on x^*, which is defined as a random variable x^B with support [0,1]. Suppose x^B has a Beta distribution with parameters α and β,[4] then the probability density function of x^B is defined as:

$$f(x \mid \alpha, \beta) = \begin{cases} \dfrac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)+\Gamma(\beta)} x^{\alpha}(1-x)^{\beta} & \text{for } x \in (0,1) \\ 0 & \text{otherwise} \end{cases}, \tag{2}$$

where

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[4] There are two primary reasons that we choose a beta distribution for the following analyses:
(1) The family of beta distribution is a conjugate family for samples from a Bernoulli distribution.
(2) When $\alpha = 1$and $\beta = 1$, the beta distribution becomes the uniform distribution on the interval (0,1). These properties simplify the analyses tremendously.

$\Gamma(\alpha) = \int_0^\infty y^{\alpha-1} e^{-y} dy$, $\Gamma(\beta) = \int_0^\infty y^{\beta-1} e^{-y} dy$, and

$\Gamma(\alpha+\beta) = \int_0^\infty y^{\alpha+\beta-1} e^{-y} dy$.

Given this distribution, the mean value of x^B is:

$$E(x^B) = \frac{\alpha}{\alpha+\beta} \tag{3}$$

Without any additional information, the consumer′s expected benefit (net of the price) from consuming the product is:

$$E(u(p)) = E(x^B) - p = \frac{\alpha}{\alpha+\beta} - p, \tag{4}$$

The consumer will purchase the product if and only if $\frac{\alpha}{\alpha+\beta} \geq p$. Therefore the consumer′ expected net benefit from the product is:

$$Eu(p) = \max(\frac{\alpha}{\alpha+\beta} - p, 0) \tag{5}$$

2.2 Consumers′ Optimal Search Rule

As defined in section 2.1, a consumer′s expected benefit from consuming the product is x^*, the real probability of a match between the consumer′s preferences and the product. Since the consumer does not know x^*, he is learning the parameter x^* through search of other consumers′ experiences. Since observing others′ experiences typically is a costly process, the consumer needs to choose an optimal sampling size based on his beliefs of the information value and the sampling costs. This choice of the optimal sampling size is best modeled as a Bayesian statistical decision problem introduced in DeGroot (1972).

If the consumer has searched N other consumers′ experiences and found that N_1 out of these N consumers have good matches, his posterior belief on the probability of product match will be updated to a Beta distribution with parameters ($\alpha+N_1$, $\beta+N-N_1$), the mean value of which is[5]:

$$E(x^B \mid \alpha, \beta, N, N_1) = \frac{\alpha + N_1}{\alpha + \beta + N}. \qquad (6)$$

Given the product price, p, we define $\hat{N}_1$ to be the N_1 such that

$$\frac{\alpha + N_1}{\alpha + \beta + N} = p. \qquad (7)$$

The consumer will purchase the product if and only if $N_1 > \hat{N}_1$. For any possible number N_1, the consumer′ expected utility from the product is:

$$Eu(\alpha, \beta, p \mid N, N_1) = \begin{cases} \dfrac{\alpha + N_1}{\alpha + \beta + N} - p, & \text{if } N_1 > \hat{N}_1 \\ 0, & \text{otherwise} \end{cases} = \max\left(\frac{\alpha + N_1}{\alpha + \beta + N} - p, 0\right)$$

(8)

As a comparison, we have shown in section 2.1 (equation (5)) that, without search, the consumer′ expected utility from the product is:

$$Eu(\alpha, \beta, p) = \max\left(\frac{\alpha}{\alpha + \beta} - p, 0\right).$$

Define the expected value of information from the search as $V^I(\alpha, \beta, p, N)$ (the superscript "I" here means "individual" to distinguish it from the value of information from club search to be introduced later), we have:

$$V^I(\alpha, \beta, p, N) = E_{N_1}(Eu(\alpha, \beta, p \mid N, N_1)) - Eu(\alpha, \beta, p)$$

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[5] The proof of this property can be found in DeGroot (1970), page 160.

$$= \int_{\hat{N}_1}^{N} \left(\frac{\alpha + N_1}{\alpha + \beta + N} - p\right) f(N_1) dN_1 - \max\left(\frac{\alpha}{\alpha + \beta} - p, 0\right),$$

(9)

where $f(N_1)$ is the generalized probability density function of N_1.

