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Why Monopolists Prefer to Make their Goods Less Durable

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This paper considers durable goods that depreciate in terms of quality over time, and permits consumers to differ in their attitude concerning the 'usability' of a durable good after it has depreciated. Given this, it is shown that, even if a monopoly can costlessly increase the durability of its product, it may choose not to do so. This does not happen in competition.

INTRODUCTION

This paper is concerned with consumer goods that depreciate over time, such as footwear, clothes, carpets and wallpaper. With any of these goods the consumer has to decide, at some point, whether to continue to use it or to discard it and buy afresh. This, in turn, presents the producer with a problem: how durable should he make his product? The relation between market structure and durability has been the subject of a considerable debate.[1] The existing literature, however, ignores an important feature of durable goods—the fact that their durability can be used as a screening device.

At first glance, it seems that increasing durability would reduce profit by reducing the frequency of purchase. This was Chamberlin's (1957) view; but it is flawed because, as the producer raises durability, he can raise price to compensate for the reduction in sales (see e.g. Barro, 1972). It seems therefore (and this belief is widely shared in the literature) that a profit-maximizing monopolist would raise durability as much as possible, if production costs were independent of durability and the capital market were perfect. It is shown in this paper that this position is, in turn, untenable once we recognize that consumer preferences are heterogeneous.

This is formalized here by assuming that there are two types of consumers: the 'lavish', who are fastidious about quality and would buy a new unit as soon as the old one is slightly worn out, and the 'thrifty', who prefer to use goods up to a point of greater depreciation. Now, even if a monopolist has to charge the same price from each consumer, he can discriminate between the two groups by choosing a suitable amount of durability. For instance, if he makes the good less durable, the lavish consumers make more frequent purchases per unit of time. Hence, although both consumer types pay the same price per unit of *commodity*, the lavish ones pay more per unit of *time*. That is, they pay a higher *effective* price. Hence, by making the product less durable, the monopolist manages to price-discriminate between consumers.

I. DURABILITY AND CONSUMER BEHAVIOUR

I am concerned with a consumer good that depreciates over time. It is not a good that remains new for n days and then disintegrates but, more realistically, one that loses its newness with time before finally disintegrating.[2] The simplest way to capture this idea is to assume that the good lasts one period (and then completely disintegrates), but within this period, during the first q units of time the good is new and has a quality level of N units, and during the remaining $(1-q)$ units of time it is depreciated and has a quality level of D units. Of course, $N > D$.

The extent of durability of the good is captured by this parameter q. If q becomes larger, we say that the good is now 'more durable' or that it 'depreciates more slowly'. If $q = 1$, the good is described as 'fully durable'. If $q = 0$, then this good is never new. We are here interested in goods that are new for some time, however little. Hence we assume that there exists a very small real number $e > 0$ such that q must be greater than or equal to e. Throughout, it is assumed that q is a variable which the producer has to select from the interval $[e, 1]$. But before we go on to the question of producer's decision, we need to model the consumer.

For simplicity, I shall suppose that we are talking of a good which, by its very nature, is such that the consumer would want to possess at most one unit at each point of time. Toothbrushes, pianos, dining tables and wallpaper are examples of such goods.[3] Hence, the consumer's main problem is whether to buy the good, and if 'yes', how often to replace it (i.e. discard it and buy a new one).

Assume that there are n consumers, indexed by i. Let $Q(t)$ be the density function of the number of units of quality that consumer i gets over time, and let M_i be his income and X_i his expenditure on this good in one period. Hence, he spends $M_i - X_i$ units of money on other goods. The utility that consumer i gets from one period is assumed to be given by

$$U^i = \int_{t=0}^{1} f^i(Q(t))\, dt + M_i - X_i$$

where $\partial f^i / \partial Q > 0$. Clearly we can redefine the function f^i so as to include M_i. Hence, without loss of generality, we write i's utility function as

$$U^i = \int_{t=0}^{1} f^i(Q(t))\, dt - X_i$$

where $\partial f^i / \partial Q > 0$ and $f^i(0) = 0$. Note that, since each period looks the same, U^i may be interpreted as the average utility over steady state.

