PREMIUMS FOR HIGH QUALITY PRODUCTS AS RETURNS TO REPUTATIONS*

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This paper derives an equilibrium price-quality schedule for markets in which buyers cannot observe product quality prior to purchase. In such markets there is an incentive for sellers to reduce quality and take short-run gains before buyers catch on. In order to forestall such quality cutting, the price-quality schedule involves high quality items selling at a premium above their cost. This premium also serves the function of compensating sellers for their investment in reputation. The effects of improved consumer information and of a minimum quality standard on the equilibrium price-quality schedule are studied. In general, optimal quality standards exclude from the market items some consumers would like to buy.

I. INTRODUCTION

It has long been recognized that a firm which has a good reputation owns a valuable asset. This is often referred to as the "goodwill" value of the firm's brand name or loyal customer patronage. This paper develops a model that explores the implications of firm-specific reputations in a perfectly competitive environment. The equilibrium price-reputation schedule is derived under conditions of perfect competition but imperfect consumer information. A natural byproduct of the analysis is a theory of optimal consumer information provision and optimal product quality standards.

The idea of reputation makes sense only in an imperfect information world. A firm has a good reputation if consumers believe its products to be of high quality. If product attributes were perfectly observable prior to purchase, then previous production of high quality items would not enter into consumers' evaluations of a firm's product quality. Instead, quality beliefs could be derived solely from inspection.

When product attributes are difficult to observe prior to purchase, consumers may plausibly use the quality of products produced by the firm in the *past* as an indicator of present or future quality. In such cases a firm's decision to produce high quality items is a dynamic one: the benefits of doing so accrue in the future via the effect of building up a reputation. In this sense, reputation formation is a type of signaling activity: the quality of items produced in previous periods

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When consumers rely on sellers' reputations, a seller who chooses to enter the high quality segment of the market must initially invest in his reputation via the production of quality merchandise. During this investment period such a seller must sell his product at less than cost: he cannot command those prices associated with high quality items until his reputation is established. The necessity of investment in reputation implies that, in equilibrium, high quality items must sell for a premium above their costs of production. This premium represents the return on the initial investment in reputation. A snapshot of the competitive equilibrium will reveal some firms earning a flow of "profits" that are in fact merely a competitive return on their investments in reputation.

The premiums that reputable firms earn also serve a crucial role in inducing such sellers to *maintain* their reputations. Without premiums for high quality items, sellers would find that a *fly-by-night* strategy of quality reduction would be profit maximizing. The reason is that, in markets with reputations, sellers can always increase profits in the short-run by reducing the quality of their products. After all, quality reductions will yield immediate cost savings, while the adverse effect on reputation will arise only in the longer run. Since positive profits can be earned via the fly-by-night strategy, it would always dominate, unless positive profits could also be earned via the *faithful strategy* of quality maintenance. This idea has been recognized and explored informally by Klein and Leffler [1981]. Their major observation is that firms producing high quality items must be earning a flow of profits to prevent them from being tempted to cut quality. Put differently, the faithful strategy involves foregoing the opportunity to earn profits through quality reductions. This opportunity cost must be included in the price of high quality items, which therefore exceeds their cost of production.

A major issue that has not been resolved, and indeed has been an apparent paradox, is how this flow of profits can be reconciled with free entry.[1] The key question is what expenditures are required of an entrant to attain a position in which this profit flow can be earned. Equilibrium can arise only when such expenditures exactly match the subsequent profits, so that firms earn zero profits ex ante. The in-

1. Klein and Leffler suggest a number of interesting mechanisms, such as advertising, for the dissipation of these profits. None of these stories has been modeled or made consistent with consumer behavior, however. Reputation serves this function quite naturally.

troduction of *reputation* as an asset that must initially be built up resolves this paradox, and permits an equilibrium model to be constructed that includes perfect competition, free entry, and quality choices by firms under imperfect information.

In addition to modeling reputation under competitive conditions, this paper makes a number of related contributions. Consumer information is explicitly modeled, and the relationship between consumer information flows and equilibrium prices and welfare is made explicit. This permits an analysis of the welfare consequences of information provision activities. Perhaps most important of all, the model naturally provides a theory of optimal minimum quality standards. Leland [1979] has done such an analysis in a model like that of Akerlof [1970], where the supply at various qualities is exogenous. An analysis of quality standards when sellers can choose quality has not previously been made. This necessarily involves heterogeneous consumers (otherwise the problem of choosing an optimal quality standard is trivial).

The equilibrium price-quality schedule involves a gap between price and cost for high quality items. This premium can be viewed either as a return to reputation or as an incentive payment to induce quality maintenance. The higher the legal minimum quality standard, the lower the premium necessary to induce high quality supply (since the fly-by-night strategy is less attractive if minimum quality is high). As a result, consumers who use high quality items benefit from an increase in the minimum quality standard. There is a positive "informational externality" associated with raising the quality standard. Increases in minimum quality reduce the equilibrium price of high quality products, and hence increase consumer surplus for those using high quality products. The optimal standard is found by just balancing these benefits against the direct losses to those customers who would choose to purchase a product of quality below the standard if possible.

