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PRICE ADVERTISING AND THE DETERIORATION OF PRODUCT QUALITY*

by

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I. Introduction

A large debate over the potential benefits and harms of advertising by providers of professional services has occurred in the last decade as self-enforced prohibitions against advertising have been subjected to increasingly successful challenges by government agencies, consumer activists, and individual members of the professions themselves.[1] A common theme of the arguments favoring these self-enforced advertising bans has been that it is much more difficult to transmit objectively verifiable information regarding most aspects of the quality of a professional's services than it is for many other items that consumers purchase. This stems partially from the fact that a professional provides a service instead of a good (thus there are fewer tangible features to describe) and partially from the fact that the services provided are complex enough so that no easily transmittable facts are likely to exist which credibly signal high quality. In fact the price of his service might be one of the few pieces of information which a professional can effectively communicate through advertising. This being the case, allowing professionals to advertise runs the risk of producing "excessive" price competition -- i.e. -- firms will compete vigorously on the highly observable, salient price dimension partially at the cost of their own profits but partially at the expense of the less observable and less salient quality of their product. The costs of this deterioration in product quality might easily exceed any benefits to be had from lower prices.

The idea that competition in two attribute variables will stress the attribute consumers are better informed about seems very reasonable. Whether better information about one variable could actually reduce welfare in equilibrium is less clear, but the wealth of negative welfare results in modern information economics certainly suggests that this is possible. The purpose of this paper is to show that the above argument finds little support in a standard model of markets with imperfect information and, in fact, fails to identify the key factor upon which welfare results hinge.

The fact that information is imperfect is captured by assuming that consumers can visit a firm to determine its terms, but only at a cost. This cost varies across consumers. Under no advertising consumers must visit a firm to determine its price and quality. Under advertising all consumers know all firms prices and must visit the firm only to determine its quality. Thus consumers can choose which price segment to shop in when price is advertised. All firms are identical and earn zero profits in equilibrium due to free entry. Equilibrium is a symmetric Nash equilibrium. Thus when there is no advertising there is a single equilibrium price and quality. Under advertising there is an equilibrium quality in each price segment. This is simply a natural extension of the model of sequential search equilibrium first introduced by Diamond [1971] and elaborated by Rob [1984] and Stiglitz [1984] among others.

The key insight which the analysis of this paper rests on is that when price advertising is allowed, price will serve as a signal of quality. The economic reason for this is very simple. Fix the price a firm charges. The benefit to raising quality is that more consumers who visit the firm will actually patronize it. As price rises above marginal cost this benefit is larger and there is a larger incentive to increase quality to capture this benefit. Thus, in equilibrium firms producing in a higher price segment of the market will produce higher quality.

The major analytic results of this paper are that the equilibria satisfy three properties. First, the equilibrium price quality pair available under no-advertising is one of the pairs available in the advertising equilibrium.

Second, in the no-advertising equilibrium consumers receive the first-best quality. Third, in the advertising equilibrium the premium of price over marginal cost is strictly increasing in quality.

These properties yield the following conclusions. First, allowing advertising is strictly Pareto-improving. When advertising is allowed, consumers could choose to purchase the first best quality at the same price as it was available for under no-advertising. However, because the premium of price over marginal cost increases in quality, consumers settle for lesser quality in order to obtain a more-than-compensating price reduction. Thus allowing advertising will cause a reduction in quality as its opponents claim. However, this reduction is welfare improving!

Second, because quality and thus the premium of price over marginal cost is reduced in the advertising equilibrium, the number of firms which can be supported in a zero-profits equilibrium will decrease if advertising is allowed. Professional associations interested in preventing the forced exit of some members would thus rationally be opposed to allowing advertising.

Third, if consumers with differing willingnesses to pay for quality exist, a variety of different price-quality pairs will be offered in equilibrium when advertising is allowed. This equilibrium will have the property that higher quality products are produced by smaller firms, even though there is no direct productive reason for this to occur. This is because the premium of price over marginal cost rises with quality. Therefore firms producing higher quality must be smaller in a zero profits equilibrium. This prediction suggests that the stylized fact that professional services are provided by large, low price, low quality firms and small, high price, high quality firms[2] may be due to the nature of the signaling equilibrium and not necessarily to productive factors.

This paper is most closely related to the work of Chan and Leland [1982] which addresses the same questions considered in this paper. The approach of modeling advertising as completely revealing all prices is due to them. The major difference between their paper and this paper, is that they assume consumer search is non-sequential. Consumers choose to become perfectly informed at a cost or precommit to accept the offer of the first firm they visit no matter how bad this offer turns out to be. The informational structure is thus similar to that in Salop and Stiglitz [1977]. A consequence of this approach is that the possibility for price to signal quality is assumed away. Therefore the case of sequential search considered in this paper yields a very different type of model.[3]

This paper is also related to the large literature on price as a signal of product quality. Almost all of the papers in this literature have focused on the idea that in markets for experience goods there may be an incentive for firms to "fly-by-night" if sunk costs of production are not very high.[4] Thus a high price signals that a firm is not planning to operate for only one period, produce low quality, and exit. Some aspects of a professional's quality of service can only be evaluated through consumption and thus this type of model is potentially applicable. However, fly-by-night operators do not appear to be the major problem in many professional service markets. This is consistent with the fact that professionals have large sunk costs of acquiring their training and cannot recoup these by operating for a short period of time and then exiting.