Let us compute the utilities associated with three specific options. First, if the consumer does not buy this good, $Q(t) = 0$ for all t (it is being assumed that quality is something that only this good provides) and $X_i = 0$. The utility that he gets by not buying the good is denoted by U^{i0} and is given by

$$U^{i0} = 0$$

Second, let U^{iL} be the utility that he gets if he decides to buy afresh as soon as the old good depreciates in quality. Denoting the price of the good by p, it is obvious that

$$(1) \qquad U^{iL}(p, q) = f^i(N) - p/q.$$

If a person buys afresh as soon as the good depreciates, we shall say that he acts *lavishly*.[4]

Third, let U^{iT} be the utility he gets if he chooses to buy one unit at the beginning of the period and not buy again in this period; i.e., he acts *thriftily*. Clearly,

$$U^{iT}(p, q) = f^i(N)q + f^i(D)(1-q) - p. \tag{2}$$

We have so far considered three options: acting lavishly, acting thriftily and not buying. There are other options, like buying one unit, after it depreciates continuing with it for some time and then buying a new one again. It is easy to check that such options can be ignored because the consumer's best strategy always includes one of: not buying, being thrifty and being lavish. Given this, the following tie-breaking assumption is fairly innocuous and is maintained throughout this paper: faced with a (p, q), if a consumer is indifferent between buying and not buying a good, he buys it; and, having decided to buy, if he is indifferent between acting thriftily and lavishly, he acts lavishly.

II. Monopoly

Suppose there is one producer and he offers the price–durability pair (p, q). Let c be the cost of producing each unit of good. It is assumed for simplicity that the cost does not depend on the product's durability.[5] Note that this is the most adverse assumption for what I am trying to establish.

If $n^L(p, q)$ and $n^T(p, q)$ are the numbers of consumers who act lavishly and thriftily, then the monopolist's profit, R, is given by

$$R(p, q) = (p-c)\left\{\frac{n^L(p, q)}{q} + n^T(p, q)\right\}. \tag{3}$$

Definition. (p^*, q^*) is a *monopoly equilibrium* if and only if

$$(p^*, q^*) = \operatorname{argmax} R(p, q)$$

with $p \in [0, \infty)$, $q \in [e, 1]$.

It will be assumed throughout that there exists some (p, q), that gives the monopolist a positive profit.

It will now be shown that, although it does not cost the monopolist anything to make the product more durable, he may nevertheless prefer to make it less durable (i.e. to set $q < 1$). For this result and other discussions in this section, I make use of the fact that a monopoly equilibrium always exists. Hence, we first need to establish existence.

Let P be a price at which consumer demand is 0. Define a set K as follows:

$$K = \{(p, q) \mid p \in [c, P], q \in [e, 1]\}.$$

Consider the real-valued function R on K. It may be checked that R is an upper semi-continuous function. This follows from our tie-breaking assumption in Section I which says that, whenever a consumer is indifferent between any two of the options in the set {not buy, act lavishly, act thriftily}, he will choose the one that gives the producer a larger profit. Since K is compact, it follows that R attains a maximum in K. Since for all (p, q) not belonging to K, $R(p, q) \leq 0$ and we have assumed that for some (p, q), $R(p, q)$ must be positive, it follows that the maximum value attained by R in K is greater than zero. Hence, that is also the maximum value that R attains on an unrestricted domain of price–durability pairs, ie., with $p \in [0, \infty)$ and $q \in [e, 1]$. The existence of monopoly equilibrium being assured, we may now examine the relation between monopoly and durability.

Theorem. There exist equilibria where monopolists sell goods of limited durability (i.e. $q < 1$). A necessary condition for this to happen is that consumers have heterogeneous preference.

Proof. The following example establishes the first part of the theorem. Assume there are only two consumers, with the following characteristics:

$$f^1(N) = 4; \qquad f^1(D) = 0$$

$$f^2(N) = 2; \qquad f^2(D) = 1$$

In addition, assume $c = 0$ and $e \leqslant 1/4$. Using equation (1) and (2), we get

$$\text{(4)} \qquad \begin{cases} U^{1L}(p, q) = 4 - p/q; & U^{1T}(p, q) = 4q - p \\ U^{2L}(p, q) = 2 - p/q; & U^{2T}(p, q) = q + 1 - p. \end{cases}$$

Let us check the maximum profit that the monopolist can earn, given that q is fixed at 1 (i.e., we want the value of max $R(p, 1)$). Inserting $q = 1$ in (4), it is clear that as long as $p \leq 2$ he can sell two units (one each to consumers 1 and 2), and if p is in $[2, 4]$ he can sell one unit (to consumer 1). Hence, $\max R(p, 1) = R(4, 1) = R(2, 1) = 4$. To prove the theorem, we merely have to show that there exists q in the interval $[e, 1]$ such that, for some p in $[0, \infty)$, $R(p, q) > 4$. Consider $q = 1/4$ and $p = 1$. Inserting these in (4), we get

$$U^{1L} = 0; \qquad U^{1T} = 0$$

$$U^{2L} = -2; \qquad U^{2T} = 1/4.$$

Hence, 1 will act lavishly and 2 thriftily. That is, 1 will buy four $(=1/q)$ units and 2 will buy one unit. Hence, $R(1, 1/4) = 5$. Since we know that a monopoly equilibrium always exists, the equilibrium value of q must be less than 1.

