Product Characteristics and Price Advertising with Consumer Search.

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Abstract. Many advertisements inform the consumer about product characteristics, while others give price information with very little product information, and some provide both types of information. We propose a framework to analyze the incentives for firms to provide various types of information. We consider the case of a single seller. There is no incentive to provide information on product characteristics only, since doing so leads to a holdup problem that the consumers would rationally expect the firm to charge such a high price that no consumer would wish to incur the prior search cost. (A more general argument applies to markets with several firms.) However, price-only and price-and-characteristics advertising can arise depending on the relative strength of product differentiation and consumer search costs. Even when it costs the firm very little to inform consumers the firm may have no incentive to advertise if consumers will sample it anyway. For low search costs the firm has a strict incentive NOT to let consumers know because the firm garners higher profit when consumers have sunk the search cost. Forced disclosure and dissemination of information improves social welfare by eliminating useless search behavior that leads to no purchases (as well as enabling consumers to buy at lower prices). Second, even when the firm must advertise to bring in consumers (i.e., for larger search costs), the firm may prefer to keep consumers in the dark about how much they like the product - this behavior again entails excessive search. Finally, even when the firm finds it optimal to inform consumers of both their match values and the price charged, the level of advertising is too small because the firm only accounts for its private benefit per consumer informed when determining how much to advertise, and not the extra benefit to consumers of making a valuable match.

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1. Introduction.

Consumers are often poorly informed about the price and characteristics of products which they buy infrequently. Then the market outcome may depend to a large extent on how this information may be obtained. Although consumers may be able to obtain such information through their own endeavors (this is the case for search goods) they may do so only at some cost, for instance, the cost of visiting a store selling the product. Firms on the other hand may be able to provide such information to the consumers before they visit the store, in particular by means of advertising. This raises the question of whether a firm prefers consumers to be informed prior to shopping or to find out the information once they have sunk the shopping cost. Since such information may concern price as well as characteristics one may wonder which dimension the firm chooses to inform consumers about, if it decides to advertise. These are the two main questions we wish to address in this paper.

The literature on the economics of advertising traditionally distinguishes persuasive from informative advertising. Persuasive advertising is viewed as shifting consumer tastes (see for example the somewhat controversial paper by Dixit and Norman, 1978 and the comments thereon in later issues of the Bell Journal). Informative advertising works by telling consumers something about the product that then makes them more likely to buy, or to buy at a higher price. Informative advertising can be further split into that which indirectly informs consumers, and that which directly communicates product characteristics, quality, or price. Indirect information is communicated in signalling models (such as Milgrom and Roberts, 1986) in which advertising allows consumers to infer high quality in an adverse selection context. This paper is concerned with directly informative advertising, by which we mean advertising involving credible information about the product (price, availability, characteristics, quality, etc.). The credibility of the message is ensured by legal sanctions on misleading advertising.

Directly informative advertising has been the topic of several previous studies, an early

example being the paper of Butters (1977). However, to the best of our knowledge, no previous work has discussed the choice of the type of information transmitted in advertisements. In most models, firms are assumed to advertise only the price charged (and therefore also that the product exists in the market at the quoted price). A major result in this context is that of Butters (1977) that the market provides the socially optimal amount of advertising, although the extension by Stegeman (1991) shows that the market tends to err on the side of under-advertising. However, much advertising concerns more than just prices; it also, or exclusively, involves informing consumers about product attributes. The choice of content of the advertising message has not been analyzed before. At least in part, this is because most models have assumed the product sold by firms is homogeneous, so that there are no product attributes to communicate anyway.

Even when products are modeled as differentiated, if there is no search then there is no channel through which consumers can learn information that is not advertised. If consumers face no search costs then advertising the existence of a product is all that is necessary since then consumers know prices and characteristics of all products of which they are aware. That is, there can be no role for separate price and characteristics advertising because consumers can find these attributes costlessly once they know that the product is on sale. Hence consumer search costs must be an integral part of any model that purports to look at the two dimensions of advertising messages. (Search costs were considered in the Butters paper and the extensions by Stegeman, 1989, and Robert and Stahl, 1993, but products are homogeneous in these models so there is no role for product advertising.) These search costs can be viewed as the cost to consumers of going to stores to check out the product: the search good hypothesis is that characteristics are observable on inspection (before purchase), as opposed to experience goods that must be bought before knowing characteristics (wine perhaps). We assume that incurring the search costs enables consumers to purchase the good; if price and/or characteristics are previously

communicated via advertising messages, a consumer may decide not to incur the cost if the expected benefit falls short of the search cost.

