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"Consumer Information, Equilibrium Industry Price, and the Number of Sellers: A Topic in Monopolistic Competition Theory"*

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1. Introduction

The economist's intuition is that if an industry is neither a monopoly nor an oligopoly, then an increased number of sellers causes the equilibrium price of the industry's product to fall. This paper's purpose is to show that this is not necessarily so: within an industry that sells a reputation good an increased number of sellers may cause the industry's equilibrium price to rise. A reputation good is any product or service where (a) sellers' products are differentiated and (b) consumers' search among sellers consists of a series of inquiries to relatives, friends, and associates for recommendations. Examples of reputation goods are personal legal services and primary medical care.

The logic that supports this conclusion is summarized in the next five paragraphs. Since the industry sells a differentiated product and is neither monopolistic nor oligopolistic, it is appropriately modeled as monopolistic competition. If within such a market the demand that each seller faces becomes less elastic for some reason, then the equilibrium price they charge rises. The paper's focus therefore is to show explicitly how an increase in the number of sellers may cause the demand that each seller faces to become less elastic. This is done by constructing a sequence of three linked models.

The first of the models is a simple Markov model of consumers' decisions to visit and switch among competing sellers. It shows that a principle determinant of the demand that any particular seller i faces is the probability that a consumer who has become dissatisfied with his current seller will pick i as the replacement. This probability is called the seller i's acquisition rate. Specifically, the model shows that if the acquisition rate becomes less price elastic, then the seller's demand also becomes less price elastic.

The second model describes the amount of useful information a consumer typically possesses about the sellers in his market area. It shows that as the number of sellers in the community increases, the information each consumer posses tend to decrease. This is important because the number and quality of the recommendations that a consumer who is searching for a seller receives from an inquiry of a friend depends on what the friend knows. If on average each consumer knows the reputations of several sellers then the cost in time and effort to a searching consumer of generating sufficient recommendations to find an acceptable seller will be low. But if on average each consumer knows the reputation of only one or two sellers, then a searching consumer may have to make a large number of inquiries before he generates sufficient recommendations to find an acceptable seller. Thus,in the latter case, the efficiency of the consumer's search is low.

The crucial result of this second model is that, under reasonable assumptions, as the number of sellers increases, the usefulness of the information consumers possess concerning sellers tends to decline. This leads to less efficient search on the part of consumers. The reason for this may be easily seen by considering the example of primary care physicians. If the number of primary care physicians in a community is small -- seven for example -- then each physician has a detailed reputation throughout the community. Seven physicians are easy to keep track of. Each consumer has friends who go to each of the seven and each consumer can remember what is said about each. If the number of physicians is larger -- thirty, for example -- then each physician's reputation is much less distinct. An average consumer can not accurately catalogue in his mind what he hears about thirty different physicians. Thus the tendency in communities with a large number of physicians is for each consumer to have accurate information only about his own physician and, perhaps, one or two others. Consequently, the usual response of a friend concerning the qualifications of a particular physician is, "I have never heard of him." Therefore, as the number of physicians within the community increases, the quality of information consumers have concerning relative qualifications and prices of physicians declines, which makes searching for new physicians harder.

The third model uses standard search theory to show that, within the context of this analysis, a decrease in the efficiency of consumer search may cause each seller's acquisition rate to become less price elastic. Recalling the results of the first two steps, this implies that an increase in the number of sellers may cause each seller's demand to become less price elastic. This completes the argument because if demand becomes less elastic for each monopolistic competitor, then the equilibrium price they charge in the market increases.

Crucial to the development of the paper's model are two ideas that appear to be new. The first idea,which is well described in the summary statement above, is that for reputation goods an increase in the number of sellers may cause an increase in comsumer search costs.[1] The second idea, which is not as well described above, is that the quality of each seller's product is evaluated by each consumer differently.[2] Thus in this model consumer A may prefer seller i to seller j while consumer B may prefer seller j to seller i. This reversal in orderings stems from the assumption that different consumers place widely varying values on the several attributes that compose each of the differentiated products that the several sellers produce. In other words, the quality of each each seller's product is specific to each consumer. The effect of quality being consumer specific is to give each seller market power in the usual sense of facing a downward sloping demand curve. As a consequence the industry's equilibrium price necessarily ends up somewhere between the competitive price and the monopoly price. This is unlike many models of product markets incorporating search where the equilibrium price is either at the extreme of the competitive price or at the extreme of the monopoly price. For examples of the latter phenomena, see Rothschild's survey paper (1973) or Butter's clear note (1977).

Much in this paper, however, is not new. It owes a large debt to the literature on search and information. Rothschild's (1973) survey paper "Models of Market Organization and Imperfect Information: A Survey" in particular influenced the approach taken here. His stress on the modeling of both buyer and sellers as rational agents and of solving for an equilibrium that is consistent with every agent maximizing is important and useful.

The predictions of this paper's model are empirically testable. Pauly and I (1978) have done a test using as a sample the prices that primary care physicians charged in 1973 within each of 92 large United States' metropolitan areas. The results obtained are consistent with this paper's model: ceterus paribus, an increase in the number of primary care physicians within a metropolitan area causes the prices they charge to rise.

2. Basic Definitions and Critical Assumptions

Reputation Goods: A Definition. The idea of a reputation good is a refinement of Nelson's (1970) categorization of consumer goods into two classes: search goods and experience goods. Define as a reputation good any product or service that meets the following four criteria.

a. Each seller's product is differentiated from every other seller's product.

b. Product quality is consumer specific, i.e. one perfectly informed consumer may prefer seller i's product over seller j's product while a second perfectly informed consumer may prefer seller j's product over seller i's. This is because different consumers value each seller's product's attributes differently, not because different consumers perceive the attributes of a seller's product differently.

c. The attributes of each seller's product can only be fully evaluated by experience with the product over a significant length of time.

d. The product is important to consumers, i.e. each consumer is willing to expend significant effort in order to find a seller offering a product that is, according to his particular preferences, high quality and reasonably priced.

The implication of these four criteria is that a consumer before purchasing a reputation good searches for an appropriate seller by asking family, friends, and associates for recommendations of appropriate sellers. Thus a consumer bases his purchase decision not on direct search or experience, but on the reputation of the several sellers.

Criteria (b) and (c) are particularly important. Criterion (b) implies that a searching consumer can obtain useful information from another consumer who has experience with a particular seller. Criterion (c), together with criterion (d), implies that a searching consumer can not get good information about sellers' products by himself; he must depend on the recommendations of experienced users. Moreover criterion (c) limits how useful advertising is to consumers since the only way he can verify an advertiser's claims, short of lengthy experience, is to check on the advertiser's reputation with experienced users.