Since we are not interested in how the market equilibria depend on α and β, for the remaining of the paper we assume that $\alpha=\beta=1$, i.e. the consumer′s prior belief on the probability of a product match is a uniform distribution on (0,1), and $E(x^B) = 1/2$. The consumer′s value of information from sampling N consumers′ experiences becomes

$$V^I(p, N) = \int_{\hat{N}_1}^{N} \left(\frac{1 + N_1}{1 + 1 + N} - p\right) f(N_1) dN_1 - \max(1/2 - p, 0),$$

(10)

where $\hat{N}_1$ is the smallest integer which makes $\frac{1 + N_1}{1 + 1 + N} > p$, and $f(N_1) = 1/(N+1)$ (for $N_1=0, 1, 2, \ldots, N$) comes from the density function of the uniform distribution on [0,1]. Then the consumer′s value of information from searching N consumers′ experience becomes:

$$V^I(p, N) = \frac{N - \hat{N}_1 + 1}{(N + 2)(N + 1)}\left[1 - p(N + 2) + \frac{N + \hat{N}_1}{2}\right] - \max(1/2 - p, 0)$$
$$= \left(\frac{1 - p}{2}\right)\left((1 - p) - \frac{p}{N + 1}\right) - \max(1/2 - p, 0)$$

(11)

We assume that the consumer incurs a constant marginal cost, c, from each additional sampling. He will choose an optimal sample size, which is a function of c and p, to maximize his expected utility net of search costs. Denoting this optimal sampling size as $N^*(p, c)$, we have

$$N^*(p,c) \equiv \underset{N}{\arg\max}\, V^I(p,N) - cN$$

$$= \frac{1-p}{2}((1-p) - \frac{p}{N+1})) - \max(1/2 - p, 0) - cN, \tag{12}$$

The first order condition yields:

$$\frac{(1-p)p}{2}(\frac{1}{N+1})^2 = c. \tag{13}$$

The solution to (13) is

$$N = [\frac{(1-p)p}{2c}]^{1/2} - 1$$

Therefore the optimal sampling size is:

$$N^*(p,c) = [\frac{(1-p)p}{2c}]^{1/2} - 1, \tag{14}$$

and the value of information from the optimal search becomes

$$V^I(p,c) = \frac{(1-p)^2}{2} - (\frac{p(1-p)c}{2})^{1/2} - \max(1/2 - p, 0) \tag{15}$$

We need to make sure that the consumer is getting a positive expected net benefit from the search, otherwise he will just simply make his purchase decision based on his prior beliefs. For any given price $p \in (0,1)$, we can find the critical value of $c^*(p)$ above which the consumer will not search by letting $V^I(p,c)$ be greater than zero:

$$c^*(p) = \begin{cases} \dfrac{p}{2}\left(2 - 3p - 2(1-p)^{1/2}(1-2p)^{1/2}\right) & \text{for } p \le 1/2 \\ \dfrac{1-p}{2}\left(3p - 1 - 2p^{1/2}(2p-1)^{1/2}\right) & \text{for } p > 1/2 \end{cases}$$

(16)

Example 1: if p=1/2, the critical value of c* is 1/8 as shown in Figure 1.