Consumers do experience switching costs when moving from one professional to another, however. These include costs of inquiring among friends to obtain a general idea of a professional's price schedule and to obtain reassurance that at least some people feel the quality of service offered is satisfactory. This paper shows that the existence of such switching costs is sufficient to generate on equilibrium where price signals quality even if there is no problem with "fly-by-night" operators.

Two other signaling papers not focusing on the problem of "fly-by-night" operators are by Farrell [1980] and Wolinsky [1983]. Farrell [1980] has consumers use a fixed non-optimal search rule. Wolinsky's [1983] paper contains the most closely related signaling model to that of this paper. Although he formally assumes that consumers observe quality with an error instead of that consumers have switching costs the resulting mathematical structure is similar. The approach of this paper avoids some technical difficulties of Wolinsky's approach.[5] As well as Wolinsky's approach requires the assumption that there is an absolutely disconfirming observation for any level of quality (i.e. -- for any specified quality level it is possible for consumers to observe a signal such that they know with probability one that quality must be lower than the specified level).

Section 2 outlines the general model. Section 3 considers the case of no-advertising where price and quality are both search variables; Section 4 considers the case of advertising where all firms' prices are known and only quality is a search variable. Section 5 considers generalizations where consumers with differing willingness to pay for quality exist and where advertising is costly.

2. The Model

A. Firms

All firms are identical and produce a given quantity of output, x, of quality, q, according to the cost function C(x,q). It is assumed that C(x,q) satisfies the following conditions. (These are discussed after their formal statement.)

(A.1) $C(x,q) = c(q)x + V(x) + F$

(A.2) $c(q)$ is defined and twice continuously differentiable over $[0,\infty)$. Furthermore $c(0) = 0$, c is strictly increasing, strictly convex, $c'(0) = 0$ and $\lim_{x\to\infty} c'(x) = \infty$

(A.3) V is defined and twice continuously differentiable over $(0,\infty)$. Furthermore $V(0) = 0$, V is strictly increasing and strictly convex.

(A.4) $F > 0$

According to assumption (A.1), average costs are additively separable in output and quality. This implies that the first best firm size is independent of output. Furthermore it will also be shown to imply that an optimal quality exists independent of firm size. Chan and Leland [1982] also make this assumption to perform their welfare analysis. Many of the results of this paper generalize to the case where first-best size is non-increasing in quality.[6] However this involves significantly more calculation so it will not be presented.

According to (A.2), average costs shift up at a decreasing rate as quality increases. The assumption that $c'(q)$ maps onto $[0,\infty)$ is made for technical convenience. It guarantees that interior solutions exist to various maximization problems.

Assumptions (A.3) and (A.4) imply that the cost function (viewed as a function of x for any fixed positive q) is of the following form. Average costs are strictly concave and reach a (unique) local minimum. Marginal costs are strictly increasing. It is straightforward to also consider the case where V is linear and thus average costs are constantly declining. This is not formally considered to minimize notation.

Let AC(x,q) and MC(x,q) denote average and marginal cost.

$$(2.1) \qquad AC(x,q) = c(q) + \frac{V(x) + F}{x}$$

$$(2.2) \qquad MC(x,q) = c(q) + V'(x)$$

B. Consumers

The standard assumptions of sequential search models are made. Namely, each consumer purchases exactly one unit of the good. Each consumer knows the distribution of prices offered by firms and can search sequentially among firms at a cost of s per search. Although s is fixed for each consumer, it varies among consumers. Each consumer's value of s is assumed to be drawn from some distribution F(s). Let f(s) denote the density function of F(s) where it exists.

Consumers' utility is assumed to be additively separable and linear in quality, price, and search costs. A consumer who searches t times, and pays a price of p for a good of quality q will receive utility of

$$(2.3) \qquad q - p - ts.$$

It will also be assumed that a consumer who does not consume one unit of the good receives utility of $-\infty$. This simplifies the exposition because an equilibrium where trade occurs always exists. It is straightforward to relax this assumption.

The distribution of consumer search costs is assumed to satisfy the following conditions.

(A.5) $F(s)$ is defined over $[0,\infty)$ and is differentiable at $s = 0$.

(A.6) $f(0) > 0$.

(A.7) $F(s) \geq \dfrac{s}{s + \dfrac{1}{f(0)}}$ for every $s \geq 0$.

(A.8) $F(0) = 0$.