Primary medical care is an exemplary example of these considerations. Considering the criteria (a)-(d) in turn, criterion (a) is satisfied because every physician delivers services that are differentiated from every other physician's services. Since not even experts can agree on measures of physician quality, consumers' evaluations of quality are necessarily subjective and personal. Factors such as personality and office location may have an impact on a consumer's evaluation as well as the traditional criteria of training and experience. For example, consumer A may rate a physician very highly because of his empathetic manner while consumer B may rate i very low because of his training at institutions that consumer B considers mediocre. Moreover, this divergence in evaluations is consistent with consumers A and B sharing a common base of facts and beliefs, e.g. consumer A may make his favorable judgment of i in full knowledge of the physician's training and consumer B may make his unfavorable judgment even though he agrees that the physician is very empathetic. Thus criterion (b) is met. Criterion (c) is met because a physician's skill and manner can be evaluated only after a number of patient visits. Satisfaction of criterion (d) is self-evident: the choice of a physician is important to consumers. Finally, the little empirical evidence that appears to exist on how consumers search for physicians supports the classification of primary medical care as a reputation good.[3]

<u>Sellers</u>: <u>The Assumption of Equal Quality</u>. Each seller is a maximizer who produces a differentiated product. As stated above, product quality is specific to each consumer. This specificity of quality endows every seller with monopoly power because each seller i has customers who think that its product is terrific while others of its customers are less enthusiastic. Therefore if i raises his price, its least enthusiastic customers switch to other sellers, but those customers who really like i's product continue as customers.

The assumption of symmetry among sellers can now be introduced: assume that all sellers are of the same average quality. Consistent with quality being a subjective, person specific characteristic, this means that if any two sellers were matched against each other and randomly selected consumers in the community were asked to pick the one they preferred, then the consumers would be expected to split half and half between them. Moreover, to extend the symmetry an additional step, assume that all sellers face identical demand functions. Finally, assume that all sellers have identical cost functions.

Consumers: The Assumption of Rational Search. Each consumer is assumed to be a continuing customer of one of the sellers within the market area. Nevertheless consumers do, occasionally, change sellers for any number of reasons. Two reasons for making a switch are a perceived change in product quality and an increase in price. Additionally current consumers may die or move out of the market area and be replaced by new arrivals in the market area or young adults entering the market for the first time.

Each consumer who is in the process of searching for an appropriate seller is uninformed in the sense that he does not know which specific seller best meets his standard of quality and price. All consumers are assumed to be identical except in the way that they rate the qualities of sellers. In particular, each consumer is assumed to have the same efficiency of search and to perceive the same distribution of price-quality pairs as being available on the market.

Comment. Strong assumptions of symmetry are made above both for sellers and consumers. These assumptions are made to facilitate progress towards the goal of showing that an increase in the supply of sellers may perversely cause the equilibrium industry price to rise. Relaxation of one or more of these assumptions, however, would permit other interesting questions to be investigated. For example, if all sellers are not of the same average quality, then under what conditions do those sellers who are, on average, judged by consumers to be of higher quality charge a higher price than those sellers who are, on average, judged to be of lower quality.

3. The Demand for Sellers' Services

As stated in the introduction, the focus of this theory is an explicit analysis of how an increase in the number of sellers within a market area may cause each seller's demand curve to become less elastic. This section develops a model of how consumers switch among the competing sellers within the market area. Its conclusion is that a seller's price elasticity of demand can be written as the sum of several, more basic price elasticities. This is useful because the effect of an increase in the number of sellers can then be analyzed by considering the effect that an increase in the number of sellers has on each of the terms that compose the seller's demand elasticity. The model developed here is similar to the brand choice model Telser (1962) developed in economics and Massy, Montgomery, and Morrison (1970) discussed in marketing.

Consider a market area that has a population of N consumers and M sellers. Each consumer is a customer of one and only one seller. Let N_i^t represent the number of consumers who are members of seller i's customer panel during week t.[4] Clearly $\Sigma_{i=1}^{M} N_i^t = N$. Let p_i be the price seller i charges, let $v(p_i)$ be the probability that a randomly chosen member of its panel makes a purchase during week t, and assume that v is a decreasing function of p_i. Customers are assumed to purchase no more than one unit of the product during any week. Seller i's expected unit sales for the next week are therefore $v(p_i)N_i^t$. The price p_i is the only argument of v for two reasons. First, the level of prices that other sellers charge is not likely to affect the probability that a person will visit his regular seller. They only affect the consumer's probability of switching to a different seller. Second, since average quality is assumed to be equal across all sellers, quality is not included as an argument of v. The function v is common to all sellers because of the equal quality assumption.

Each consumer who is a member of seller i's customer panel periodically evaluates the satisfactoriness of the product he is receiving. Let the probability that during any given week he decides to switch to another seller be $s(p_i,\overline{p}_i)$ where $\overline{p}_i = (p_1,\ldots,p_{i-1}, p_{i+1},\ldots,p_M)$ is the vector of other sellers' prices. Presumably s is an increasing function of p_i and a decreasing function of each component of $\overline{p}_i$, i.e. a consumer is more likely to switch to another seller if his present seller's relative price increases.[5] The expected number of consumers seller i expects to lose from its panel during week t is $\Delta^- N_i^t = s(p_i,\overline{p}_i)N_i^t$. The probabilities $v(p_i)$ and $s(p_i,\overline{p}_i)$ are respectively called seller i's visit rate and switching rate.

Each week seller i adds to his panel a number of consumers who are switching from other sellers with whom they have become dissatisfied. Let $w(p_i,\overline{p}_{ij})$ be the probability that a customer who quits seller j picks seller i as his new seller where $\overline{p}_{ij} = (p_1,\ldots,p_{i-1},p_{i+1},\ldots,p_{j-1},p_{j+1},\ldots,p_M)$. Necessarily

$$\sum_{\substack{i=1\\ i\neq j}}^{M} w(p_i,\overline{p}_{ij}) = 1 \qquad j=1,\ldots,M \tag{3.01}$$

because every customer who quits seller j picks a new seller. The probability $w(p_i,\overline{p}_{ij})$ is called seller i's acquisition rate with respect to seller j. It is assumed to be decreasing in p_i, i.e. the higher i's price, p_i, the smaller the probability that a dissatisfied consumer picks i. The expected number of new customers that seller i acquires during week t is

$$\Delta^{+}N_i^t = \sum_{\substack{j=1\\ j\neq i}}^{M} w(p_i,\overline{p}_{ij})s(p_j,\overline{p}_j)N_j^t. \tag{3.02}$$

Given the vector of prices $(p_1,\ldots,p_M)$ that sellers within the community are charging, the customer panels of the M sellers are in equilibrium if each seller during the next week expects the number of new sellers gained to offset the number lost. If, for example, the number of new consumers $\Delta^{+}N_i^t$ that seller i expects to acquire in the next week exceeds the number $\Delta^{-}N_i^t$ that it expects to lose, then its panel is not in equilibrium because it will tend to grow.