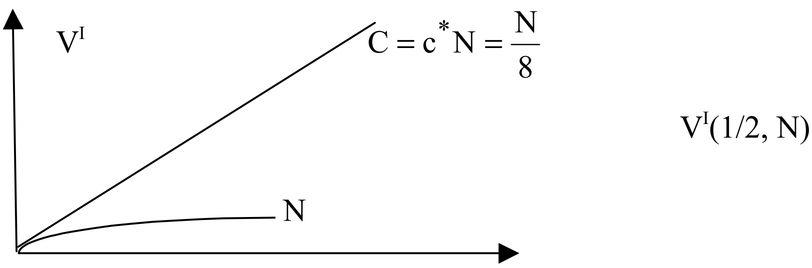


Figure 1

Example 2: if p=2/3 or p=1/3, the critical value of c^* is $\frac{1}{18(3+2\sqrt{2})}$ as shown in Figure 2.

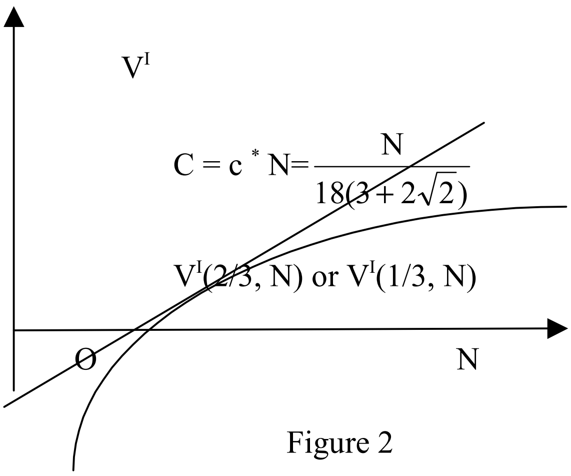


Figure 2

Not surprisingly, the optimal sample size is a decreasing function of the search costs c and does not dependent on the real value of x^*. A more interesting result from equation (14) is that:

Proposition 1. The consumer will search most extensively when the firm is charging his willingness to pay for the product.

Proof: If c is a small number, the consumer can get a positive value of information from an optimal search. From (14), the consumer′ optimal sampling size is $N^*(p,c) \equiv [\frac{(1-p)p}{2c}]^{1/2} - 1$, which is maximized at p = 1/2 = $E(x^B)$. *Q.E.D.*

2.3 Firm′s Optimal Pricing with Consumer Search

As shown in Proposition 1, the consumer′s optimal sampling size is a function of the product price p. By charging a price that is equal to the consumer′s prior belief of the product benefit, 1/2, the firm is inducing the consumers to choose the largest sampling size.

The consumer′s posterior belief on the product benefit after observing $N^*(p,c)$ consumer′s experiences is $\frac{1+N1}{2+N^*(p,c)}$, where N1 is the number of consumers who have good matches. Since the expected value of N1 is $N^*(p,c)x^*$, we have

$$E(\frac{1+N1}{2+N^*(p,c)}) = \frac{1+N^*(p,c)x^*}{2+N^*(p,c)}.$$

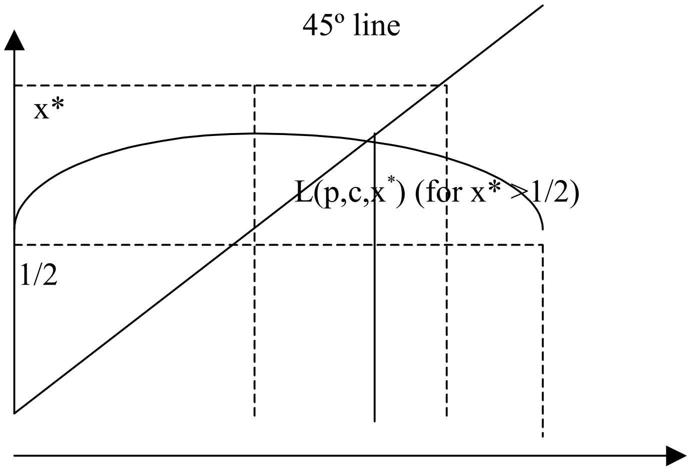
The firm's optimal price p^* will be the solution to the following equation:

$$\frac{1+N^*(p,c)x^*}{2+N^*(p,c)} = p. \qquad (17)$$

(The firm charges the price according to the consumer′ posterior expected value of the product benefit).