Assumption (A.5) is definitional. Assumptions (A.6) and (A.7) guarantee the existence of a symmetric equilibrium. They can both be interpreted as requiring that "enough" consumers with low search costs exist. Condition (A.6) requires that at least some consumers with very small search costs exist. Condition (A.7) is a "stochastic dominance" condition -- there must be at least as many low search cost consumers as determined by the distribution $\dfrac{s}{s + \dfrac{1}{f(0)}}$. Assumption (A.8) is not required for the existence of a symmetric equilibrium. However, if it is violated the only possible symmetric equilibrium involves every firm offering the full-information price and quality. Thus (A.8) restricts attention to the class of interesting cases -- those where consumer search costs result in departures from the full-information equilibrium.

C. First-Best Outcome

It will be useful to define the full-information equilibrium or first-best outcome in order to provide a baseline with which to compare the equilibria calculated in later sections. The first-best firm size and quality maximize the net surplus per consumer. This is given by

$$(2.4) \qquad q - c(q) - \frac{V(x) + F}{x} .$$

By the previous assumptions there is a unique maximizer of (2.4). Let (x_F, q_F) denote this point. It is determined by

$$(2.5) \qquad c'(q_F) = 1$$

and

$$(2.6) \qquad V'(x_F) = \frac{V(x_F) + F}{x_F} .$$

3. Price and Quality Unknown

A. Existence

First the case of no advertising will be considered where consumers do not know price or quality without conducting a search. An equilibrium will be defined to be a price and quality, (p^*, q^*), and number of customers per firm, x^*, such that

(i) any given firm will choose to offer (p^*, q^*) given that all other firms do so.

(ii) every firm makes zero profits.

To formally define an equilibrium, a firm's demand curve given it offers (p,q) when all other firms offer (p^*,q^*) and there are x^* customers per firm must be calculated. Let $d(p,q,p^*,q^*,x^*)$ denote this demand curve. Rob [1985] shows that demand is given by

$$(3.1) \qquad d(p,q,p^*,q^*,x^*) = \begin{cases} x^*[1-F(u^*-u)] & , \quad u \leqslant u^* \\ x^*[1+(u-u^*)f(0)] & , \quad u \geqslant u^* \end{cases}$$

where u and u^* are defined by

$$(3.2) \qquad u^* = q^* - p^*$$

and

$$(3.3) \qquad u = q - p.$$

The derivation will not be repeated here. Also see Stiglitz [1984] and Rogerson [1986b] for further discussion of this procedure. Two points should be noted about this demand curve. First, it is calculated under the assumption that there are a large number of consumers and firms. Formally, this is accomplished by calculating the demand curve when there are a finite number of firms and consumers and taking the limit of these curves as the number of firms and consumers increases to infinity, holding the consumer to firm ratio constant at x^*. Second, demand is continuous at the value $u = u^*$ and the derivative is the same calculated from the left or right. Thus there is no "kink" in demand.[7]

Let a firm's profits given it offers (p,q) when all other firms offer (p^*,q^*) and there are x^* customers per firm be denoted by $\pi(p,q,p^*,q^*,x^*)$. It is given by

$$(3.4) \qquad \pi(p,q,p^*,q^*,x^*) = pd - C(d,q)$$

where d denotes $d(p,q,p^*,q^*,x^*)$.

An equilibrium can now be formally defined.

Definition: The triple (p^*,q^*x^*) is a no-advertising equilibrium if

$$(3.5) \qquad \text{(i)} \qquad (p^*,q^*) \in \underset{(p,q)}{\operatorname{argmax}}\ \pi(p,q,p^*,q^*,x^*)$$

$$\text{(ii)} \qquad \pi(p^*,q^*,p^*,q^*,x^*) = 0 .$$

Theorem 1 now describes the unique equilibrium under no advertising.

Theorem 1:

A unique no-advertising equilibrium, (p_N,q_N,x_N), exists and is the unique solution to the following three equations.

$$(3.6) \qquad p = MC(x,q) + \frac{c'(q)}{f(0)}$$

$$(3.7) \qquad p = AC(x,q)$$

$$(3.8) \qquad q = q_F$$

proof:

See Appendix.

Q.E.D.

B. Welfare

Note that the quality is the first-best quality. This is because firms have the option of "ripping off" consumers through directly taking money from them (by raising price) as well as by lowering quality. Reducing quality below the first best level is not optimal because consumers' marginal loss is greater than the firm's marginal cost saving. Thus the firm would be better off to supply the first-best quality and directly take money from consumers by raising price. Thus for any given utility drop of consumers, raising price yields greater return to the firm than lowering quality below the first-best level.

Figure 1 illustrates the nature of the equilibrium price and firm size. The first-best firm size occurs at the minimum of average cost, where marginal cost intersects average cost. However, by equations (3.6) - (3.8), the equilibrium price and firm size occur where average cost intersects the marginal cost curve shifted up by $\frac{c'(q_F)}{f(0)}$. Therefore equilibrium firm size is smaller than the first best and equilibrium price is higher than the first best. Corollary 1 summarizes these results.