Formally, for the given vector of prices $(p_1,\ldots,p_M)$ that the sellers are charging, the consumer panels are in long run equilibrium if the vector of panel sizes $(N_1,\ldots,N_M)$ satisfies the following M+1 equations:

$$N = \sum_{i=1}^{M} N_i \tag{3.03}$$

$$0 = -s(p_i,\bar{p}_i)\, N_i + \sum_{\substack{j=1 \\ j\neq i}}^{M} w(p_i,\bar{p}_{ij})s(p_j,\bar{p}_j)N_j \qquad i=1,\ldots,M \tag{3.04}$$

Notice that these equations are linear in the vector $(N_1,\ldots,N_M)$. Because each of the M equations of (3.04) is dependent on the other M - 1 equations of (3.04), one may be discarded to give a system of M independent linear equations in M unknowns. Generally a unique solution exists for such a system.[6]

Recall that the purpose of setting up this model of sellers' demands is to facilitate calculation of each seller's price elasticity of demand when the market is in equilibrium. Since I have assumed symmetry among all physicians and among all consumers, the equilibrium is certain to preserve the symmetry: in equilibrium all sellers charge the same price $p^o = p_1 = p_2 = \ldots = p_M$ and have the same size customer panel $N^o = \frac{N}{M} = N_1 = \ldots = N_M$. Moreover, if seller i should increase his price p_i while all other sellers keep their prices steady at p^o, then seller i's customer panel would contract by ΔN_i customers and the other M-1 sellers would each have their customer panels grow from N/M customers to

$$\frac{N}{M} + \frac{\Delta N_i}{M-1} \tag{3.05}$$

customers. Thus, in order to determine how each seller's customer panel is affected by seller i alone changing his price p_i away from the equilibrium price p^o, the system (2.03) and (2.04) can be rewritten in simple form:

$$N = \sum_{j=1}^{M} N_j, \tag{3.06}$$

$$0 = -s(p_i,\overline{p}_i^o)N_i + \sum_{\substack{j=1 \\ j\neq i}}^{M} w(p_i,\overline{p}_{ij}^o)s(p_j^o,\overline{p}_j)N_j \ , \tag{3.07}$$

$$N_1 = N_2 = \ldots = N_{i-1} = N_{i+1} = \ldots = N_M \ . \tag{3.08}$$

Define $N_{\sim i} = N_1 = N_2 = \ldots = N_{i-1} = N_{i+1} = \ldots = N_M$. The symbol $N_{\sim i}$ is read as: N subscript not i. Equations (3.06)-(3.08) can in turn be written as two equations in two unknowns:

$$N = N_i + (M-1)N_{\sim i} \tag{3.09}$$

$$0 = -s_i(p_i)N_i + (M-1)\omega(p_i)s_{\sim i}(p_i)N_{\sim i} \tag{3.10}$$

where $\omega(p_i) = w(p_i,\overline{p}_{ij}^o)$, $s_i(p_i) = s(p_i,\overline{p}_i^o)$, and $s_{\sim i}(p_i) = s(p_j^o,\overline{p}_j)$. Simple manipulation gives

$$N_i(p_i) = \frac{\omega(p_i)s_{\sim i}(p_i)}{\omega(p_i)s_{\sim i}(p_i) + s_i(p_i)} \ N \tag{3.11}$$

$$N_{\sim i}(p_i) = \frac{s_i(p_i)}{\omega(p_i)s_{\sim i}(p_i) + s_i(p_i)} \ \frac{N}{M-1} \tag{3.12}$$

as the solution to (3.09) and (3.10).[7]

The number of sales that seller i expects to make during one week is

$$Q(p_i) = v(p_i)N_i(p_i) \tag{3.13}$$

The function $Q(p_i)$ is seller i's long run demand curve: given that other sellers keep their fees constant at the equilibrium level p^o, $Q(p_i)$ describes how its expected unit sales per week varies with changes in its price.[8] Therefore (3.11) and (3.13) allow computation of seller i's long run price elasticity of demand. It is

$$e_Q^i = \frac{p_i}{Q_i(p_i)} \frac{dQ(p_i)}{dp_i}$$

$$= e_v^i + C(p_i)(e_\omega^i - e_s^i + e_s^{\sim i}) \tag{3.14}$$

where

$$e_v^i = \frac{p_i}{v(p_i)} \frac{dv(p_i)}{dp_i} < 0, \tag{3.15}$$

$$e_\omega^i = \frac{p_i}{\omega(p_i)} \frac{d\omega(p_i)}{dp_i} < 0, \tag{3.16}$$

$$e_s^i = \frac{p_i}{s_i(p_i)} \frac{ds_i(p_i)}{dp_i} > 0, \tag{3.17}$$

$$e_s^{\sim i} = \frac{p_i}{s_{\sim i}(p_i)} \frac{ds_{\sim i}(p_i)}{dp_i} < 0, \tag{3.18}$$

and

$$C(p_i) = \frac{s_i(p_i)}{\omega(p_i)s_{\sim i}(p_i) + s_{\sim i}(p_i)} \quad . \tag{3.19}$$

The quantities e_v^i, e_ω^i, and e_s^i are respectively the price elasticities of seller i's visit rate, acquisition rate, and switching rate. The quantity $e_s^{\sim i}$ is the cross elasticity of seller j's ($j \neq i$) switching rate with seller i's price. The coefficient $C(p_i)$ has the property that $C(p^o) = (M-1)/M$. This follows from the complete symmetry that exists among all sellers including seller i when $p_i = p^o$. Specifically, the symmetry and equation (3.01) imply $s_i(p^o) = s_{\sim i}(p^o)$ and $\omega(p^o) = 1/(M-1)$, whence the result. Therefore, when M is reasonably large and p_i is not greatly different from p^o, an adequate approximation is

$$e_Q^i \approx e_v^i + e_\omega^i - e_s^i + e_s^{\sim i} \tag{3.20}$$

Approximation (3.20) expresses seller i's demand elasticity as the sum of several more fundamental elasticities. It permits the effect of an increase in the number of sellers to be analyzed in terms of the effect the increase has on the component elasticities.

4. The Number of Sellers and the Efficiency of Consumer Search

This section shows that for reputation goods an increase in the number of sellers, M, may cause the efficiency of consumer search to decrease. Section 5 below shows that a decrease in the efficiency of consumer search may cause the price elasticity of each seller's acquisition rate to change. Equation (3.20) immediately above implies that such a change in sellers' acquisition rate elasticities causes a change in sellers' demand elasticities. Therefore an increase in the number of sellers may cause a change in either direction of the industry's equilibrium price.

Recall that the behavior of a reputation good's consumer who becomes dissatisfied with his present seller and decides to seek a new seller is to ask friends and associates for recommendations. The fruitfulness of a representative query depends on the number of sellers about which the friend provides useful information. Moreover, casual empiricism suggests that whenever an individual asks a friend for advice, he incurs a significant fixed cost in the form of good will expended and time spent exchanging pleasantries. Therefore the average cost of learning the reputation of an additional seller declines as each query, on average, nets usable information about more sellers, i.e. his efficiency of search increases.

A friend, when asked to recommend sellers, can at best only recount that information he possesses. Therefore, a model of how much information each consumer possesses concerning each seller is necessary. The rudimentary model I propose is as follows.[9] Individuals in the normal course of social life talk with each other and occasionally exchange stories about the reputation goods' sellers they patronize.[10] Suppose that on average, each week, each consumer is matched with another consumer at random and together they exchange stories about the sellers from which they are currently purchasing. Each listens and remembers what the other says about his seller. Over time, however, the memory fades and eventually, unless it is reinforced by another friend, disappears. Thus, each consumer has a constantly turning over store of information about the reputation of different sellers in his community.