First, if $x^*=1/2$, from (17), the optimal price is $p^*=1/2$.

To solve for cases when $x^* \neq 1/2$, let $L(p,c,x^*)$ denote the left-hand side of (17). If $x^* > 1/2$, $L(p,c,x^*)$ is bounded between 1/2 and x^* as shown in Figure 3. From (14) and (17), we also know that $L(p,c,x^*)$ is an increasing function of p at $p \in [0,1/2]$ and a decreasing function of p at $p \in [0,1/2]$. $L(p,c,x^*)$ is maximized at $p = 1/2$.



O 1/2p* x* 1

Figure 3

Hence the optimal price p* is the p at which $L(p,c,x^*)$ crosses 45º line. Obviously p* lies between 1/2 and x*.

Similarly, if $x^*<1/2$, the optimal price is also between x* and 1/2 as shown in Figure 4.

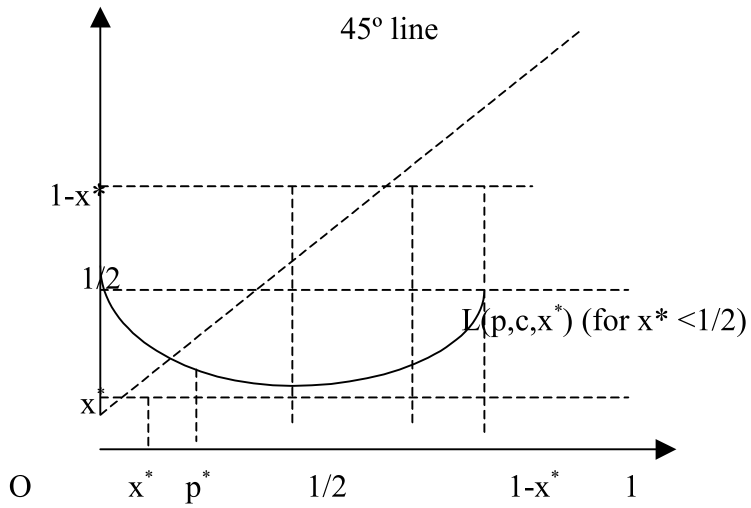


Figure 4

This has proved the following results:

Proposition 2 If the consumer has biased beliefs on the probability of a product match between his preferences and the product, the firm will charge a price between the real product benefit and the consumer′s beliefs of this number.

The importance of reducing the search cost c can also be proved by looking at Figure 3 and Figure 4:

Proposition 3 The higher the search cost c, the closer the firm′s optimal price p^* is to the consumers′ beliefs of this number (1/2) and the farther away p^* is from the real number x^*.

Proof:

If $x^*>1/2$, $dL(p,c,x^*)/dc = [dL(p,c,x^*)/dN^*(p,c)][dN^*(p,c)/dc] < 0$.

If $x^*<1/2$, $dL(p,c,x^*)dc = [dL(p,c,x^*)/dN^*(p,c)][dN^*(p,c)/dc] > 0$

In Figure 3, since $x^{*}>1/2$, the higher the search cost c, the lower the $L(p, c, x^{*})$ curve, therefore the closer p* is to 1/2 and the farther away it is from x*. The case for x* < 1/2 can be shown similarly. Q.E.D..

This result is very intuitive. The higher the search costs, the less incentive the consumers will have to search and the less information he can get about the true product benefits, then the farther away the consumers′ willingness to pay from the true value. As a result, the price will be closer to their prior expected value of the product benefits.

3 Market Equilibrium with an Information Intermediary

We now explore the market equilibria in the presence of an information intermediary.

Information has one of the characteristics of a public good: the non-rivalness in consumption. Once a piece of information is created, it can be used over and over again. There are thus important economies of scale to be realized by an intermediary who collects information and then tells it to all the people wishing to use this information. First, we assume that the consumers who are going to purchase the same product form an information club and search for information jointly to exploit the public good feature of information. We will show the efficiency gain from the formation of the club. Second, we investigate the profitability of an independent third-party for-profit intermediary who searches for information and sells it to the consumers.