The model identifies some surprising yet instructive aspects of the role of *reputation* in the competitive process. In particular, reputation need not carry with it any market power. Nor need reputation constitute a barrier to entry, although there necessarily are costs to building up a reputation. Reputation constitutes a cost of entry, but not necessarily a barrier to entry.

A number of effects are not considered in this paper in order to focus on reputation. In particular, sunk costs in assets that are specific to high quality production are ruled out. Such costs would have the effect of imposing a loss on firms that reduce quality, in addition to the loss of reputation. Capital equipment that is not sunk will not alter the model: the rental rate on the equipment can be included in the per period cost of production. Sunk costs, however, could serve as a signal of quality, if they are observable *and* if they are specific to the production of high quality products. The interaction between such cost-side capitals assets and the demand-side asset of reputation is a subject of future research.

Finally, we rule out guarantees as a quality-assuring mechanism. This is not because we believe them to be unimportant, but simply imperfect. Indeed, the minimum quality in the model may be interpreted as the *maximum* quality enforceable by warranties. The point is that there is usually room for potential quality cutting by the seller, the guarantee notwithstanding. For a variety of moral hazard and adverse selection reasons, perfect guarantees are not feasible. For example, a washing machine may have a one-year guarantee, but the consumer is expecting a lifetime of ten years from it. Reputation rather than the warranty provides the seller an incentive to produce a machine that lasts ten years. Whenever sellers can make some quick profits via quality reductions, the analysis below will apply.

The remainder of the paper is organized as follows: the next section sets up the model and defines the steady-state reputation equilibrium around which the paper is built. Section III derives the equilibrium price-quality schedule from supply side considerations alone. Section IV shows how to interpret information flows and consumer learning in the model. Section V shows how consumers respond to changes in the information technology and the minimum quality standard. These results are used in Sections VI and VII to perform a welfare analysis of information provision and quality standards, respectively. A major result of the paper, identifying the optimal minimum quality standard, is stated in Theorem IV. A conclusion follows.

II. An Equilibrium Model of Product Quality and Reputation

A. Production and Timing

The model is dynamic, since reputation is fundamentally a dynamic concept. It is set in discrete time, where the length of the period T reflects the lag between successive sales by a given producer. For some products, such as restaurant meals, T will be quite small, while for others, such as houses, T may be large. We shall study the role of

T below. Calling i the market interest rate per unit time, we can define the one-period interest rate $r = e^{iT} - 1$, and the one-period discount factor $\rho = e^{-iT}$.

In order to focus on firms' quality choices, it is assumed that each firm produces a fixed number of items each period. For simplicity, this number is set at unity. The cost of producing an item of quality q is denoted by $c(q)$, where $c'(q) \geq 0$ and $c''(q) > 0$. The units of measurement for quality are discussed in the subsection on consumers below. Each seller chooses a sequence of qualities over time to maximize the present value of profits.

Each seller faces perfectly elastic demand at any given date. The price he can earn at date t for his product depends only upon his reputation at that date R_t and is denoted by $p(R_t)$. By reputation in this paper we mean expected quality (from the point of view of consumers). The fact that a seller of a given reputation has no control over price reflects competitive conditions: there are many sellers with a given reputation at any time. An entrant can sell his product at the entrance price of p_e during his initial period in the market. We shall discuss p_e below.

Finally, there is a minimum quality q_0 below which it is illegal to produce. This mainly serves the function of limiting the extent to which firms can reduce quality if following a fly-by-night strategy of quality deterioration. As such, q_0 may be interpreted in other ways besides that of a legal minimum. It can be thought of as the quality level below which consumers can detect quality reductions by inspection and hence refuse to purchase. (Therefore a seller milking his reputation cannot profitably reduce quality below q_0.) Alternatively, q_0 can be interpreted as the quality level guaranteed by a warranty, so again a seller can reduce quality only as low as q_0 profitably. Adverse selection and moral hazard problems may make warranties for qualities in excess of some level of q_0 infeasible. This reflects actual guarantees as usually observed in consumer goods markets: reputations play a prominent role in assuring quality that warranties cannot.

B. Information Structure

Reputation formation is a critical feature of the model. We wish to take only a small step away from perfect information, so we assume that reputation is common knowledge or public information. With private information each firm would have a number of reputations with different consumers; that would be a considerable complication and would necessitate a specification of how information is transmitted throughout the population. The assumption here is that all consumers communicate with each other to share information about products (perhaps through publications), but that such information necessarily comes with a lag.

The adjustment of a seller's reputation requires both that the quality of his product be observable after it is purchased *and* that this information be communicated to other potential buyers. The simplest possible information structure is one in which this observation and communication process takes place immediately after the product is sold. In such a case, a seller's reputation could adjust quite rapidly toward the quality just produced. The simplest adjustment equation is given by

$$R_t = q_{t-1}. \tag{1}$$

Equation (1) reflects the fact that consumers cannot observe quality prior to purchase, and so sellers can, at least for one period, surprise their customers with lower quality than was expected.