In order to prove the second part, suppose $f^1 = \cdots = f^n$, (p^*, q^*) is a monopoly equilibrium and $q^* < 1$. Since consumers are identical, either (i) everybody acts lavishly or (ii) everybody acts thriftily. Suppose (i): then

$$\text{(5)} \qquad R(p^*, q^*) = (p^* - c)\frac{n}{q^*}$$

and from (1) and (2) it follows that (since $U^{iL} \geq U^{iT}$)

$$\text{(6)} \qquad f^i(N) - f^i(D) \geq p^*/q^*, \text{ for all } i.$$

If the monopolist raises p and q proportionately (i.e. ensuring that $p/q = p^*/q^*$), then (6) implies that everybody remains lavish and (5) implies an increase in profit.

Suppose (ii). Then choose $p > p^*$ and $q > q^*$ so that

$$U^{iT}(p, q) = U^{iT}(p^*, q^*).$$

Two things can happen with this: (a) people remain thrifty, or (b) people become lavish. If (a), then

$$R(p, q) = (p - c)n > (p^* - c)n = R(p^*, q^*).$$

If (b), then

$$R(p, q) = (p - c)\frac{n}{q} > (p^* - c)n = R(p^*, q^*).$$

This contradiction establishes that the original situation could not have been an equilibrium. Q.E.D

There are several models (e.g. Parks, 1974) in which monopolists offer many price-durability (or price-quality) pairs and practise price discrimination. In such models it is expected that monopolists would be able to screen consumers because the problem is analogous to the screening in standard nonlinear pricing and optimal income tax theory.[6] What is interesting in the present model is that, even by offering a *unique* price-durability pair, the monopolist manages to price-discriminate. He does this by inducing different consumers to respond differently and thereby to pay different *effective* prices for the good.

Finally, note that, while the question of durability is obviously related to the one of quality, my central theorem exploits the natural relation between *durability* and the frequency of purchase. Hence, this problem is distinct from the problem of quality choice as discussed in, for instance, Sheshinski (1976) and Mussa and Rosen (1978).

III. Competition

In the case of competition with identical firms and free entry, products would invariably be fully durable.[7] This is because in such a case profits of firms would be 0. Now if $q < 1$, a firm can raise q a bit and also raise p, but sufficiently little to retain some customers. It will then be earning a positive profit since p will exceed c. This contradiction establishes that $q = 1$.

In concluding, it may be pointed out that it should be possible to use this model to throw light on the relation between durability and second-hand markets, the effect on durability of intermediate market structures like oligopoly, and the engineering of fashions and their decay.

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NOTES

1. See, for example, Levhari and Srinivasan (1969); Sieper and Swan (1973); Kamien and Schwartz (1974); Leibowitz (1982).
2. This kind of assumption is used by, among others, Leibowitz (1982) and Bond and Samuelson (1984). Stokey's (1981) and Bulow's (1982) durable goods, on the other hand, never lose their newness.

3. Such goods have been analysed by several authors; see, e.g., Gabszewicz and Thisse (1979). In the present model this assumption can be relaxed at the expense of a messier algebra.
4. We ignore the problem that p/q might not be an integer.
5. Several authors in this area make this same assumption: see, for example, Barro (1972).
6. It is easy to demonstrate that in some situations a monopolist will, given a choice, prefer to offer more than one (p, q) pair and to offer at least one less durable product. consider the example where $f^1(N)=5, f^1(D)=0, f^2(N)=2, F^2(D)=1$, $e=1/8$ and $c=1$. If the monopolist has to offer one (p, q) pair, it would choose $(5, 1)$ and its profit would be 4. It is easy to see that, if he were allowed to offer more than one type of good, he could earn a larger profit by offering, for example, the following (p, q) pairs: $(5, 1)$ and $(1\frac{1}{6}, 1/6)$. Person 1 would choose the former and 2 the latter, and profit would be equal to 4 plus 1/6.
7. A formal model of this section is available from the author on request.

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