3.1 Formation of an Information club to perform joint search

We assume that the information club has the same costs of producing information as each individual member; i.e. it incurs search costs of c per sample searched. The information produced by the club is like: N1 out of N consumers who have tried the product found matches between their preferences and the product. The consumers in the information club will share this information.

The club′s problem is to choose its optimal sampling size, which depends on the costs of collecting the information and the members' willingness to share the costs. We assume the club′ costs of collecting and sharing information include the following parts: (1) A fixed cost, F, which is independent of the sampling size and the number of the club members, and may be thought of as the costs of setting up an online newsgroup; (2) Cost of collecting information which is an increasing function of the sampling size; (as defined above, let c denote the costs of searching one additional sample); (3) Transaction cost which is an increasing function of the number of the club members and we denote the transaction costs per member as b. The transaction costs may be thought of as the costs of informing each club member of the search result. Denoting by N the sampling size chosen by the club, and M the number of the club members. Then the total costs equal

$$TC = F + cN + bM. \qquad (18)$$

The cost per member is $TC/M = F/M + cN / M + b$. Clearly, to each consumer the formation of an information club reduces the marginal cost of searching for each additional sample from c to c/M. However, each consumer needs to bear a share of the fixed cost, b + F/M.

By joining the club and sharing the information from a search of N consumers′ experiences, the value of information to a consumer remains the same as the case of individual search (but we change the notation from $V^I(p,N)$ to $V^C(p,N)$ to indicate that the information comes from club search rather than from individual search):

$$V^C(p,N) = (\frac{1-p}{2})((1-p) - \frac{p}{N+1}) - \max(1/2 - p, 0)\,. \tag{19}$$

We are trying to solve for the new equilibrium resulting from the changed cost structure. Since we assume all the consumers are identical, the optimal number of N could be solved as one representative club member′ choice, which is defined as:

$$N_c^* = \arg\max_N \,[(\frac{1-p}{2})((1-p) - \frac{p}{N+1}) - \max(1/2 - p, 0) - (F/M + b + cN/M)]$$
$$= [\frac{Mp(1-p)}{2c}]^{1/2} - 1\,. \tag{20}$$

(the c in N_c^* represents club to distinguish from the optimal sampling size $N^*(p,c)$ in section 2)

The following 2 facts follow directly from a comparison of (20) and (14).

Fact 1: the fixed cost, F, and transaction cost, b, do not affect the club′s optimal sampling size, provided that the consumers prefer joining the club to performing individual search.

Fact 2: the sampling size is higher from a search by an information search than that from a consumer′s individual search.

However we need to give the conditions under which the club will perform a search and the consumers prefer to join the club to individual search, then we have:

Fact 3: the club will search if and only if :

$$(c/M)^{1/2} + [(b + F/M) + (p(1-2p)/2)]^{1/2} \le (p(1-p)/2)^{1/2}$$

$$\text{for } \; p \le 1/2; \qquad (21)$$

$$(c/M)^{1/2} + [(b + F/M) + ((1-p)(2p-1)/2)]^{1/2} \le (p(1-p)/2)^{1/2}$$

$$\text{for } p > 1/2. \qquad (22)$$

Proof: A consumer's value of information from an optimal club search can be solved by plugging (20) into (19):

$$V^C(p, N_c^*) = (\frac{1-p}{2})((1-p) - \frac{p}{N_c^* + 1}) - \max(1/2 - p, 0).$$

$$= (\frac{1-p}{2})((1-p) - \frac{p}{(Mp(1-p)/2c)^{1/2}}) - \max(1/2 - p, 0)$$

To make the information club perform a search, we need $V^C(p, N_c^*) \ge 0$, which is equivalent to:

$$(c/M)^{1/2} + [(b + F/M) + (p(1-2p)/2)]^{1/2} \le (p(1-p)/2)^{1/2}$$

$$\text{for } \; p \le 1/2; \qquad (23)$$

$$(c/M)^{1/2} + [(b + F/M) + ((1-p)(2p-1)/2)]^{1/2} \le (p(1-p)/2)^{1/2}$$

$$\text{for } p > 1/2. \qquad (24)$$

Q.E.D.