The reputation adjustment equation captures consumer information in this model. Alternatives to equation (1) that reflect either a reduced ability of consumers to observe quality after purchase or increased lags in transmitting quality information to other buyers will be explored in Section IV below. These will provide a way of evaluating policies designed to improve consumer information.

C. Consumer Preferences

The demand side of the market is described by a set of heterogeneous consumers. It is consumer heterogeneity that supports the sale of a variety of qualities in equilibrium. We assume for simplicity that consumers are interested in purchasing a single unit of the commodity, but they differ in their willingness to pay for the product. Consumers differ both in their general willingness to pay for the product v, and in their taste for quality, denoted by θ. A consumer of type (θ,v) attaches gross benefits of $U(q,\theta) + v$ to a unit of quality q. By convention we assume that $U_{q\theta} > 0$; i.e., higher values of θ mean a greater marginal utility of quality. Of course, $U_q > 0$ for all consumers; that is what we mean by quality.

The net benefits to a consumer of type (θ,v) of a product of quality q selling at price $p(q)$ are given by $U(q,\theta) + v - p(q)$. Such a consumer will find the quality that maximizes net benefits and then actually buy a unit of that quality if its net benefits are positive. Aggregate demand is generated by a distribution of consumers in (θ,v)

space, denoted by $f(\theta,\upsilon)$. We assume that the distribution of consumers is contained within the region $[\underline{\theta},\overline{\theta}] \times [\underline{\upsilon},\overline{\upsilon}]$ in (θ,υ) space. As we shall see below, the distribution of consumers determines the number of firms producing at each quality level, but not the location of the equilibrium price-quality schedule.

For convenience, we shall assume that consumers' utility functions $U(q,\theta)$ are separable in q and θ, so that $U(q,\theta) = g(q)h(\theta)$. This is not necessary for any of the results, but simplifies the exposition. Given this separability, we can choose the units of quality so that $g(q) = q$, and the units of θ so that $h(\theta) = \theta$. Therefore, separability implies that we can write the net benefits to a consumer of type (θ,υ) as $\theta q + \upsilon - p(q)$.

Consumer expectation formation has already been described via the reputation adjustment equation, (1). These expectations are adaptive, yet in equilibrium they are fully rational: in equilibrium consumers expect firms to maintain their reputations, and that is precisely what firms do. The adaptive expectations reflect the fact that firms could alter their quality for some time without detection by consumers.

D. Reputation Equilibrium

The equilibrium in the model is a steady-state configuration in which firms maintain quality over time, fulfilling consumers' expectations, and in which the price as a function of reputation schedule is unchanging over time. Since $q = R$ in equilibrium, the price schedule will be written as a function of quality $p(q)$.

Formally, a *reputation equilibrium* is a price function across qualities, $p(q)$, and a distribution of firms across qualities, $N(q)$, such that

(a) Each consumer, knowing $p(q)$, chooses his most preferred product on the schedule to consume (if he uses the product at all).

(b) Markets clear at every quality level (this determines $N(q)$).

(c) A firm with reputation R finds it optimal to produce quality $q = R$ rather than to deviate. Put differently, consumers' expectations are fulfilled.

(d) No new entry is attractive.

This equilibrium notion is the natural extension of perfect competition to an imperfect information context. A firm takes price as given in a given period, but over time it can change the price it receives by changing its quality. Consumers also take the $p(q)$ schedule as given and choose a product that yields the maximum net benefits. Consumers have perfect information about all firms' prices and reputations, but cannot observe quality directly.

III. A Derivation of the Equilibrium Price-Quality Schedule

In this section the equilibrium $p(q)$ schedule is derived from elementary arguments, without reference to demand conditions at all. The prices at which various qualities are forthcoming are independent of demand, although there may be no active sellers at a given price-quality combination if there are no consumers who prefer that point to others on the equilibrium $p(q)$ schedule. This is analogous to the fact that price is determined solely by costs under perfect competition (in the long run with perfectly elastic factor supplies), and to the fact that some products may not be produced if there is no demand for them at these prices, given the other available products and their prices.

There are two conditions that are used to derive the equilibrium $p(q)$ schedule: Conditions (c) and (d) in the definition of a reputation equilibrium. First, consider condition (c) that a firm with reputation q does *not* wish to milk its reputation. One way to milk reputation is to cut quality to the minimum, taking short-run gains, and exit the market. This would yield "profits" of $p(q) - c(q_0)$ during the initial period. The alternative strategy of maintaining quality forever yields a constant flow of "profits" of $p(q) - c(q)$, which has a present value of $(p(q) - c(q))(1 + r)/r$. A necessary condition in order that milking not be attractive is that $(p(q) - c(q))(1 + r)/r \geq p(q) - c(q_0)$, which can be rewritten as

$$p(q) \geq c(q) + r(c(q) - c(q_0)). \tag{2}$$

We call this the *no-milking* condition. As argued above, price must exceed cost in order to prevent quality deterioration. This is because short-run profits can always be earned by milking one's reputation. The no-milking condition puts a lower bound on the price at which items of a given quality can be sold in equilibrium.