Other papers that allow for product differentiation are Grossman and Shapiro (1984) and Meurer and Stahl (1994). Grossman and Shapiro (1984) use a circle model (as in Salop, 1979) to model product differentiation. They assume that firms advertise both prices and characteristics simultaneously and consumers are unaware of products for which they receive no advertisement. The main model expounded below uses a slightly different approach grounded in discrete choice models of product differentiation (see Anderson, de Palma, and Thisse, 1992, for a coverage of such models). Meurer and Stahl (1994) analyze a model in which only product characteristics are advertised. However, all consumers are assumed to observe prices. Even consumers who receive no ads may still buy (although it is assumed that characteristics are only revealed upon purchase if no ad is received) and consumers are assumed not to purchase from the second firm if the first match turns out to be bad.

The objective in this paper is to consider the two dimensions of advertising, price and characteristics. We are interested in determining the incentives for firms to provide the two types of advertising, the welfare properties of the market solution, the biases induced by the market system, and possible corrective mechanisms. Our starting point is the models of consumer search in Anderson and Renault (1999a and 1999b), which in turn build on Wolinsky (1986). These papers consider models of consumer search in markets for heterogeneous products while ruling out advertising as a means of transmitting information.

We consider a monopolist selling a product for which consumers have unit demand and whose characteristics are unknown to consumers. If the firm does not advertise, consumers find out both the price and their match with the product once they have visited the firm. The firm may choose to advertise price only, match only, both price and match, or not to advertise at all.

In the event that the firm decides to advertise, consumers must still incur the cost of visiting the firm in order to buy the product. Consumers who do not observe a price advertised rationally anticipate the price charged by the firm.

We first show that the firm never resorts to match-only advertising because then consumers would anticipate a hold-up problem by which the firm always has an incentive to increase its price slightly if some of them came. There is thus no price that the firm would credibly sustain and that would induce the consumers to come. Then we show that the firm may choose no advertising, price-only advertising, or price-and-match advertising depending on the level of search costs. For low search costs, the firm does not advertise at all and charges the monopoly price. Because the cost is low enough, all consumers are willing to visit the firm to find out about their matches, and an individual buys if her match exceeds the monopoly price. For larger search costs, the firm needs to use advertising to commit to a price. It then chooses to advertise only price for intermediate values of search costs, and both price and match if search costs become high enough.

We then compare the market outcome to first-best and second-best socially optimal solutions. In the first-best social optimum, advertising, when it occurs, always concerns matches while consumers anticipate being charged the marginal cost of production. The social benefit of advertising is first increasing in search costs, when they are low, and then decreasing, when search costs become so large that consumers would decide not to visit the firm if they did not receive an ad. The market outcome may exhibit under-advertising by the firm. It may also exhibit over-advertising, in particular when the firm advertises price only.

In our second-best welfare analysis, we first consider the socially optimal solution when the firm chooses the price and the advertising type. We find that when the firm advertises price only, it has the right incentives to advertise since consumers receive no surplus. On the other

hand, when the firm chooses to advertise price and match, it under-advertises relative to the social optimum because it does not take into account the consumer surplus. Finally, we compare the advertising type chosen by the firm to what would be socially optimal. We find that when the firm chooses to advertise price and match, it is optimal from the social point of view. We also find that when the firm chooses not to advertise, it may be socially optimal to force it to disclose both price and match.

The paper is organized as follows. The model is described in Section 2. Section 3 characterises the market outcome for each possible advertising option (none, match-only, price-only and price-and-match) and the option actually chosen by the firm is determined in Section 4. Finally we compare the market outcome to the first-best and some second-best socially optimal solutions.