The situation is graphically depicted in Figure 5: the right-hand side of (23) and (24), $(p(1\text{-}p))^{1/2}$, is represented by curve OFG; the left-hand side of (23) is curve ABC and the that of (24) is curve CDE. We can see that curve OFG is maximized at p = 1/2, and curve ABC and curve CED are maximized at 1/4 and 3/4 respectively; the maximum values of these three curves are $\sqrt{2}/4$, $(c/M)^{1/2} + [(b+F/M+1/16)]^{1/2}$ and $(c/M)^{1/2} + [(b+F/M+1/16)]^{1/2}$. We also know that curve ABC is minimized at p = 0 and p = 1/2 with value $(c/M)^{1/2} + [(b+F/M)]^{1/2}$ and curve CDE is minimized at p = 1/2 and p = 1 with value $(c/M)^{1/2} + [(b+F/M)]^{1/2}$. For any give price p, conditions (21) and (22) are interpreted as: the club will search if and only if ABC or CDE is below OFG at that particular p. At p=1/2, both (21) and (22) become:

$$(c/M)^{1/2} + [(b+F/M)]^{1/2} \le \sqrt{2}/4 \qquad (25)$$

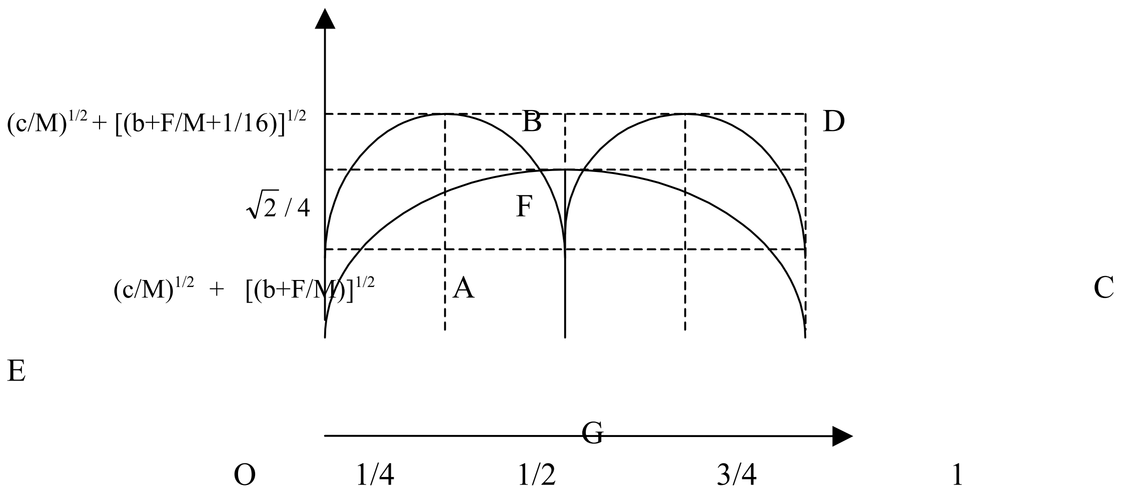


Figure 5

Based on these analyses, we conclude that if p is in a small neighborhood of 1/2 and condition (25) holds, condition (23) and (24) will also hold, and the club will perform a search. In other words, if p is in a small neighborhood of 1/2, (25) is a necessary and sufficient condition for (23) and (24).