This process may be modeled as a Markov chain. Focus on consumer j and suppose, without loss of generality, that he is a patron of seller one. Let the (M-1) dimensional vector

$\theta^t = (\theta_2^t, \theta_3^t, \ldots, \theta_M^t)$ represent his knowledge at time t about each of the other M-1 sellers. Let $\theta_i^t = 0$ represent no knowledge about seller i and let increasing values of θ_i^t represent increasing knowledge about seller i. Each period the value of θ^t changes in two ways. First, individual j forgets a little. This is represented by decrementing each component of θ^t by a positive constant δ subject to the constraint that a component can not be reduced below zero. Second, individual j picks a friend at random and the friend talks about his own seller. If consumers are uniformly distributed among sellers because all sellers charge the same price, then each seller each week has a 1/M probability of being discussed for the benefit of consumer j. If seller i is the seller who is discussed, then θ_i^t is increased one unit. Thus,

$$\theta^{t+1} = \theta^t - \delta(\theta^t) + \mu \tag{4.01}$$

where

$$\delta(\theta^t) = [\delta(\theta_2^t),\ \delta(\theta_3^t),\ldots,\delta(\theta_4^t)], \tag{4.02}$$

$$\delta(\theta_j^t) = \begin{cases} \theta_j^t & \text{if } \theta_j^t - \delta \leq 0 \\ \delta & \text{if } \theta_j^t - \delta > 0 \end{cases} \tag{4.03}$$

and μ is a (M-1) dimensional random vector whose probability mass function is:

$$\begin{aligned} & \Pr\{\mu = [0,0,\ldots,0]\} = \Pr\{\mu = [1,0,0,\ldots,0]\} \\ = \ & \Pr\{\mu = [0,1,\ldots,0]\} = \ldots = \Pr\{\mu = [0,0,\ldots,0,1,\ldots,0]\} = \ldots \\ = \ & \Pr\{\mu = [0,0,\ldots,0,1]\} = \frac{1}{M}\ . \end{aligned} \tag{4.04}$$

The case where μ is the zero vector occurs whenever consumer j talks to a friend who also goes to seller one. The case where μ is the vector with a one as the (i-1)th component occurs whenever individual j talks to a friend whose seller is i.

Now suppose a friend asks a consumer j for information concerning sellers. First, j generally recounts his experience with the seller he is currently patronizing. Additionally, he may share with his friend a portion of the hearsay that the information vector θ^t represents. He does this, however, only for those sellers about which he recalls enough to say something substantive. In other words, if individual j's information θ_i^t about seller i is less than some positive threshold level η, then he remains silent about that seller because he believes that that information θ_i^t is too incomplete or too unreliable to be of use to his friend. If, however, $\theta_i^t \geq \eta$, then he does recount what he recalls concerning seller i.[11]

The expected number of sellers about which individual j gives useful information is therefore just one plus the expected number of components of θ^t that exceed the threshold η.[12] The question is: how does this expected value, which is a measure of the ease of searching for a new seller, vary as the number, M, of sellers in the community varies? Intuitive consideration of the model indicates that if the expected value of each component of θ^t is high and if the threshold value of η is low, then a query for information on average yields direct information about the seller individual j is currently patronizing and secondhand information about several other sellers. Inspection of the model shows that as M increases, the expected value of each component θ_i^t decreases. Therefore the expected number of components of θ^t that exceed η decreases as M increases. This means that the efficiency of searching for a new seller decreases as the number of sellers in the community increases.

The correctness of this intuitive argument can, in principle, be checked by calculating the complete long run, steady state distribution of θ^t and then computing for different M the expected number of components that exceed η. This is difficult, however, because when M is large, the state space for θ^t becomes very large. A more tractable approach is simulation. Table 1 reports simulation results for different values of M and δ. The results confirm the intuitive argument made above.[13] They therefore -- to the degree that this model of consumer information is credible -- indicate that consumers' search efficiency may decrease as the number of sellers increases.

This conclusion is not valid for goods other than reputation goods. For example, Nelson (1970) defines a search good to be one for which consumers do direct comparison shopping before making a purchase, e.g. groceries. Because entry of more firms into the grocery business reduces the average distance between competing grocers, entry tends to increase consumers' efficiency of search.

Table 1. Effect of Number of Sellers on Consumer Information

$\delta = .125, \quad \eta = 1.25$

Number of Sellers Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	0	0	3	10	15	16	5	1	0	6.26
15	0	3	25	13	8	1	0	0	0	0	3.58
25	7	24	15	3	1	0	0	0	0	0	2.34
35	30	16	4	0	0	0	0	0	0	0	1.48

$\delta = .167, \quad \eta = 1.25$

Number of Sellers Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	6	17	20	6	1	0	0	0	0	3.58
15	12	24	13	1	0	0	0	0	0	0	2.06
24	25	23	2	0	0	0	0	0	0	0	1.54
35	35	14	1	0	0	0	0	0	0	0	1.32

$\delta = .125 \quad \eta = .5$

Number of Sellers Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	0	0	0	1	11	21	14	3	0	7.14
15	0	0	0	2	9	15	18	5	0	1	6.38
25	0	0	0	7	14	16	11	2	0	0	5.74
35	0	0	0	2	28	13	7	0	0	0	5.50

$\delta = .167 \quad \eta = .5$

Number of Sellers Recommended

M	1	2	3	4	5	6	7	8	8	10	Average
10	0	0	0	12	24	12	2	0	0	0	5.08
15	0	0	4	20	21	4	1	0	0	0	4.56
25	0	1	8	17	20	4	0	0	0	0	4.36
35	0	1	4	30	13	2	0	0	0	0	4.22

Explanation: When the memory deprecation rate δ had value .125, the threshold η had value 1.25, and the number of sellers was 15, then 8 of the 50 consumers simulated had information vectors θ^t that enabled them to recommend 5 sellers. On average the 50 consumers were each able to recommend 3.58 sellers.

5. Efficiency of Search and the Price Elasticity of Demand

This section considers the individual consumer who has decided to search for a new seller. Given that his search consists of asking friends and relatives for recommendations, what effect does a decreased efficiency of search on his part have on each seller's price elasticity of demand. This section demonstrates that almost certainly the effect is not zero: decreased efficiency of search may lead to more elastic demand or, more plausibly, to less elastic demand. The path by which search efficiency affects sellers' elasticities is through the acquisition rate's price elasticity, e^i_ω, and approximation (3.20), which describes how the acquisition rate elasticity affects the demand elasticity.

It is quite conceivable that a change in consumers' search efficiency might also affect other terms of (3.20), e.g. e^i_s, the switching rate's price elasticity. I have been unable, however, to construct a convincing theory of how such effects would occur. Therefore I have ignored their possible existence throughout the remainder of this analysis on the a priori grounds that it is extremely unlikely that a change in search efficiency necessarily creates exactly offsetting effects on the several terms of (3.20).