2 The Model.

The monopoly model is as follows. Each consumer buys one unit, at price p, or else does not buy. Consumer tastes are heterogeneous, as modeled by idiosyncratic draws ε from a distribution, with intensity parameter μ, so that each consumer's "match value" with the product is $\mu\varepsilon$. The support of ε is $[a,b]$, with $b > 0$ and we suppose that the "hazard rate" $f/(1- F)$ is increasing, where f is the density and F is the cumulative distribution. Consumer utility is given by

(1) $$U = y - p + \mu\varepsilon$$

if the product is purchased at price p, and

(2) $$U = y$$

if the good is not bought, where y is consumer income net of search costs, c. Denote consumer gross income by Y. If the monopoly product is not sampled, utility is given by (2) with y = Y. If it is sampled and not bought then y = Y - c. If the product is bought, y is given by Y - c in (1) since the good must be sampled to be consumed.

The monopolist can send advertising messages which may contain price information, match information or both. In order to concentrate on the demand side incentives we assume that advertising reaches all consumers.

3 Advertising Strategies and Pricing.

In this section we describe the equilibrium outcome for price and advertising level conditional on advertising type. We consider in turn no advertising, match-only advertising, price-only advertising and price-and-match advertising.

3.1 No Advertising.

If the firm does not advertise, then consumers must rationally anticipate the price it will charge and decide whether to search on the basis of whether their expected surplus exceeds the search cost c. Consumers do not know their match values so the firm cannot infer any information about those who show up. The probability a consumer buys at price p is then $1 - F(p/\mu)$ so that the monopolist then charges the standard monopoly price p^m which maximizes expected revenue $p[1 - F(p/\mu)]$.[1] Anticipating this outcome, consumers only choose to search if their expected surplus at price p^m exceeds c.[2] Algebraically, the condition for the market to be served is that:

[1] The assumption that the hazard rate is non-increasing ensures that the monopoly price is uniquely determined.

[2] There are also degenerate equilibria at which consumers expect a price so high that they would expect a surplus below the search cost should they sample the firm, and so do not sample.

(1) $$\int_{p^m/\mu}^{b} [\mu\varepsilon - p^m] f(\varepsilon)\, d\varepsilon \geq c.$$

If the market is served in the absence of advertising, the monopoly price is charged to each consumer. The firm can never do better than the monopoly price through advertising, and so will choose not to advertise if advertising is costly. If condition (1) is violated and there is no advertising, then no consumer will search and there will be no market for the good. For high search costs advertising can enable socially profitable matches to be consummated by ensuring that only those with high valuations have to incur shopping costs. However, advertising matches alone may not improve market performance.

3.2 Match-Only Advertising.

When only match advertising is possible, the firm never finds it worthwhile to advertise at all so that the market outcome is the same as in the no advertising case. To explain this result, suppose that consumers who receive an ad expect some price p. Then all consumers coming to the firm after observing an ad have match values in excess of $p + c$. The firm could then increase its price to $p + c$ without losing any of these customers. Hence, there is no price that consumers will rationally expect the firm to maintain.

One might have thought that match advertising is a way to induce search by consumers with high valuations, a sub-population to which it is possible to charge a high price. However, for any price expected by this sub-population that would give them positive surplus prior to search, the monopolist can charge a price higher by an amount c and still sell to all of them because they have sunk the cost c (this is similar to the paradox of Diamond, 1971). Faced with

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Consistent with no consumer showing up, the firm may as well charge such a price. We disregard such equilibria in the sequel.

this holdup problem, rational consumers will anticipate the monopolist's incentives and the problem unravels, so that the market no longer exists. Thus match-only advertising does the monopolist no good.

3.3 Price-Only Advertising.

Next consider the case in which only price may be advertised. It is helpful here to first consider the case where θ is the same for all consumers, say 1 without loss of generality, so that all consumers have a valuation of μ for the product. Since the full monopoly price is μ, then consumers would expect no surplus in the absence of advertising so that the market would not exist. Under price-only advertising, the equilibrium price advertised is the highest one consistent with the constraint that consumer surplus be non-negative, that is, $\mu - c$.