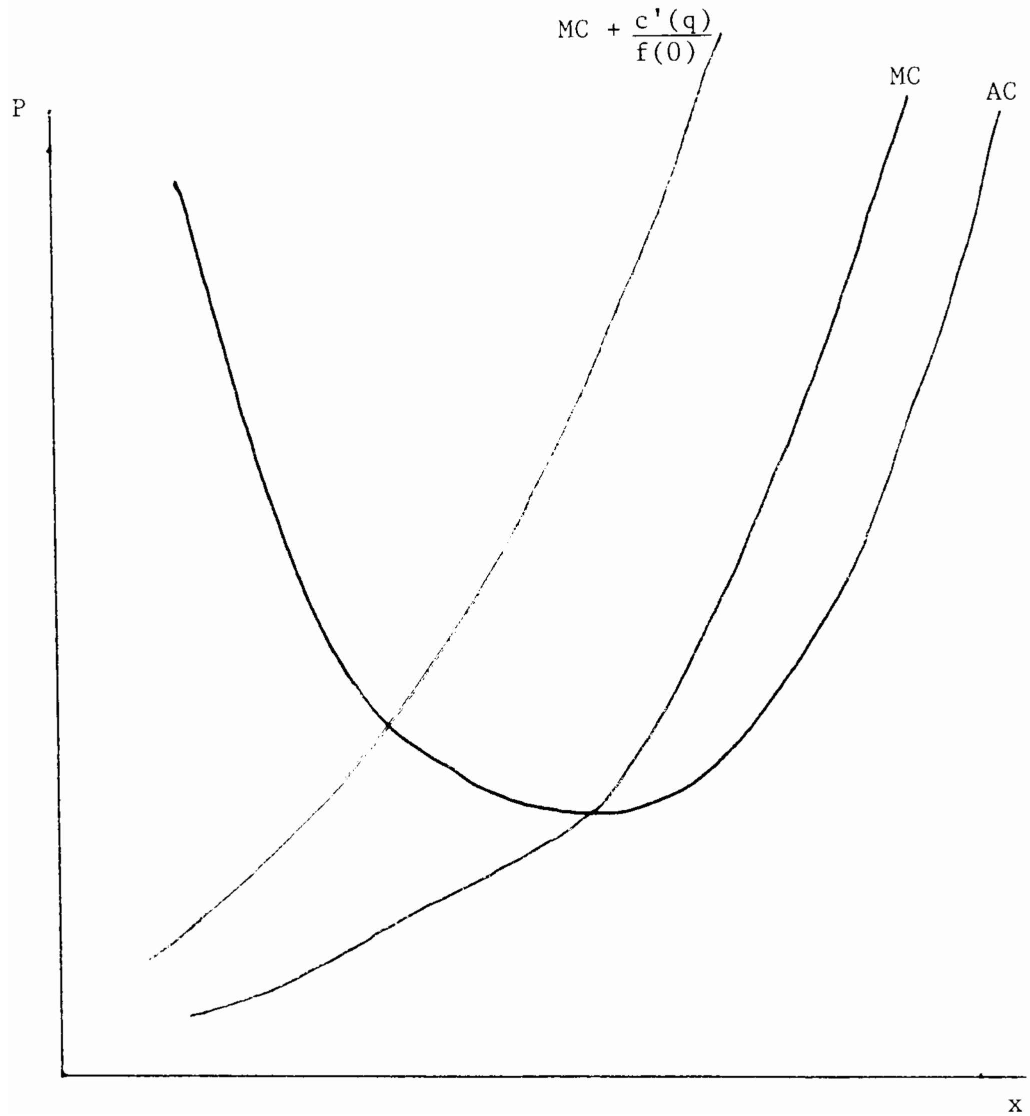
Corollary 1:

The first-best quality occurs in the no-advertising equilibrium. However firms are smaller and prices are higher than the first-best.

proof: As above.

Q.E.D.

Figure 1



4. Price Known; Quality Unknown

A. Existence

Now the case will be considered where advertising occurs so that all firms' prices are known and only quality is a search characteristic. The key factor determining the nature of equilibrium in this case is that price will be a signal of quality in the sense that firms charging a higher price will have an incentive, in equilibrium, to supply higher levels of quality. The clearest way to see this is to first define the notion of equilibrium for a fixed price.

Definition: (q^*, x^*) is an equilibrium given p^* if

$$(4.1) \qquad q^* \in \underset{q}{\operatorname{argmax}}\ \pi(p^*, q, p^*, q^*, x^*)$$

$$(4.2) \qquad \pi(p^*, q^*, p^*, q^*, x^*) = 0$$

Condition (4.1) states that q^* is a Nash equilibrium quality level; condition (4.2) is simply the zero profits constraint.

Theorem 2 presents conditions which characterize the triples (p,q,x) such that (q,x) is an equilibrium given p.