The model is as follows. Individual consumers who are seeking a new seller take price and quality as their criteria. Specifically, let individual i's evaluation of seller j be

$$u^i_j = \chi^i_j - \gamma p_j \tag{5.01}$$

where χ^i_j is the quality of seller j as perceived by individual i,

p_j is seller j's price, and γ is a positive parameter common to all consumers that describes the importance they place on price relative to quality. Recall two crucial assumptions from Section 2. First, each consumer's rating of seller j, χ_j^i, is assumed to be independent of every other consumer's rating of seller j. This independence of quality evaluations is consistent with consumers being able to describe to each other the attributes of each seller's product because its source is diversity of consumers' utility functions, not a diversity of consumers' perceptions of product attributes. Second, each seller produces a product that, on average, is rated the same as every other seller's product. Specifically, if two sellers charge the same price, then consumers will split evenly as to whose product they prefer. Finally, as one additional assumption, assume that all consumers follow identical search strategies. These several assumptions together imply that, except for the consumer specific nature of quality, all consumers are effectively identical and all sellers are effectively identical.

Consider any consumer i who is seeking a new seller and is asking friends and associates for recommendations. Assume that the informational content of any recommendation of seller j by a friend is sufficient for i to form usable estimates of p_j, χ_j^i, and, consequently, u_j^i.[14] Assume also that consumer i believes that all sellers in the market area charge a common price of p^o.[15] Individual i's search is therefore for quality, not price, though if he should find a seller who charges a price different than p^o, then he uses equation (5.01) to evaluate the importance of the difference.

Given this structure, the calculation of the elasticity of each seller's acquisition rate as a function of his price and of consumers' efficiency of search is straightforward. Let D be an index of consumers' search efficiency where a small value of D represents <u>high</u> efficiency and a large value of D represents <u>low</u> efficiency. Because all sellers are identical, the elasticity of every seller's acquisition rate, e^j_ω, is the same. Therefore it is sufficient to calculate e^j_ω for any single seller j. Recall that j's acquisition rate, $\omega(p_j)$, is the probability that a consumer who is dissatisfied with some other seller will select j. Since consumers' quality judgments are assumed to be independently distributed, any consumer i can be used as a proxy for all consumers. Thus

$$\omega(p_j,D) = \Pr(A^i_j|D)\ \Pr(B^i_j|A^i_j,p_j,D) \equiv g(D)h(p_j,D) \qquad (5.02)$$

where A^i_j is the event that seller j is recommended to consumer i at some point during his search for a new seller, B^i_j is the event i selects j as his new seller, $\Pr(A^i_j|D) \equiv g(D)$ is the probability of j being recommended to i given the efficiency of search D, and $\Pr(B^i_j|A^i_j,p_j,D) \equiv h(p_j,D)$ is the probability of i selecting j conditional on j being recommended to i and given p_j and D. Notice that g(D), unlike $h(p_j,D)$, does not have p_j as an argument. This is because consumer i believes that all sellers charge the common price p^o; if seller j should charge a different price, then consumer i discovers the error in his expectations only after it is too late for him to change his search strategy and thus change g(D).

The price elasticity of $\omega(p_j)$ may be calculated from (5.02):

$$e_\omega^j = \frac{p_j\omega'(p_j)}{\omega(p_j)}$$

$$= \frac{p_j h_p(p_j,D)}{h(p_j,D)} \tag{5.03}$$

where h_p is the partial derivative of h with respect to p_j. Differentiation with respect to D shows how the consumer's efficiency of search affects this elasticity:

$$\frac{\partial e_\omega^i}{\partial D} = p_j\left\{\frac{h(p_j,D)h_{pD}(p_j,D)-h_p(p_j,D)h_D(p_j,D)}{[h(p_j,D)]^2}\right\}. \tag{5.04}$$

Inspection shows that the necessary and sufficient condition for D not to affect e_ω^j is that a change in D affects by equal proportions both h_p and h.

Consideration of this condition within the context of a simple example immediately suggests that it is unlikely to be fulfilled. Let p_j = \$10.00 and suppose, for D=D′, that $h(p_j,D=D') = 0.20$ and $h_p(p_j,D=D') = -.05$. This means that if seller j increases his price to \$11, then the probability that a consumer who has had j recommended to him will in fact choose j falls to 0.15. Thus, for D=D′, $e_\omega^j = -2.5$. Now suppose consumer efficiency of search worsens to D=D″ where D″ > D′. This certainly causes the probability that a consumer who has had j recommended to him will choose j to rise: $h(p_j,D=D'') = .28$ for example, What the increase in D does to h_p is not as clear. Intuitively, however, either no change or a slight decrease seems sensible because the decrease in search efficiency would most likely decrease price sensitivity. Suppose, consistent with this logic, that $h_p(p_j, D{=}D'') = -.04$. Then $e^j_\omega = -1.43$ for $D{=}D''$, which is less elastic than $e^j_\omega = -2.5$ for $D{=}D'$.

This example is suggestive that the acquisition rate, and therefore demand, becomes less elastic as the efficiency of search decreases, but it does not constitute a proof. Proof can only be provided by an analysis of how each consumer's optimal search strategy changes as his efficiency of search changes. Based on the discussion of this and previous sections, particularly Section 4, each consumer's search problem may be characterized as consisting of two stages. Stage 1 is the decision to approach a friend for the recommendation of a seller. If the decision is yes, consumer i incurs a cost of d_1 that includes the time spent in initial pleasentries, etc. Stage 2 consists of the decision to ask a friend, who has already given at least one recommendation, to give another recommendation, if possible. If the decision is yes, the consumer incurs a cost of d_2 where $d_2 < d_1$ since the fixed costs of making the initial approach to the friend have already been incurred.

Calculation of the optimal search strategy for this situation is complex and beyond the scope of this paper. Instead I explicitly calculate the effect D has on e^j_ω within a straightforward and classic situation: simple sequential search where each search has a constant cost of d and the optimal strategy is to set a reservation price-quality level. The result is exactly what the example above suggested: only in special cases does variation in d, the cost of search, which in the sense of D is an index of the efficiency of search, leave e^j_ω constant. Moreover, the most plausible effect of an increase in d is to cause e^j_ω to rise towards zero, i.e. for the acquisition rate, and thus demand, to become less elastic. This, I think, is good evidence that in all but very unusual or pathological situations e^j_ω varies with the efficiency of search.

Let individual i be an expected utility maximizer and let the probability distrbution $F(\chi)$ represent his uncertainty regarding the outcome of his inquiries of friends for recommendations. That is, if individual i seeks out a friend and asks for an additional recommendation, then i's subjective probability that the recommended seller's quality will be less than or equal to quality level χ_o is $F(\chi_o)$.[16] The standard theory for simple sequential search states that his optimal strategy is to continue asking for recommendations until he finds a seller j such that

$$u^i_j \geq u^* \tag{5.05}$$

where u* is called the reservation price-quality level.[17] Individual i picks u* such that if he has not found a seller j for whom $u^i_j \geq u^*$, then the gain in utility he expects to realize by seeking an additional recommendation and perhaps finding a seller of higher quality than he has already found either equals or exceeds the utility cost d of securing the additional recommendation . A well-known result is that as d increases, the value of u* decreases, i.e. as search becomes more expensive, individual i's minimum acceptable price-quality level u* decreases.[18] Consequently u* is a decreasing function of d: $\partial u^*/\partial d < 0$.