We proceed in the same manner when the match value distribution is not degenerate. First note that a consumer who does not (yet) know her match value bases her sampling decision on the price she sees advertised. She samples if and only if the price is below some threshold value $\hat{p}$ where $\hat{p}$ equates the consumer's expected surplus to the search cost, that is

(2) $$\int_{\hat{p}/\mu}^{b} [\mu\theta - \hat{p}] f(\theta) d\theta = c.$$

When condition (1) holds, $\hat{p}$ exceeds p^m so that the monopolist's best strategy under price-only advertising is to advertise the monopoly price. When (1) does not hold, $\hat{p}$ is clearly less than p^m. Without advertising, no consumer would sample because of the hold-up problem by which the monopolist would charge them p^m if they did. Then in order to sell the monopolist must commit to a price of $\hat{p}$ by advertising it. All consumers sample, but only those for whom $\mu\theta \geq p^m$ buy. Here advertising is needed for a market to exist because it credibly caps the monopolist's price. Note from (2) that the price $\hat{p}$ is decreasing in the search cost c: a lower price is required to

induce consumers to sample when search costs are higher. A similar qualitative property holds under price-and-match advertising for rather similar reasons, although the price advertised may be lower or higher than that charged under price-only advertising.

3.4. Price-and-Match Advertising.

Now suppose that an advertisement contains both price information and match information. Consumers learn their match values when they receive an advertisement, and in that case will buy if the advertised price is not above the revealed match value net of the search cost. The demand facing the firm when it advertises matches and price p is therefore $(1-F([p+c]/\mu))$, the inverse demand curve being thus shifted down by c from its original position. Clearly then the price, p^{mc}, that maximizes profit against this demand curve is below p^m.[3] Profits are likewise lower. We now determine when price-only advertising or price-and-match advertising prevail in equilibrium.

4. Equilibrium Advertising Strategies.

The type of advertising that the firm prefers depends on the search costs of consumers since these costs determine the price that can be charged and the quantity demanded. In order to compare profits for the two advertising types, we first study how each of the two profits evolves as a function of search costs.

First note that if search costs are zero, the firm's profit is the standard monopoly profit whether it advertises price only or price and match. For low c such that (1) holds, the firm still earns the full monopoly profit under price-only advertising while its profit is strictly decreasing in c under price-and-match advertising. At the point where (1) stops holding, $\hat{p} = p^m$, so that

[3] Again the assumption on the hazard rate guarantees this price is uniquely determined.

price-only advertising still dominates price and match advertising. By continuity this remains true for slightly larger c. Since for such values of c, (1) does not hold, price-only advertising is the optimal strategy because the market could not be served without advertising. At the other extreme, if $c > b/\mu$, there is no price at which the market could be served regardless of the advertising strategy because no consumer's valuation is higher than the search cost. For c slightly below b/μ, price only advertising is not profitable, because even if a zero price were advertised, there would still be no demand since the expected surplus of a consumer coming to the firm is strictly less than b/μ. However, with price-and-match advertising, the firm could sell to consumers with high matches at a (small) positive price. Hence, for a high enough $c < b/\mu$, price-and-match advertising maximizes profit. We now show that the two profits as functions of c cross only once, meaning that the optimal strategy for the firm runs from no advertising to price-only advertising and then to price-and-match advertising as search costs increase. We prove the crossing property by showing that profit is concave in c under price-only advertising but convex under price-and-match advertising.

For price-only advertising, the profit function is $\pi = \hat{p}[1 - F(\hat{p}/\mu)]$. From the definition of $\hat{p}$ in (2), $\frac{d\hat{p}}{dc} = \frac{-1}{1 - F(\hat{p}/\mu)}$. Hence

$$\frac{d\pi}{dc} = \left[1 - F(\hat{p}/\mu) - (\hat{p}/\mu)f(\hat{p}/\mu)\right]\frac{-1}{1 - F(\hat{p}/\mu)}$$
$$= -1 - (\hat{p}/\mu)\frac{f(\hat{p}/\mu)}{1 - F(\hat{p}/\mu)}.$$

The second term on the right-hand side of the latter equation is increasing in $\hat{p}$ from the increasing hazard rate assumption. Since $\hat{p}$ is decreasing in c, profit is concave in c.