Theorem 2

(q,x) is an equilibrium given p if and only if (p,q,x) satisfies

$$(4.3) \qquad p = MC(q,x) + \frac{c'(q)}{f(0)}$$

$$(4.4) \qquad p = AC(q,x)$$

proof:

Equation 4.3 is the first order condition for a Nash equilibrium in quality choice; equation (4.4) is the zero profits condition. To show that the first order condition is actually sufficient for firms to be at a global maximum in profits, the same technique is used as in Theorem 1.

Q.E.D.

It remains to show that a unique equilibrium given p exists for every p and then to describe the behavior of the equilibrium (q,x) as p varies. The clearest way to do this is to consider solutions for p and x to (4.3) and (4.4) for fixed values of q. Lemma 1 does this.

Lemma 1:

For every $q \in [0,\infty)$ there exists a unique (p,x) which satisfies (4.3) and (4.4).

proof:

Choose any $q \in [0,\infty)$. Then (4.3) and (4.4) require a (p,x) such that average cost intersects the function created by shifting marginal cost up by $\frac{c'(q)}{f(0)}$. This is illustrated by Figure 1. Since average cost is U shaped and marginal cost is increasing, a unique intersection always exists.

Q.E.D.

Let $\phi(q)$ and $\psi(q)$ denote, respectively, the values of p and x which satisfy (4.3) and (4.4) for a given q.

Lemma 2 describes the properties of ϕ and ψ. Let $\underline{p}$ denote the minimum average cost of producing the lowest possible quality.

(4.5) $$\underline{p} = \min_{x} \frac{V(x) + F}{x}$$

Lemma 2:

(i) $\phi(q)$ and $\psi(q)$ are continuously differentiable over $[0,\infty)$.

(ii) $\phi(0) = \underline{p}$

$\psi(0) = x_F$

(iii) For every $q \in (0,\infty)$

(4.6) $$\phi'(q) > c'(q) > 0$$

(4.7) $$\psi'(q) < 0$$

(iv) $\phi'(0) = 0$

proof:

Condition (i) is simply a consequence of the implicit function theorem. Condition (ii) follows from substituting $q = 0$ into (4.3) and (4.4). To prove (iii) and (iv) totally differentiate (4.3) and (4.4) and reorganize to yield

(4.8) $$\phi'(q) = c'(q) - \frac{c''(q)}{f(0)} \frac{AC'(x)}{V''(x) - AC'(x)}$$

and

(4.9) $$\psi'(q) = \frac{-c''(q)}{f(0)[V''(x) - AC'(x)]} .$$

Based on the analysis in the proof of Lemma 1, AC'(x) is negative for $q > 0$ and equal to zero for $q = 0$. Conditions (iii) and (iv) now follow immediately.

Q.E.D.

According to Lemma 2 price is strictly increasing in quality and in fact increases at a greater rate than c(q). Firm size is strictly decreasing in q. The reasons for this can be easily seen by reference to Figure 1. Suppose q increases from q_1 to q_2. This causes marginal cost and average cost to both shift up by $c(q_2) - c(q_1)$. Recall that the equilibrium is determined by the intersection of average cost with marginal cost shifted up by some number, δ. If δ remained unchanged, the equilibrium firm size would remain unchanged and equilibrium price would also increase by $c(q_2) - c(q_1)$. However δ equals $\frac{c'(q)}{f(0)}$. Since c is strictly convex, δ increases as q increases from q_1 to q_2. Thus equilibrium price increases by more than $c(q_2) - c(q_1)$ and equilibrium firm size decreases.

Since price is strictly increasing in quality there exists a unique equilibrium quality and firm size for every price greater than or equal to $\underline{p}$. Theorem 3 summarizes this.

<u>Theorem 3</u>:

For every $p \in [\underline{p},\infty)$ there exists a unique equilibrium given p. It is determined by

$$q = \phi^{-1}(p)$$

$$x = \psi(\phi^{-1}(p))$$

(ii) q is strictly increasing in p

(iii) x is strictly decreasing in p

proof:

This follows immediately from Lemmas 1 and 2.

Q.E.D.

Theorem 3 completes the demonstration that price will be a signal of quality in equilibrium. In particular a higher price will result in a higher equilibrium level of quality. The intuition for this result follows from the nature of a firm's incentive to supply high quality. The advantage to deteriorating quality is that costs go down. The disadvantage to deteriorating quality is that the firm loses some customers. A loss of one customer causes profit to fall by an amount equal to price minus marginal cost. Therefore a firm will only have an incentive to supply high quality if price exceeds marginal cost and the incentive to supply high quality will be greater as the premium of price over marginal cost increases. This incentive effect is captured in (4.3) which is the first-order condition for a Nash equilibrium in quality.

An important feature of the relationship between price and quality is that price rises faster than $c(q)$. This occurs because the premium of price over marginal cost in (4.3), given by $c'(q)/f(0)$, is increasing in quality. The reason for this is that the marginal gain to deteriorating quality becomes larger as q grows (i.e. -- $c'(q)$ increases in q.) Therefore firms require a larger incentive to provide higher levels of quality. This is provided by a larger premium.