The probability that consumer i will select seller j conditioned on seller j being recommended is:

$$Pr(B_j^i | A_j^i, p_j, d) \equiv h(p_j, d) = 1 - F(u^* + \gamma p_j) \qquad (5.06)$$

where u* is consumer i's reservation price-quality level. Equation (5.06) follows from the fact that if consumer i is to select seller j and if seller j charges price p_j, then individual i must perceive seller j's quality to be at least $u^* + \gamma p_j$. Otherwise $u_j^i = \chi_j^i - \gamma p_j < u^*$ and consumer i rejects seller j. The price elasticity of $\omega(p_j)$ may be calculated by substituting (5.06) into (5.03):

$$e_\omega^j = -\frac{\gamma p_j F'\{u^* + \gamma p_j\}}{1-F\{u^* + \gamma p_j\}} \qquad (5.07)$$

where F', the first derivative of F, is the probability density function implied by F. The derivative of this elasticity with respect to d is:

$$\frac{\partial e_\omega^j}{\partial d} = -\gamma p_j \frac{\{1-F(u^* + \gamma p_j)\} F''(u^* + \gamma p_j) + \{F'(u^* + \gamma p_j)\}^2}{\{1-F(u^* + \gamma p_j)\}^2} \frac{\partial u^*}{\partial d} \qquad (5.08)$$

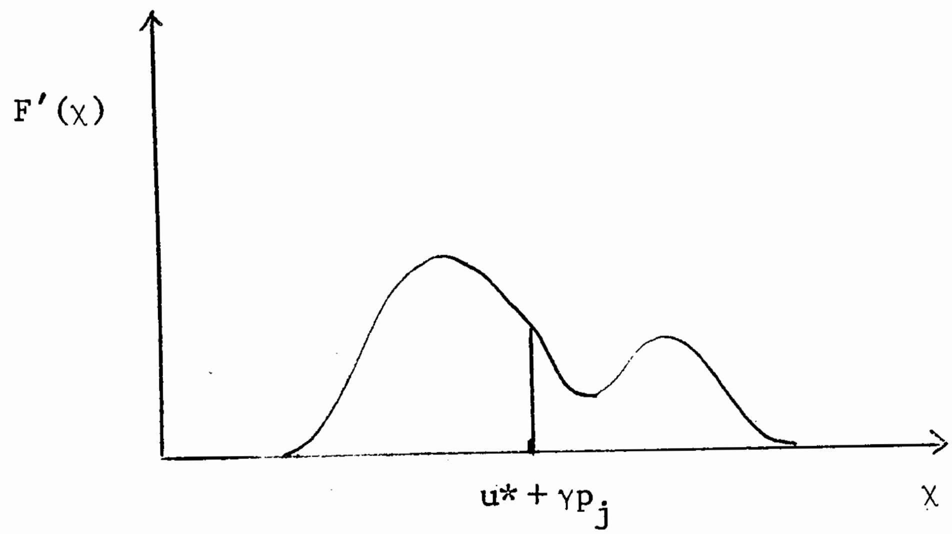
The sign of $\partial e_\omega^j/\partial d$ is indeterminate because F'', which is the slope of the probability density function F', may be either positive or negative depending on the distribution that F represents and on the value of $u^* + \gamma p_j$. Specifically, if $F''(u^* + \gamma p_j)$ is positive, then $\partial e^j_\omega / \partial d$ is positive, which implies that seller j's acquisition rate, and thus his demand, becomes less elastic as consumers' search costs increase. On the other hand, if $F''(u^* + \gamma p_j)$ is negative, then an increase d may cause seller j's demand to become either more or less elastic depending on the magnitude of the several quantities included within (5.08).

This means that a principal determining factor for the sign of $\partial e^j_\omega / \partial d$ is the distribution F that describes consumers' beliefs regarding the quality of sellers. This is an empirical question whose answer may vary depending on the specific characteristics of the product being sold. Some speculations, however, may be based on the observation that if and only if F is exponential with parameter α,

$$F(\chi) = 1 - e^{-\alpha\chi}, \tag{5.09}$$

then $\partial e^j_\omega / \partial d = 0$ for any positive value of α and all values of $u^* + \gamma p_j$. Thus for $\partial e^j_\omega / \partial d$ to be negative at $u^* + \gamma p_j$, the tail of F to the right of $u^* + \gamma p_j$ must be <u>heavier</u> than the tail of the exponential distribution. This condition can be met, but only with difficulty. For example, distributions such as the uniform, triangular, and the normal do not satisfy it for any value of $u^* + \gamma p_j$. The only obvious type of situation for which $\partial e^j_\omega / \partial d$ would be negative would be if F', the density function, is bimodal and if $u^* + \gamma p_j$ takes on an appropriate value. See Figure 1 for an illustration of such a distribution.

Figure 1



Two conclusions, therefore, result from this analysis of the classical situation of constant cost sequential search. First, and most important, only in the very special case of F being an exponential distribution is $\partial e_\omega^j/\partial d = 0$ for all values of $u^* + \gamma p_j$. Consequently consuer search efficiency may generally be expected to affect e_ω^j since no effect at all is a knife-edge phenomenon. Second, it appears plausible that $\partial e_\omega^j/\partial d > 0$, rather than $\partial e_\omega^j/\partial d \leq 0$. This, together with equation (3.20), implies that the plausible effect of decreased consumer search efficiency is for each seller's demand to become less elastic.

6. Industry Equilibrium and Price Behavior

Each seller's objective is maximization of his net income. Focus on seller j and consider a static model of his costs and demand. Assume j delivers a service that is homogeneous and divisible. Let p_j be the price j charges and let $\overline{p}_j = (p_1,\ldots,p_{j-1}, p_{j+1},\ldots,p_M)$ be the vector of prices that the other M-1 sellers charge. Let $Q(p_j,\overline{p}_j,D)$ be the quantity demanded from seller j given its price p_j, the others' prices $\overline{p}_j$, and consumers' search efficiency D. Let each seller's total cost be C(Q,W) where Q is the quantity demanded and W is the vector of input prices.[19] The functions C and Q are unsubscripted because all sellers are assumed identical. Seller j's net income is therefore

$$\pi(p_j,\overline{p}_j,D,W) = p_jQ(p_j,\overline{p}_j,D) - C[Q(p_j,\overline{p}_j,D),W] \, . \tag{6.01}$$

The seller's problem is to pick p_j to maximize π_j.

Seller j in picking p_j is assumed to take $\overline{p}_j$ as given, i.e. behavior is assumed to be Cournot. The basis for this assumption is that in any community with a large number of sellers a rise in price by one seller has a neglible effect on other sellers. This is because the consumers that seller j loses from its panel as a result of raising its price is split (M-1) ways among the other sellers, i.e. seller j's substantial loss is an insignificant gain for each other seller when M is large. Consequently no seller has any reason to react specifically to another seller's price changes.

These assumptions imply that the industry is in equilibrium if each seller j is charging the price p_j that maximizes its net income π_j given the prices $\overline{p}_j$ of every other competitor.[20] The goal of this section is to show (a) that an equilibrium price for the industry does generally exist and (b) that an increased number of sellers--or anything else that changes the efficiency of consumer search--may cause a change in the industry's equilibrium price. Proofs of these results are straightforward because of the assumptions made above that all M sellers are of identical underlying quality and have identical cost and functions.