Under price-and-match advertising, the profit function is $\pi = p[1 - F([p+c]/\mu)]$. The first order condition that determines p^{mc} yields $p^{mc} - \mu\frac{1 - F}{f} = 0$, where the argument of F and f

is $(p^{mc} + c)/\mu$ and has been suppressed to lighten notation. Applying the implicit function theorem gives

$$\frac{dp^{mc}}{dc} = -\frac{f^2 - [1-F]f'}{2f^2 - [1-F]f'}.$$

Both the numerator and the denominator are positive under the increasing hazard rate assumption, so that $(dp^{mc}/dc) \in (-1,0)$. With this property in mind, we can evaluate the derivative of the profit function, using the envelope theorem, as

$$\frac{d\Pi}{dc} = -\frac{p^{mc}}{\mu} f\left(\frac{p^{mc} - c}{\mu}\right)$$
$$= -[1 - F\left(\frac{p^{mc} - c}{\mu}\right)].$$

The last step follows from the first order condition. Now, since $p^{mc} + c$ is increasing in c, $d\Pi/dc$ is increasing in c so that profit is convex.

From our earlier arguments, the profit function for price-only starts out above that for price-and-match and ends up below. These functions being continuous, they must cross at least once. At the earliest crossing point, the price-only profit crosses the price-and-match profit from above, so that it is steeper. The concavity and convexity properties ensure that they do not cross again at larger values of c.

5 Welfare Analysis.

In order to render the social optimum problem non-trivial, we introduce a fixed cost $A > 0$ of informing all consumers. We first consider the first-best solution. It is assumed that in the first-best, consumers expect a price of 0 which, given our normalization, is marginal cost. If there is no advertising, all consumers come as long as the threshold value in (2), $\hat{p} \geq 0$. Those with a match value above 0 then buy the product. With advertising, only those consumers with

match value above c come and purchase the product. The social benefit of advertising is therefore $\int_0^{c/\mu}(c-\mu\theta)f(\theta)d\theta - F(0)c$. This is a convex and increasing function of c. For $\hat{p} < 0$, no consumer comes to the firm unless she sees an add. Then the social benefit of advertizing is the surplus generated for those consumers who find out that their match is above c and decide to go and buy. It is given by $\int_{c/\mu}^{b}(\mu\theta - c)f(\theta)d\theta$, which is decreasing and reaches 0 for $c = \mu b$.

We now compare the first best social optimum with the advertising behavior of the firm. First consider low c so that $\hat{p} > p^m$. Then, from section 4, the firm chooses not to advertise at all. Since the first-best social benefit of advertising is positive as long as $c > 0$, if the social benefit exceeds A, then the firm's under-advertises. Otherwise, the equilibrium advertising level of 0 is also optimal. At the opposite extreme, if the search cost is large enough that $\hat{p} \leq 0$, then the first best social benefit of advertising always exceeds the firm's benefit so that the firm's advertising behavior may once again lead to insufficient advertising. To see this note that the firm, which advertises price-and-match in this range of search costs, earns the monopoly profit corresponding to the inverse demand shifted down by c, while the social benefit is total social surplus corresponding to this same inverse demand and is therefore larger.

We finally consider intermediate values of c such that $\hat{p} \in [0, p^m]$. From the above argument, when c becomes large enough so that $\hat{p}$ is close to 0, profit is necessarily less than the first best social benefit. Furthermore, since the first best social benefit is increasing while profit is decreasing, for this range of values of the search cost, they cross at most once. Whether they cross or not depends on the relationship between social benefit and profit at the value of c which equates $\hat{p}$ to p^m. Below we show by means of two examples that this relationship may go either way.

Example 1. Suppose that ε is uniformly distributed on [0,1] and $\mu = 1$, so that the demand curve when consumers know their matches and have incurred the search cost is linear with price intercept 1 (and quantity intercept 1). Thus $p^m = 1/2$, with associated profit of 1/4. The critical expected price for deciding to visit the firm without knowing one's match is given by

$$\int_{\hat{p}}^{1} (\varepsilon - \hat{p})\, d\varepsilon = c$$

which simplifies to $(1 - \hat{p})^2 = 2c$ or $\hat{p} = 1 - (2c)^{1/2}$.[4] This value equals p^m (= ½) for $c = 1/8$, and the corresponding profit is 1/4. The first-best social benefit is $c^2/2 = 1/128$, which is clearly smaller.