It is also interesting to note that the signaling equilibrium defined by (4.3) and (4.4) is distinctly different than the signaling equilibrium predicted by the standard analysis of the incentives to be a fly by night operator.[8] Equation (4.4), the zero profits condition, is unchanged. However, the incentive constraint replacing (4.3) is

$$(4.10) \qquad p = c(q) + \frac{V(x)}{x} + rc(q)$$

where r denotes the interest rate. The above condition states that price must equal "average non-salvagable costs plus a premium"; condition (4.3) requires price to equal "marginal cost plus a premium." Condition (4.3) is much easier to work with and analyze than (4.10). Thus the technology of this paper may prove to be useful in other applications.

An advertising equilibrium can now be defined. If any price occurs in equilibrium all firms offering it will offer the equilibrium quality given p. (They will also all be of the equilibrium size given p.) Consumers' expectations are assumed to be rational; they believe that firms offering a price of p will offer a quality of $^{-1}(p)$. Consumers choose an optimal price segment to shop in given these beliefs. Since all consumers have identical willingesses to pay for quality, they all choose to shop in the same price segment. This is formalized in the following definition.

<u>Definition</u>: (p,q,x) is an advertising equilibrium, if

(i) $p = \phi(q)$ and $x = \psi(q)$

and

(4.11) (ii) $q \in \underset{\hat{q} \in [0,\infty)}{\operatorname{argmax}} \ \hat{q} - \phi(\hat{q})$

Theorem 4 shows that an equilibrium exists. There may be multiple equilibria because ϕ will not in general be strictly convex.

Theorem 4:

An advertising equilibrium exists.

proof:

It is obvious sufficient to prove that $q - \phi(q)$ achieves a maximum on $[0,\infty)$. By assumption, $c'(q) > 1$ for every $q > q_F$. Therefore by (4.6), $\phi'(q) > 1$ for every $q > q_F$. This means that $q - \phi(q)$ is strictly decreasing for $q > q_F$. Since $q - \phi(q)$ is continuous it achieves a maximum on $[0,q_F]$. By the above this is also a maximum for over $[0,\infty)$.

Q.E.D.

B. Welfare

The key to both formally proving and intuitively understanding the welfare results of this section is Lemma 3.

Lemma 3:

(q_N, x_N) is an equilibrium given p_N.

proof:

Equations (3.6) and (3.7), are the same as equations (4.3) and (4.4)

Q.E.D.

The reasoning behind Lemma 3 is very simple. For a triple (p,q,x) to be a no-advertising equilibrium it must be a Nash equilibrium in both price and quality choice as well as generate zero profits for firms. In particular, then, it is a Nash equilibrium in quality choice and generates zero profits (holding p fixed.) This is the definition of an equilibrium (q,x) given p.

Thus both the no advertising and advertising equilibrium satisfy $p = \phi(q)$ and $x = \psi(q)$. However the equilibrium quality levels differ. Under no-advertising, the first-best quality level is chosen for reasons explained in Section 3. Under the advertising equilibrium consumers can choose any price-quality pair satisfying $p = \phi(q)$. This is because they can choose which price segment to shop in. Corollary 3 shows that consumers will always choose a quality level strictly less than the first best! Thus by revealed preference consumers are strictly better off under the advertising equilibrium.

Corollary 3:

Suppose that (p_A, q_A, x_A) is an advertising equilibrium. Then

(i) $q_A < q_N$

(ii) $x_A > x_N$

(iii) $p_A < p_N$

(iv) Consumers strictly prefer the advertising equilibrium

-- i.e. --

$q_A - p_A > q_N - p_N$.

<u>proof</u>:

it is sufficient to show (i). The other results then follow from Lemma 3 and the above comments. A necessary condition for q_A is that $' \; q_A \; = 1$ since q_A satisfies (4.11). By definition $c'(q_F) = 1$. Since c is convex, $c'(q) \;\; 1$ for every $q \;\; q_F$. Therefore by (4.6), $'(q) > 1$ for every $q \;\; q_F$. Therefore $q_A < q_F$.

Q.E.D.

If consumers were allowed to choose any (p,q) pair satisfying $p = c(q)$ they would choose the first-best quality. However this is not the choice facing consumers. They must choose a (p,q) pair satisfying $p = \;\; (q)$. In particular, $\;(q)$ increases more quickly than $c(q)$. Therefore consumers choose less than the first best quality.

Thus according to this model, opponents of advertising who argue that allowing advertising will cause quality to deteriorate are correct. However, their conclusion that this is undesirable is incorrect! In equilibrium, higher levels of quality can only be supplied by firms which charge a higher premium of price over marginal cost. This means that second-best quality level (given these information constraints) is less than the first-best quality level.