The first order condition for seller j's maximization is (for given $\overline{p}_j$, W, and D) to pick p_j such that

$$\frac{\partial\pi(p_j,\overline{p}_j,W,D)}{\partial p_j} = Q(e+1) - C_Q Q_p = 0 \tag{6.02}$$

where $e = (pQ_p)/Q$ is j's price elasticity of demand, $C_Q = \partial C/\partial Q$ is marginal cost, and $Q_p = \partial Q/\partial p_j$. This elasticity e is a function of the prices $(p_j,\overline{p}_j)$ being charged in the market and the efficiency D of consumer search. Substitution of $(eQ)/p_j$ for Q_p into (6.02) and some rearrangement gives a more tractable form of the first order condition:

$$\frac{\partial\pi(p_j,\overline{p}_j,W,D)}{\partial p_j} = \frac{Q(p_j,\overline{p}_j,D)}{p_j} \{p_j[1+e(p_j,\overline{p}_j,D)]$$

$$- C_Q(Q(p_j,\overline{p}_j,D),W)\ e(p_j,\overline{p}_j,D)\} = 0 \tag{6.03}$$

Unless the maximum is degenerate with either $Q=0$ or $p_j=0$, the first order condition must be satisfied and the quantity in braces must necessarily equal zero. The second order condition, which must be satisfied for a non-degenerate maximum, is that $\partial\pi^2/\partial p_j^2 < 0$.

Since all sellers are assumed to be identical, a perfectly symmetric market equilibrium where each seller charges an identical price $p = p_1 = p_2 = \dots = p_M$ is likely to exist. Demonstration that under general conditions such an equilibrium price does exist for given D, W, and M is as follows. Since a symmetric equilibrium is being sought, $p = p_1 = p_2 = \dots = p_M$ may be substituted for $(p_i, \bar{p}_i)$ in both $e(p_j, \bar{p}_j, D)$ and $Q(p_j, \bar{p}_j, D)$. Thus e may be rewritten as $e(p,D)$ and Q may be rewritten as $Q(p,M)$. The inclusions of M as an argument of e and D as an argument of M stem from Section 3's demand model. Equation (3.20) shows that e is the sum of several component elasticities, none of which are directly affected by M. Equations (3.11) through (3.13) show that if all sellers charge the common price p, then the expected quantity demanded from each of them is $v(p)(N/M)$, which is a function only of p and M.

Substition of these forms for e and Q in (6.04) gives:

$$f(p,M,W,D) \equiv \frac{Q(p,M)}{p} \{p[1 + e(p,D)] - C_Q[Q(p,M),W]e(p,D)\} = 0. \qquad (6.04)$$

If, for given M, W, and D, the equation $f = 0$ can be solved for p, then that p is the market equilibrium price that every seller charges. This is because (6.04) is a rewrite of (6.03) for the special case of a symmetric equilibrium. Sufficient conditions for f to have a solution are that $e(0,D) \geq -1$ and, for some price $p_+ > 0$, $e(p_+,D) = -\infty$.[21] These are the requirements that (a) if all sellers are charging zero price, then the demand for each seller's product is inelastic and

(b) that some price p_+ exist such that if all sellers charge it, then the demand for each's product be perfectly elastic.

Requirement (a) may be interpreted as the reasonable assumption that if the industry's price is so low that it is nominal, then each firm's demand is inelastic. Requirement (b) may be interpreted as the assumption that if the industry's price is high enough, then each firm's demand becomes very elastic. This is true for any product for which a prohibitive price exists. In other words, each firm's demand curve is perfectly elastic at the lowest price at which the quantity demanded from each firm is zero. This is true because any demand curve is perfectly elastic at the point where it intersects the vertical axis.

Equation (6.04) implicitly defines the price function $p^*(M,W,D)$ for the industry. It is a structural relation that describes the price each seller charges for its product as a function of M (number of sellers), W (input prices), and D (consumer efficiency of search). It should not be confused with a reduced form price equation. For example, in a complete model of the industry which would involve several additional structural relations, M would generally be endogenous. This would mean that the reduced form price equation, unlike the structural price function, would not have M as an argument.[22]

Assume that the industry's equilibrium is not degenerate and is stable. Differentiation of (6.04) with the function p^* substituted for p gives the response of the industry's equilibrium price to changes in the value of the parameters M, W, and D. The analysis of Section 5 indicates that three main cases exist: $\partial e/\partial D > 0$ (case 1), $\partial e/\partial D < 0$ (case 2), and $\partial e/\partial D = 0$ (case 3). Recall that case 1, where demand becomes less elastic as search cost increases, appears to be the most plausible. Each case has in turn three subcases: $C_{QQ} \equiv \partial C_Q/\partial Q = 0$ (subcase a), $C_{QQ} > 0$ (subcase b), and $C_{QQ} < 0$ (cubcase c). These subcases are an exhaustive catalog of how quantity may affect short-run marginal cost. Table 2 shows the signs that result from differentiating p* for each of these nine cases.

The calculations on which Table 2 is based are straightforward. For example, sign p^*_M = sign $\partial p^*/\partial M$ is derived for case 1a as follows. Substitution of p* into (6.04) and multiplication of both sides by (p*/Q) gives:

$$g[p^*,M,W,D] \equiv p^*[1+e(p^*,D)]$$

$$- C_Q[Q(p^*,M),W]\ e(p^*,D) = 0 \qquad (6.05)$$

Differentiation with respect to M results in:

$$p^*_M = \frac{g_M}{g_p} = \frac{eC_{QQ}Q_M - [p^*-C_Q]e_D\frac{\partial D}{\partial M}}{[1+e]+[p^*-C_Q]e_p - eC_{QQ}Q_p} \qquad (6.06)$$

The sign of (6.06) is positive because the signs of its numerator and demoninator are both negative. This follows from several facts and assumptions. The denominator is negative because if it is not, then the industry equilibrium is not stable, which is contrary to assumption.[23] The elasticity e is defined so as to be negative. The term $[p^*-C_Q]$ is positive because in imperfect markets with downward sloping demand equilibrium price is set above marginal cost. Section 4's result is that an increase in the number of sellers decreases consumers' search efficiency, i.e. $\partial D/\partial M$ is positive. From the definition of case 1a, e_D is positive and C_{QQ} is equal to zero. Finally, from equations (3.11) and (3.13), Q_M is negative.

7. Conclusions

For cases 1a, 1c and 3c an increase in the number of sellers increases the equilibrium market price. Demonstration that this is possible within the context of maximizing behavior on the part of both consumers and sellers is the paper's specific result. It was derived in two steps. First, a decrease in consumers' efficiency of search may cause each seller's demand curve to become less elastic with the result that equilibrium price rises. Second, an increase in the number of sellers may decrease consumer information about sellers and consequently cause consumers' efficiency of search to decrease.

More important, however, than the specific results is the general implication that in monopolistically competitive markets all types of parameters may affect the elasticity of demand each seller faces and, as a consequence, the industry's performance.