In this example, profit and first-best social benefit of advertising cross. Over-advertising in equilibrium is therefore possible if c is sufficiently low (before the crossing point), and A is larger than social benefit and lower than profit. If c is large enough so that profit is below the social benefit of advertising, then only under-advertising may prevail as was the case for very low search costs ($\hat{p} > p^m$) or very large search costs ($\hat{p} < 0$). However, for different demand specifications, over-advertising may not occur at all, as Example 2 below illustrates.

Finally, it can be shown that if the firm chooses price-and-match advertising, then there cannot be over-advertising. To see this, note that the price-and-match profit is $\left[\frac{1-c}{2}\right]^2$, so that the value of c such that it equals the first best social benefit is $\bar{c} = \sqrt{2} - 1$. It is readily verified that for this level of search costs, price-only profit exceeds price-and-match profit (since the equilibrium price loci also cross at $\bar{c} = \sqrt{2} - 1$ and we know the price loci cross before the profit loci cross. Hence the firm chooses to advertise price and match for larger values of c, at

[4] We can discard the other root since $\hat{p} > 1$ implies no consumer would ever find a valuable match.

which the corresponding profit is less than the first-best social benefit.

Example 2. Suppose that c has a cumulative distribution function $F(c) = 1 - c^{-\alpha}$, with $\alpha > 1$, so that its support is $[a,b] = [1, \infty]$. The corresponding monopoly profit is increasing for prices below 1 and decreasing for larger prices, so that the monopoly price is 1 with a profit of 1. Since a consumer buys with probability 1, her expected consumer surplus is $\int_a^b [1 - F(c)]dc = \frac{1}{\alpha - 1}$. Note that, by definition of $\hat{p}$ we have $\hat{p} = p^m$ when c equals the expected consumer surplus at the monopoly price. Now the first-best social benefit of advertising may be written as $\int_{c^{-\alpha}}^1 [c - x^{-1/\alpha}]dx$ which equals $c - \frac{\alpha - 1}{\alpha}$. When c has the value computed above, The social benefit of advertising clearly exceeds profit when $\hat{p} = p^m$ and from our analysis in the general case this remains true for larger values of c.

We now turn to a second-best welfare analysis. Let us first compare the choice of the firm to advertise or not to what would be socially optimal, given that the price and the advertising type (price-only or price-and-match) are chosen by the firm. First note that when the firm prefers price-only advertising to price-and-match advertising, consumer surplus is zero so that social surplus equals profit. The firm then has the right incentives when it chooses to advertise or not. Under price-and-match advertising, on the contrary, the firm must leave some surplus to consumers so that it may choose not to advertise while it would be socially optimal to do so.

Finally we consider whether the firm chooses the right type of advertising. The question here is whether a central planner might want to force the firm into a different advertising strategy. First suppose that search costs are high enough so that profits under price-and-match advertising are higher than profits under price-only advertising. Then, price-and-match

advertising is clearly socially preferred since it leaves a positive surplus to consumers while consumer surplus is zero under price-only advertising. For lower values of c, there are two opposing effects. On the one hand, the price on which consumers base their purchasing decision under price-and-match is $p^{mc} - c$, which is larger than the monopoly price p^m, while under price only they base their purchasing decision upon $\hat{p}$, which is less than p^m. This generates more gross social surplus (gross of search costs). On the other hand, all consumer incur search costs under price-only advertising, including some who end up not buying the good or who buy while their match value is less than c.

In the setting of Example 1 above, where matches have a uniform distribution, it can be shown that when the firm chooses not to advertise at all ($c < 1/8$), the social surplus would be larger if it were forced to advertise price-and-match. A forced disclosure policy would thus be desirable. To see this note that social surplus without advertising is 3/8 - c (with the firm charging the monopoly price) while price-and-match advertising would yield a surplus of $\frac{3}{2}\left[\frac{1-c}{2}\right]^2$.[5]

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[5] For $c > 1/8$ the welfare function under price-only advertising is $(1 - \sqrt{2c})\sqrt{2c}$ while under price-and-match advertising it is $\frac{3}{2}\left[\frac{1-c}{2}\right]^2$.

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1. Introduction

Consistent with the paper of Butters (1977). However, to the best of our knowledge, no previous

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[illegible] The assumption that the hazard rate is non-increasing ensures that the monopoly price is uniquely determined.