The free-entry condition, (d) in the definition of a reputation equilibrium, places an *upper* bound on the price at which any quality can be sold. Free entry requires that the profits of a potential entrant into the quality q segment of the market be nonpositive. The profits of such an entrant are $p_e - c(q)$ in the first period and $p(q) - c(q)$ in all subsequent periods, so the free-entry condition is $p_e - c(q) + (p(q)$

$-c(q))/r \leq 0$. This can be written as

$$p(q) \leq c(q) + r(c(q) - p_e). \tag{3}$$

Clearly the entrance price p_e, which reflects consumers' willingness to pay for "unknown" products, is an important variable in the free-entry condition. We now argue that $p_e = c(q_0)$; i.e., new products sell at the cost of producing an item of minimum quality. Equivalently, we are claiming that the quality attributed to entrants without investment in reputation, i.e., the entrance quality q_e, is equal to q_0. The reason is that there is a potentially infinite supply of fly-by-night sellers who would overrun the market with items of minimum quality if they could make profits doing so. If $p_e > c(q_0)$, an entrant could make positive profits by selling items of minimal quality. Free entry therefore demands that $p_e \leq c(q_0)$. On the other hand, consumers know that all products are of quality of at least q_0, so they are willing to pay at least the cost of minimal quality items for entrants' products; i.e., $p_e \geq c(q_0)$. These arguments together imply that $p_e = c(q_0)$. Effectively, this condition states that an entrant begins with a reputation of q_0 before he undertakes any investment in reputation. A problem with assuming that $p_e = c(q_0)$ is that consumers' expectations about new products are not fully rational: on average, entrants' qualities are higher than q_0. Since there is no equilibrium with fully rational expectations about new products, and since introductory offers are a common practice, we assume that consumers protect themselves from potential suppliers of minimal quality items by refusing to pay more than $p_e = c(q_0)$ for entrants' products.

Substituting $c(q_0)$ for p_e into the free entry condition (3), we find that it is the same as the no-milking condition with the inequality reversed. These two conditions therefore determine the equilibrium price-quality schedule $p(q)$, as

$$p(q) = c(q) + r(c(q) - c(q_0)). \tag{4}$$

The price for an item of quality q is at once the minimal price necessary to make it worthwhile for the seller to maintain his reputation, and the maximum price at which entrants have no incentive to come in to undercut existing sellers. It is possible that, given the $p(q)$ schedule, there are some qualities at which no consumers wish to purchase. In that case we can interpret $p(q)$ as the price at which items of quality q would be forthcoming, i.e., the supply price of quality q products. So long as the distribution of consumers' tastes for quality θ has no gaps in it, however, all qualities within some range will be sold in equilibrium.

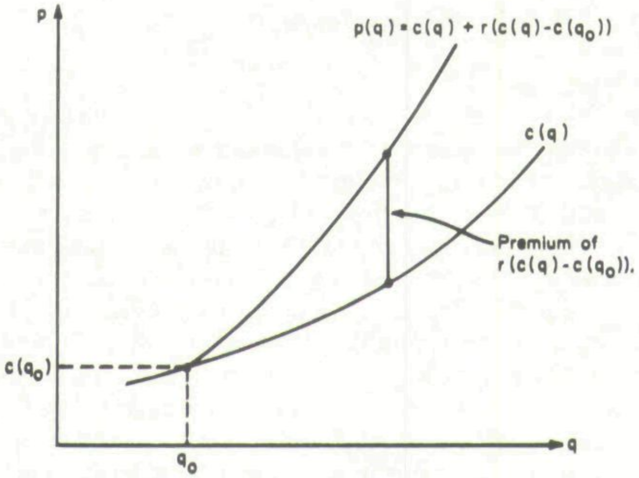

FIGURE I

An implication of equation (4), the central equation in the paper, is that $p(q_0) = c(q_0)$; i.e., minimal quality items sell at cost. This is because no investment in reputation is necessary to sell products of quality q_0. Effectively, there are no informational problems in the q_0 segment of the market: either qualities less than q_0 are illegal, or they can be detected by inspection, or avoided via warranties. Of course, q_0 may be low enough such that no consumers wish to purchase minimal quality products.

The equilibrium price-quality schedule is shown in Figure I above. It is clear that qualities in excess of the minimum sell at a premium above their cost, and that this premium, $r(c(q) - c(q_0))$, is larger for higher quality products. For very high quality products, alternative mechanisms or institutions may arise to provide the product.