Given that firms make zero profits in either case, one might wonder why, in the real world, professional associations representing these firms argue so vehemently against allowing advertising. This model provides an explanation. If advertising were allowed, the lower quality level would be associated with a lower premium of price over cost. Thus firms would have to be bigger in order to make zero profits. Since demand is assumed to be totally inelastic, the number of firms in the industry must drop. Thus allowing advertising would lower price-cost margins and induce exit from the industry. Professional associations interested in preventing the forced exit of some members (and possibly negative industry profits during the adjustment phase) would rationally be opposed to allowing advertising.

5. Generalizations

A. Multiple Types of Consumers

In many markets for professional services not all consumers demand the same quality when faced with the same price-quality schedule. This is because different types of consumers exist with different willingnesses to pay for quality, possibly because of differences in their income or in their degree of insurance coverage (in the case of medical care.) Thus richer people (or better insured people) are willing to pay more for an increment in quality. If search costs are primarily non-monetary there is no reason to believe that search costs will vary systematically across consumer types. The model of this paper generalizes immediately in this case.[9]

Formally assume that a large number of consumers of each type α exist where α is distributed over the positive reals according to some distribution function $G(\alpha)$. A consumer of type α has a utility function given by

$$(5.1) \qquad q - \frac{p}{\alpha} - ts.$$

Thus higher higher types of consumers have a lower marginal utility of income and are willing to pay more for everything, including both increments in quality and units of their own search time and effort.[10]

The determination of an equilibrium (q,x) given p remains unchanged from the previous sections since this is determined by firms' cost functions and consumers' search costs, neither of which have changed. For the case of no-advertising, the equilibrium quality is the "first-best" for the same reasons as described in Section 3. However with a group of randomly selected consumers the average marginal utility of income, $1/\alpha$, is given by

$$(5.2) \qquad \frac{1}{\bar{\alpha}} = \int \frac{1}{\alpha} \, d\, G(\alpha) \ .$$

Thus firms set quality to be optimal for a consumer of type $\bar{\alpha}$. That is, q satisfies

$$(5.3) \qquad c'(q) - \frac{1}{\bar{\alpha}} \ .$$

Under advertising, consumers can choose any price quality pair satisfying $p = \phi(q)$. Different types will, of course, in general choose to shop in different price segments. All will be strictly better off except type $\bar{\alpha}$ which will be equally well off. Thus the welfare result is preserved; allowing advertising is Pareto-improving.

The above welfare analysis is possibly somewhat biased in favor of the advertising equilibrium because a symmetric search equilibrium is calculated for the case of no advertising -- i.e. -- an equilibrium where all firms offer the same price and quality is calculated. When all consumers have the same preferences as in the previous sections this seems reasonable. However when consumers have differing preferences for quality one might expect no-advertising equilibria where different price quality pairs are offered to be more likely. Nevertheless, advertising of prices allows perfect sorting of consumers to occur because of the signaling role of price; in the absence of advertising sorting in an asymmetric equilibrium would be partial at best. Whether the results of this paper can be formally extended to include the possibility of assymetric search equilibria is an interesting question for future research.

Independent of the welfare comparison, the structure of the advertising equilibrium has an interesting characteristic which is worth noting. This is that higher quality is produced by smaller firms, even though the first-best firm size is the same for every quality level. The reason for this is that the premium of price over marginal cost rises with quality for incentive reasons explained earlier. Thus the zero-profits condition requires that firms producing higher quality be smaller.

This prediction appears to be consistent with the stylized fact that many types of professional services are provided by large, lower quality, outlets and smaller, high quality, outlets. This can sometimes be explained by appealing to productive efficiency arguments. For example, there appear to be large economies of scale in producing run-of-the-mill low quality legal services by employing specialized para-legal help, standardized forms, etc. However, this is not always the case. The FTC, for example, found that the effect of price advertising on the market for optometry services was to segment the market into larger low quality firms offering low prices and smaller high quality firms offering high prices. [Bond, et. al. 1980] The quality variation occurred in the eye exam. Smaller firms generally offered more thorough exams. It seems reasonable to assume that large firms could just as easily offer tests which took longer and checked for more problems. The model of this paper explains why we might observe negative correlations in quality and size even in the absence of productive efficiency reasons.

B. Costs of Advertising

The result that the advertising equilibrium Pareto-dominates the no advertising equilibrium was obtained under the assumption that advertising is costless. If advertising increases fixed costs by some amount, A, this will cause the schedule of price quality pairs available under advertising to shift up -- i.e. -- every quality will be somewhat more expensive, reflecting advertising costs. This effect would tend to make the advertising equilibrium less desirable. Thus if advertising were costly enough, the welfare conclusions of this paper might be reversed.