Fact 4: A consumer will prefer individual search to joining the club if:

$$[p(1-p)]^{1/2} > \frac{b + F/M + c(1-1/M)}{(2c)^{1/2}(1-1/M^{1/2})} \qquad (26)$$

Proof: According to equation (14) and (15), the consumer′ value of information (net of search costs) from individual search is:

$$V_I(p, N^*) - cN^* =$$

$$\frac{(1-p)^2}{2} - (\frac{p(1-p)c}{2})^{1/2} - \max(1/2 - p, 0) - c([\frac{(1-p)p}{2c}]^{1/2} - 1).$$

Similarly, according to equation (19) and (20), the consumer′ value of information (net of costs) from joining the information club and sharing information is:

$$V_c(p, N_c^*) - (F/M + cN_c^*/M + b)$$

$$= (\frac{1-p}{2})((1-p) - \frac{p}{N_c^* + 1}) - \max(1/2 - p, 0) - (F/M + cN_c^*/M + b),$$

where $N_c^* = [\frac{Mp(1-p)}{2c}]^{1/2} - 1$

To make the consumer prefer joining the club to individual search, $V_I(p, N^*)$ must be less than $V_C(p, N^*)$, which is equivalent to

$$[p(1-p)]^{1/2} > \frac{b + F/M + c(1 - 1/M)}{(2c)^{1/2}(1 - 1/M^{1/2})}. \qquad \text{Q.E.D}$$

Therefore, in a small neighborhood of p=1/2, [6]a sufficient condition for a consumer to prefer joining the club to individual search is:

$$\frac{b + F/M + c(1 - 1/M)}{(2c)^{1/2}(1 - 1/M^{1/2})} < 1/2 \qquad (27)$$

If the number of the information club is large enough, condition (27) can be approximated by $(b+c)/(2c)^{1/2}<1/2$. It only requires that the costs of setting an

[6] Here we are only interested in the case of price close to the consumer's prior belief. The rationale behind this is that: from the analysis following Figure 5, we can see that if the price is far from the consumer's beliefs of the product benefits, the club does not search. Therefore the club will not exist in the first place. From (14) we also know that if p is far from 1/2, the consumer will not perform individual search either, he just behaves on his prior beliefs.

information club, b, and the costs for each sampling are small. With the advancement of information technology, these conditions are easy to satisfy. If this is the case, we can see that (25) is met automatically. Therefore the consumers will have the incentive of forming an information club and search for the product information jointly. Compared with the case of individual search, the sampling size will be larger and more accurate information can be found. As a result, the firm′s optimal price will be closer to the real product benefit. From the society point of view, this is a more efficient result.

3.2 Profitability of an Independent Third-Party Intermediary:

In this section we investigate the profitability of a for-profit third party information intermediary. An information intermediary can be modeled as one that behaves as the information club discussed in section 3.1; however it sells the product information to the consumers for profits.

The intermediary′s problem is to choose an optimal sampling size and an optimal price of a piece of the information which contains such contents "N1 out of N consumers who have tried the product found matches between their preferences and the product". Although the intermediary needs to tell the consumers the number of N, it has to be paid to let the consumers know N1.

Using the same root assumptions as in (18), the intermediary′s profit function is:

$$\underset{p,N}{\text{maximize}} \quad pM - (F + cN + bM)$$

where p is the price of information that the intermediary is charging the consumers and N is the sampling size. By duality, this problem has the same optimal N as the information club story in 3.1. The only difference is that the information intermediary will charge a price that is equal to the consumer′s value of information. In other words the value of information is transferred from the club members to the information intermediary.

4 Summary and Conclusion

This paper constitutes an attempt to endogenize information intermediary as a means to promote market efficiency. The specific context studied here is that of quality uncertainty resulting from costly information. We show that the consumers who are going to purchase the same product have the incentive to search for relevant product information jointly to exploit the public good feature of information. The potential of realizing the economy of scale in producing and disseminating product information will also be the basis for a for-profit independent third party intermediary to specialize in such activities.

The expansion of the EC marketplaces imposes great challenges to the market players on the quality uncertainty issue, which is vital to the survivability of on-line firms. We believe that information intermediaries will play important roles in reducing uncertainties and hence enhance market efficiencies. The effectiveness of this mechanism is apparent even in our simple model in which the uncertainty is just regarding one parameter, i.e., the probability of a match between the product and the consumers′ preferences.

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