There is a simple and instructive interpretation of (4). The cost of providing items of quality q is the per period production cost $c(q)$, plus the one time *information cost* of $c(q) - c(q_0)$. The information cost is the cost of establishing a reputation for quality q. A seller incurs this cost in the initial period, given our simple dynamic structure. The price of an item of quality q reflects not only the production cost, but a normal rate of return on the information cost, namely $r(c(q) - c(q_0))$. Alternatively, the asset value of reputation q is $c(q) - c(q_0)$, which must earn a rate of return r in competitive equilibrium. A key point is that the premium for a high quality product represents only

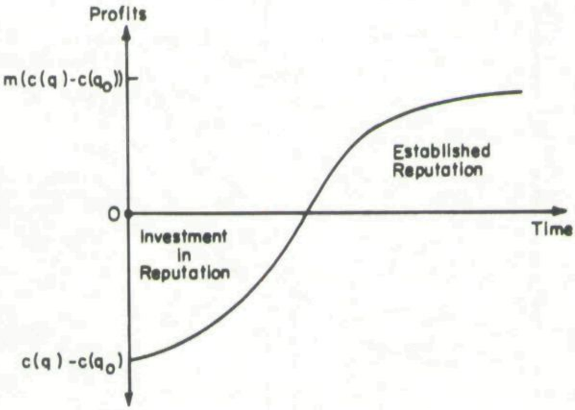

FIGURE II

a fair rate of return on the investment in reputation. The typical time pattern of profits to a seller is given by an initial period of losses, i.e., investment in reputation, followed by a stream of profits. The present value of profits is zero when viewed from the date of entry. As we shall see below, a richer time profile of profits arises when the dynamics of reputation adjustment are less stark than $R_t = q_{t-1}$. In general, the time patterns of profits for a seller who produces items of a fixed quality over time are as shown in Figure II. The higher the quality produced, the larger are the initial losses (investment in reputation) and the subsequent profits (premiums for high quality items).

It is instructive to compare the equilibrium $p(q)$ schedule with the price-quality schedule that would prevail under perfect information $c(q)$. We note

THEOREM 1. As the lag between successive sales of the product, and hence the lag with which consumers detect quality, approaches zero, the $p(q)$ schedule approaches that under perfect information.

Proof of Theorem 1. The length of the period T measures the time lag between the sale of an item and the adjustment of reputation on the basis of its quality. As $T \to 0$, $r = e^{iT} - 1$ approaches 0, so $p(q) \to c(q)$. The idea is that $T \to 0$ corresponds to immediate quality detection by consumers; in the limit this is exactly perfect information. (The effect of alternative reputation adjustment equations on $p(q)$ is treated in Section IV below.)

Q.E.D.

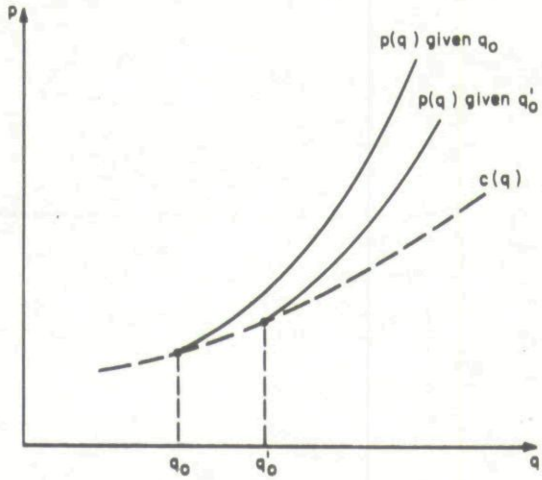

FIGURE III

The influence of T and q_0 on the equilibrium $p(q)$ schedule is easy to see using (4). A large lag T between sale and reputation adjustment leads to a large value of r and hence a steeper schedule. Basically, if T is large, the returns from investment in reputation, i.e., the premiums for high quality products, are enjoyed only after a long delay and hence must be larger in order to compensate for the investment itself.

A higher minimum quality standard q_0 has an interesting impact on the $p(q)$ schedule. The effect of q_0 on $p(q)$ is shown in Figure III. Increases in q_0 raise the price at which entrants can sell their products. This reduces the investment necessary to build up a reputation and hence reduces the premiums for high quality products. Alternatively, raising q_0 reduces the profits that a reputable firm can earn by milking its reputation and hence reduces the premium necessary to induce quality maintenance. The fact that q_0 influences the entire $p(q)$ schedule is the basis of the welfare analysis in Section VII below.

The arguments above demonstrate that $p(q) = c(q) + r(c(q) - c(q_0))$ is a necessary condition for equilibrium, but sufficiency has yet to be established. In fact, (4) is sufficient, for when it is satisfied for all qualities q, there is no inducement for entrance, exit, or switching qualities.

Using the equilibrium formula for $p(q)$, we may easily calculate the asset value of reputation q. Since it is optimal for a seller with reputation q to maintain that reputation, thereby earning a stream

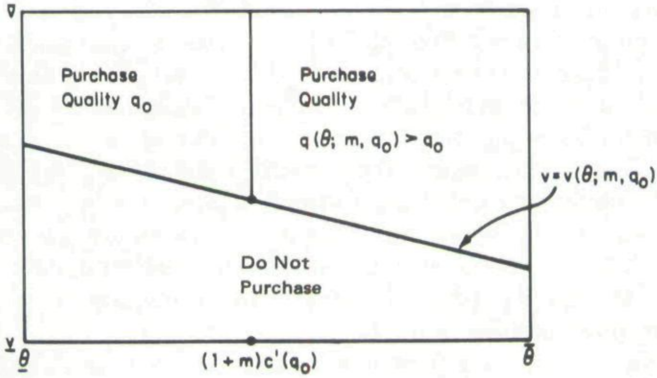

FIGURE IV

of profits of $p(q) - c(q) = r(c(q) - c(q_0))$, the asset value of reputation q is

$$V(q) = (1 + r)(c(q) - c(q_0)).$$

Naturally this is increasing in q. It is also decreasing in q_0: stringent quality standards raise the entrance price, so they reduce the cost of building up a reputation and hence reduce the value of a given reputation.