Table 2: Comparative Statics Results

Case	Subcase	p_M^*	p_W^*	p_D^*
1: $e_D > 0$	a: $C_{QQ} = 0$	+	+	+
	b: $C_{QQ} > 0$	?	+	+
	c: $C_{QQ} < 0$	+	+	+
2: $e_D < 0$	a: $C_{QQ} = 0$	-	+	-
	b: $C_{QQ} > 0$	-	+	-
	c: $C_{QQ} < 0$	?	+	-
3: $e_D = 0$	a: $C_{QQ} = 0$	0	+	0
	b: $C_{QQ} > 0$	-	+	0
	c: $C_{QQ} < 0$	+	+	0

Here I have only investigated how the number of sellers may alter consumer information and, consequently, affect the individual seller's elasticity of demand. I believe, however, that further theoretical work can sharpen the arguments made above and point out other pathways by which the individual firm's demand elasticity is modified.[24] The usefulness this general implication has for empirical work is demonstrated in a paper by Mark Pauly and me (1978) where we apply the theory developed here to fee setting by primary care physicians. Specifically, in that analysis the theory developed here suggested several types of variables be included that would never be included within the context of a more traditional analysis. Those additional variables turned out to be, with almost no exceptions, statistically significant with the expected sign.

These positive conclusions must be balanced with a reminder of the limitations of this paper's analysis. First, no welfare analysis has been done. One can not conclude that a rise in price due to an increase in the number of sellers decreases consumer welfare. For example, a large number of sellers might mean that over time consumers become matched with sellers better than would be possible with only a few sellers. Specifically, in a small community none of the physicians practicing may be to the liking of a particular consumer, but in a big city with hundreds of physicians to choose from he can almost certainly find a physician who fits his preferences. Thus within the large community the increased utility from the better matching may more than offset the decreased utility from the higher prices.[25] See Salop (1977) for systematic development of this idea. Second, the analysis of this paper consists of three linked models. A more satisfactory approach would be to derive the results from a single, comprehensive model. Third, the analysis is for pure reputation goods. Clearly only a few goods and services exist that meet the criteria for a pure reputation good. Far more common are goods that share important characteristics with reputation goods without being pure examples. An open question is to what extent this analysis carries over to such goods.

Footnotes

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1. A related idea, which was a spur to my thinking, has been noted by Salop (1976). If a consumer is searching without replacement, then he may prefer to draw his sample from a population with a small number of elements rather than from a population having the identical frequency distribution and a large number of elements.
2. Salop (1977) in a paper done independently and concurrently also explicitly introduces this idea of person specific quality. He calls it product "variety."
3. Empirical studies of why consumers choose one physician instead of another appear to be rare. One paper that does consider this question is Booth and Babchuk (1972). It generally confirms my description: an individual tends to depend on the

recommendations of those friends and relatives whom he perceives to have superior expertise about the health care system.

4. The choice of a week as the unit of time is arbitrary.

5. Note that this formulation is appropriate even though the most common reason for a consumer to switch sellers may not be dissatisfaction over price, but dissatisfaction over quality.

6. If each equation (2.03) and (2.04) is divided through by N and the system is solved for $(N_1/N,\ldots,N_m/N) = (\rho_1,\ldots,\rho_m)$, then $(\rho_1,\ldots,\rho_m)$ is the vector of steady state probabilities for the Markov process that describes each consumer's choice of seller.

7. An anonymous referee suggested this simple method for deriving equations (3.11) and (3.12).

8. A substantial number of weeks may elapse before the expected quantity demanded approaches the equilibrium quantity demanded. In the short run demand is less elastic than it is in the long run.

9. That this model is rudimentary and preliminary must be emphasized. Nevertheless my intuition is that the conclusion of this model is quite robust to changes in its specification, cf. footnotes 10 and 13.

10. The model could have been specified to allow individuals to not only exchange stories about the seller they are currently

patronizing, but also to exchange hearsay stories about other sellers. I doubt this change would affect the conclusion.

11. This account is perhaps an optimistic view of how people gossip. An alternative interpretation of the model avoids this objection. Individual j can only repeat what he has heard about seller i if he remembers its name. Moreover, j only remembers the seller's name if he possesses the threshold level of information η.

12. It is "one plus..." because j tells his friend about both his own seller and those sellers for whom $\theta_i^t \geq \eta$.

13. A modification of the model that gives the same result is to assume that information exhibits increasing returns to scale. Specifically, assume that the usefulness of the information that θ_i^t represents is not proportional to θ_i^t, but is proportional to $f(\theta_i^t)$ where f is a strictly convex function. Individual j, when asked, tells everything he recalls, i.e. there is no threshold value. The total value of this information to the friend who asked for the information is $\Sigma_{i=2}^{M} f(\theta_i^t)$. As M increases, this value decreases because the average value of each component θ_i^t decreases. The convexity of f then implies that an increase in M causes a decrease in the expected value of the information. This analysis is confirmed by simulation:

Average Value of Information

M	δ = .125	δ = .167
10	81.5	19.4
15	12.6	6.21
25	6.77	4.17
35	4.81	3.61

where $f(\theta_i^t) = (\theta_i^t)^2$.

14. It would be more satisfactory -- but beyond the scope of this paper -- to explicitly consider the uncertainty that consumer i continues to have concerning seller j's price and quality, even after receiving a recommendation about j.

15. Within the context of this model, individual i's belief that every seller charges the price p^o is rational because, as Section 6 shows, a perfectly symmetric equilibrium exists for this model.

16. Individual i's subjective distribution is assumed to remain fixed throughout his search for a new seller. He is not permitted to learn about and revise F(X) as he samples.

17. See, for example, DeGroot (1970) or Lippman and McCall (1976).

18. In this model search costs are exogenous. A more sophisticated model might consider D to be endogenous. For example, lawyers and physicians have used their professional associations to affect the cost of search by establishing ethical codes specifying how much and what types of advertising are acceptable.

19. For the case of owner-operated firms (e.g. physicians and lawyers) total costs should be defined to implicitly include a wage for the owner-operator.

20. This is the concept of Nash equilibrium.

21. Assume that $e(p,D)$ is continuous. If $e(0,D) \geq -1$, and $e(p_+,D) = -\infty$, then (i) some $p' > 0$ exists such that

$$\frac{Q}{p'}\{p'[1 + e(p',D)] - C'[Q(p',M),W)e(p,D)\} < 0$$

and (ii) some $p'' > 0$ exists such that

$$\frac{Q}{p''}\{p''[1 + e(p'',D)] - C'[Q(p'',M),W]e(p'',D)\} > 0.$$

The intermediate value theorem therefore implies that a solution to (6.04) exists. If a nonsymmetric equilibrium were being sought, then a more complicated fixed point argument would be necessary.

22. For an example of a complete model containing this structural price function, see Pauly and Satterthwaite (1978).

23. Note that because $Q(p,M)$ and $e(p,D)$ were substituted into (6.03), the denominator of (6.07) is not identical to $\partial^2\pi/\partial p_j^2$, which is necessarily negative since it is the second order condition in j's maximization problem. Therefore, in order to establish that the denominator is negative, stability must be appealed to.

24. See the second sentence of footnote 25 for an example of the direction such development may take.

25. An anonymous referee, Dennis Smallwood, and Richard Zeckhauser have each independently pointed this out to me. Moreover Richard Zeckhauser has suggested that this better matching may by itself lead to less elastic firm demand. Specifically, the better matching might lead consumers to be more loyal to their current sellers, which the sellers could take advantage of by raising their prices.

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