Appendix

Proof of Theorem 1

The clearest method of proof involves a change of variables. Letting u be defined by (3.3), a firm can be viewed as offering a (u,q) pair instead of a (p,q) pair. Then, from (3.1), demand is given by

$$(a.1)\qquad d\left(u,q,u^*,q^*,x^*\right) = \begin{cases} x^*\left[1-F\left(u^*-u\right)\right], & u \leqslant u^* \\ x^*\left[1+\left(u-u^*\right)f(0)\right], & u \geqslant u^* . \end{cases}$$

Profits are defined by

$$(a.2)\qquad \pi\left(u,q,u^*,q^*,x^*\right) = (q-u)d - C(d,q)$$

where d denotes $d\left(u,q,u^*,q^* x^*\right)$.

Then $\left(u^*,q^*,x^*\right)$ is a no-advertising equilibrium if

$$(a.3)\qquad \left(u^*,q^*\right) \in \underset{(u,q)}{\operatorname{argmax}}\ \pi\left(u,q,u^*,q^* x^*\right)$$

and

$$(a.4)\qquad \pi\left(u,q,u^*,q^*,x\right) = 0 .$$

The first order conditions corresponding to (a.3) are

$$(a.5)\qquad c'\left(q^*\right) = 1$$

and

$$(a.6) \qquad (q^*-u^*) = c(q^*) + V'(x^*) + \frac{c'(q^*)}{f(0)} .$$

It will now be shown that (a.5) and (a.6) are sufficient for the firms to be globally maximizing profits and that (a.5) and (a.6) are thus equivalent to (a.3). First, since d does not depend on q, it is clear that π is globally concave in q and reaches a global maximum in q at the value defined by (a.5) for any choice of u, u^*, q^* and x^*. It remains to show that (a.6) is sufficient for firms to be at a global maximum with respect to their choice of u.

Two cases need to be considered. First suppose that a firm contemplates choosing $u > u^*$. Then demand is linear in u and thus revenue is concave in u. Cost are, by assumption, convex in output and thus also convex in u. Thus profits are concave in price and the first-order conditions are sufficient for a maximum.

The case of $u < u^*$ is not so easily disposed of because demand is no longer linear in u. For u^* to be a global minimum it must be that

$$(a.7) \qquad x^*(q^*-u^*) - C(x^*,q^*) \geq d(q^*-u) - C(d,q^*)$$

for every $u \leq u^*$ where d denotes $d(u,q^*,u^*,q^*,x^*)$.

Rewrite (a.7) as

$$(a.8) \qquad x^*(q^*-u^*) - d(q^*-u) \geq V(x^*) + c(q^*)x^*-V(d) - c(q^*)d$$

Since V is convex and $d \leq x^*$

$$(a.9) \qquad V(x^*) + c(q^*)x^* - V(x) - c(q^*)d \leq [x^*-d][V'(x^*) + c(q^*)] .$$

Therefore a sufficient condition for (a.8) is that

$$(a.10) \qquad x^*(q^*-u^*) - d(q^*-u) \geq [x^*-d][V'(x^*) + c(q^*)] .$$

Substitute (a.1), (a.5) and (a.6) into (a.10) to yield

$$(a.11) \qquad F(u^*-u) \geq \frac{u^*-u}{u^*-u + \frac{1}{f(0)}} .$$

This is (a.7).

Thus (a.4) - (a.6) are necessary and sufficient for an equilibrium. It is straightforward to see that these correspond to (3.6) - (3.8).

Q.E.D.

Footnotes

[1] See Blair and Rubin [1980] for a number of articles describing this process as well as other references.

[2] See Bond *et. al*. [1980] for an example of this.

[3] Chan and Leland [1983] have also written a second paper which formally allows sequential search. They show that if there are two types of consumers, some with zero search costs and some with very high search costs, that the equilibrium may be the same as their previous paper in some cases in which case their previous results apply. However these cases seem to clearly be the exception and not the rule.

[4] See, for example, Allen [1984], Klein and Leffler [1981], Rogerson [1986a, 1986c], and Shapiro [1983].

[5] Wolinsky must assume that quality can assume only a finite number of values and must deal with a multiplicity of equilibria.

[6] Formally, (A.1) is replaced by the assumption that $C_{xq} \geq C_q/x$ This means that marginal cost shifts up at least as rapidly as average cost when quality increases, and thus the first best firm size does not increase. It is easy to see that Assumption (A.1) is in fact equivalent to $C_{xq} = C_q/x$.

[7] Essentially, use of the limiting demand curve instead of the demand curve when there are literally an infinite number of consumers and firms removes the kink in the latter demand curve. The latter demand curve is given by

$$\begin{array}{ll} x^*\left[1-F\left(u^*-u\right)\right] \ , & u \leq u^* \\ x^* \ , & u \geq u^* . \end{array}$$

See Stiglitz [1984] and Rogerson [1986b].

[8] See the references in footnote 4.

[9] The case of monetary search costs is more complicated. I have solved the case where $V(x) = 0$ and shown that the paper's welfare results remain true for this case, but am unable to derive results for more general V's. See Rogerson [1985].

[10] If search costs were monetary (5.1) would be

$$q - \frac{p}{\alpha} - \frac{ts}{\alpha} .$$

This is the case solved in Rogerson [1985]. See the previous footnote.

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