IV. Information Flows and Premiums for High Quality Products

Having derived the equilibrium price-quality schedule for the simple reputation adjustment equation, $R_t = q_{t-1}$, we note that it is relatively easy to see how alternative reputation adjustment processes, i.e., alternative specifications of consumer learning about quality, influence the $p(q)$ schedule. As alternatives to $R_t = q_{t-1}$, we consider

$$R_t = q_{t-n} \tag{5}$$

and

$$R_t = \gamma R_{t-1} + (1 - \gamma)q_{t-1}, \quad 0 \leq \gamma < 1. \tag{6}$$

Equation (5) captures the notion that quality information may be forthcoming only after a significant time period. This applies especially to information about durability. For example, the maintenance costs associated with 1982 model cars cannot possibly be observed until these cars have been on the road for some time. Equation (6) captures two other possible effects in reputation formation. The first is that consumers do not completely alter their judgment of a firm on the basis of its quality in a single period. Rather they may only adjust reputation partially in response to observed quality. The second concerns the probability of observing true quality. Some product attributes are difficult to detect even after purchase—e.g., safety features. If γ is the probability that the observation is known to provide no information, in which case reputation is unaltered, then (6) will hold. The earlier case (1) corresponds to rapid and certain reputation adjustment.

When $R_t = q_{t-n}$, a firm must upon entry produce high quality products for n periods before it establishes its reputation. On the other hand, it can reduce quality for n periods before its reputation is reduced. Following a line of reasoning just like the above analysis for $n = 1$, we may give the equilibrium $p(q)$ schedule when $R_t = q_{t-n}$ by

$$p(q) = c(q) + ((1 + r)^n - 1)(c(q) - c(q_0)).$$

For small values of r, i.e., small values of T, this is approximately given by

$$p(q) = c(q) + rn(c(q) - c(q_0)). \tag{4'}$$

The equation indicates that slow learning by consumers (a large n) raises the premiums for high quality products, and therefore the asset value of a given reputation.

When reputation adjustment takes place according to equation (6), the equilibrium $p(q)$ schedule is given by

$$p(q) = c(q) + (r/(1 - \gamma))(c(q) - c(q_0)). \tag{4''}$$

Equation (4″) indicates that premiums for quality products will be higher either if quality attributes are difficult to observe (such as a lawyer's effort) or if consumers are cautious in updating a seller's reputation on the basis of his recent quality. Either of these effects leads to a larger value of γ and hence raises the costs of acquiring a reputation.[2]

2. Formula (4″) also applies when reputation adjustment is of the general Markovian form of

$$R_t - R_{t-1} = \psi(q_{t-1} - R_{t-1})$$

if we simply replace $1 - \gamma$ by $\psi'(0)$.

In the subsequent analysis the size of the premiums to high quality products plays an important role. Essentially, it measures the divergence of the reputation equilibrium from the equilibrium that would prevail under perfect information. For expositional purposes we introduce a variable, m (for markup) that measures the gap between price and cost for high quality items. We thus shall write $p(q)$ as

$$p(q) = c(q) + m(c(q) - c(q_0)). \tag{7}$$

In the case where $R_t = \gamma R_{t-1} + (1-\gamma)q_{t-1}$, we have $m = (e^{iT} - 1)/(1 - \gamma)$ while in the case where $R_t = q_{t-n}$, we have $m = e^{inT} - 1$.

The parameter m measures the extent of informational problems in the market. As one would expect, informational problems are most acute when m is large. In summary, a large value of m can be interpreted as

(a) infrequent sale of the product (large T),
(b) long lags in detection of quality (large n),
(c) slow updating of reputations (large γ), or
(d) difficulty in detecting quality attributes (large γ).

In the welfare analysis of m below, m can be thought of as a policy variable, since information provision activities can influence m through several of these channels.

V. Consumers' Response to the Price-Quality Schedule[3]

In order to perform a welfare analysis of information provision (m) and minimum quality standards (q_0), it is necessary to determine the response of consumers to a given $p(q)$ schedule. Then comparative statics can be done to evaluate the impact on consumers of changes in m and q_0 that alter $p(q)$.

Consumer response to changes in m and q_0 reflect the following effects: (1) as m rises, the marginal cost to the purchaser of an increase in quality, $(1 + m)c'(q)$, increases. This causes consumers to substitute toward lower quality items. Furthermore, as m rises, so does the price itself for all qualities in excess of q_0. This causes some consumers to substitute away from the product altogether. (2) As q_0 falls, the entire $p(q)$ schedule shifts up. This causes some consumers to stop buying the product, although it does not cause any substitution across qualities.

3. A formal treatment of Sections V, VI, and VII is available in the earlier version of this paper [Shapiro, 1981].

The analysis is complicated because of the fact that consumers, given the $p(q)$ schedule, sort themselves into three qualitatively different groups: (a) those who purchase $q > q_0$, (b) those who purchase $q = q_0$, and (c) those who do not purchase at all. The division of consumers into these groups is shown in Figure IV. Consumer response to a $p(q)$ schedule will be described by identifying who purchases and who does not, and also identifying the quality selected by those who do. In general, consumer response will depend on q_0 and m, since $p(q)$ does.

Consumer (θ,v)'s problem is given by $\max_{q \geq q_0} \theta_q + v - p(q)$. If this maximum is positive, he purchases the product. As expected, consumers who place a low value on the good (low v) do not purchase it. The boundary between consumers who purchase and those who do not is shown in Figure IV. Finally, consumers with low θ (those not sensitive to quality) purchase q_0, while those with higher θ's purchase higher qualities.[4]

VI. Welfare Analysis of Information Flows

This section studies the welfare effects of changes in the speed or reliability with which consumers learn about product attributes. In view of the analysis in Section IV, information flows, e.g., the lag with which consumers learn the true quality produced, are captured in the parameter m. Decreases in m correspond to improved information in a number of possible ways. Formally, we are doing comparative statics on m. Since q_0 is fixed throughout this section, it is suppressed in the notation where possible.

The basic welfare theorem below states that there are unambiguous gains as m falls. The idea is this: the premium for high quality products, $m(c(q) - c(q_0))$, is like a tax in that it opens a gap between marginal production cost $c(q)$ and price. This gap causes welfare losses relative to the full-information outcome. The gap in fact reflects the (information) costs associated with establishing reputation q. Information costs are as real as production costs, so this gap should not be viewed as a market failure but rather as a cost due to imperfect information. In that spirit, the theorem below identifies the gross benefits of improvements in the information technology (i.e., faster learning, etc.). Naturally, the costs of any information provision

4. The description of consumer behavior can be summarized by two functions, each dependent on the parameters m and q_0: (1) $q(\theta;m,q_0)$, the quality chosen by consumers with quality preference θ who purchase the product, and (2) $v(\theta;m,q_0)$, the minimum v, among those of type θ, who purchase the good.

program would have to be weighed against the benefits studied here.

The welfare measure used is aggregate consumer surplus plus profits. Equivalently, we shall write down expressions for gross utility minus the costs of production. Since producers earn zero profits ex ante, we can identify this aggregate welfare measure with consumer surplus. This requires inclusion of the transition period, during which firms take losses to build up reputations. The easiest way to treat this period is to assume[5] that it differs from the steady state only in the prices charged (all items sell at $c(q_0)$). With this convention there is no difference in social welfare between the transition period and the steady state, because the same allocation prevails. Consequently, we can identify steady-state aggregate welfare with consumer surplus, by using the zero profit condition.

THEOREM 2. An increase in m leads to welfare losses for two reasons.

(a) Consumers who use qualities above q_0 shift to lower qualities (because the marginal price of quality rises); and

(b) Some consumers leave the market altogether, even though their benefits from the product exceed its cost of production (because their benefits do *not* exceed the price, which includes a premium).

A proof of the theorem is available in Shapiro [1981].[6] Note that there are no welfare losses, to the first order, from imperfect information when we first move away from perfect information ($m = 0$). A consequence of this is that information provision activities, if costly, should not be carried out until full information is achieved. In addition, the per capita welfare losses as m increases tend to be greater for those who value quality the most (high θ's).

The welfare gains from decreasing m arise from the reduction in the gap $p(q) - c(q)$. It is worth noting another welfare gain from bringing $p(q)$ and $c(q)$ closer in line, one not present in this model. That effect involves firms' *quantity* choices. If profits are to be earned, price must exceed minimum average cost. This will cause a reverse-

5. The welfare theorems do not depend on this assumption. They require only that a consistent description of what happens during the transition period be maintained throughout the analysis.

6. Calling $W(\theta,m)$ the aggregate consumer surplus of consumers of type θ for a given m, we may show there that

$$W_m(\theta,m) = \frac{m\theta}{(1+m)^2}\left[\frac{-c'(q(\theta;m,q_0))}{c''(q(\theta;m,q_0))}\right]\int_{v(\theta;m,q_0)}^{\bar{v}} f(\theta,v)dv - mf(\theta;v(\theta;m,q_0))[c(q(\theta;m,q_0)) - c(q_0)]^2.$$

Chamberlinian effect: firms, in setting price at marginal cost, will produce at output levels which do not minimize average cost. Rather, their outputs will be above efficient scale. This effect reinforces the welfare theorems in the paper.

Finally, note that existing producers who have established their reputations will resist efforts to improve consumer information. This is because improved information reduces m and hence the value of a given reputation. Improved information makes it easier for entrants to establish their own reputations.

VII. Welfare Analysis of Minimum Quality Standards

This section studies the welfare effects of the minimum quality standard q_0. It should be interpreted as a change in the legal minimum, assuming that this law is effectively enforced. The general result is that the optimal standard q_0^* is binding; i.e., some consumers would choose to use qualities below q_0^* if not for the law.

In a perfect information world, with perfect competition, there is no justification for a minimum quality standard. After all, its only effect would be to restrict artificially the range of products offered for sale. When product quality cannot be observed prior to purchase, however, there may be justification for such standards. The usual story is that a minimum standard or licensing protects consumers from quacks, frauds, and ripoffs, generally. This refers to a situation where consumers may be unpleasantly surprised by the quality of the product they buy.

While such a story is perfectly plausible, it is *not* the one underlying the analysis in this paper. The concern here is with the desirability of a minimum quality standard, where the standard influences the equilibrium price-quality schedule. So, even granting that consumers are never surprised (in equilibrium), i.e., that their expectations of quality are fulfilled, it is desirable to impose a minimum standard.

There are to our knowledge no other formal analyses of minimum quality standards where the supply of products of various qualities is endogenous. The case with exogenous supplies has been treated by Leland [1979].

Since we have already shown how the minimum standard q_0 influences the equilibrium $p(q)$ schedule (4), and how consumers respond to this, it is relatively easy to determine the welfare effect of a change in q_0. Then the optimal standard can be identified. These results are summarized in

THEOREM 3. Given a minimum quality standard q_0, all consumers of type $\theta > c'(q_0)$ enjoy a welfare gain from raising q_0, while those for which $\theta < c'(q_0)$ suffer as a result.

THEOREM 4. Assuming that consumers are heterogeneous in their tastes for quality, the optimal minimum quality standard is such that

(a) there are some consumers who would consume a lower quality product were the standard lowered, and

(b) some consumers use a product of quality in excess of the standard.[7]

Proofs are again available in Shapiro [1981]. Consumers of type θ are best off when the minimum quality standard is the quality they would choose under perfect information. If the quality standard is below a consumer's preferred quality, he would like to see the standard raised to reduce his premium payment. If it is higher, he would like to see it lowered so as to make available qualities more in line with his tastes.

The optimal q_0,q_0^* is set so as to balance off gains to high quality users through reduced premiums with losses to low quality users who cannot get their preferred product. Let $\underline{q}$ satisfy $c'(\underline{q}) = \underline{\theta}$. Consider raising the standard from this low level so as to make it binding (i.e., so that types $\underline{\theta}$ cannot get their most preferred quality $\underline{q}$ any longer). To the first order, there are no losses to type $\underline{\theta}$ consumers from raising q_0. Yet there are real gains to higher θ consumers. So $q_0 = \underline{q}$ cannot be optimal. Conversely, let $c'(\overline{q}) = \overline{\theta}$. Lowering the standard from $q_0 = \overline{q}$ benefits all consumers of types $\theta < \overline{\theta}$, and has no first-order impact on $\overline{\theta}$ consumers. Consequently, the optimal standard is an intermediate one: $\underline{q} < q_0^* < \overline{q}$.

The reason that the optimal standard is binding is that increases in q_0 cause the whole $p(q)$ schedule to shift down by reducing the premium for high quality products. Put differently, an increase in q_0 lowers the information costs of providing high quality products. The reduced premium brings $p(q)$ more in line with $c(q)$ and has associated welfare gains.

It is interesting to note that if we start from a steady-state equilibrium, increasing the minimum quality standard causes a capital *loss* for all firms currently selling high quality products. Increases in q_0 raise the price an entrant can command, thereby reducing the costs of building up a given reputation and hence the asset value of that

7. This theorem holds no matter what weights are placed on the utilities of different consumers in the welfare measure, as long as the weights are positive and finite.

reputation. This may help to explain industry resistance to quality standards. In this regard the model differs notably from that of Leland. With exogenously given qualities, high quality sellers benefit from the exclusion of lower quality producers from the market. With free entry (apart from the costs of building a reputation) into all quality segments of the market, however, existing high quality sellers are hurt by increases in quality standards.

VIII. Conclusions

This paper has investigated the implications of reputation in a perfectly competitive environment. It has been shown that reputation can operate only imperfectly as a mechanism for assuring quality. High quality items sell for a premium above cost. This premium provides a flow of profits that compensate the seller for the resources expended in building up the reputation.

Several common but informal notions relating to reputations have been challenged by this analysis. First, a good reputation need not confer market power on its owner. Indeed, firms face perfectly elastic demand curves in the model presented above. Second, reputations need not imply a barrier to entry either. It is true that a firm must expand resources initially to build up a reputation, but it is *not* possible, at least in this model, to earn supernormal profits by virtue of having built up a reputation. In other models it may be the case that there are first-mover advantages in reputation formation, and thus reputation could serve as a barrier. In this model, however, it does not.

Care must be taken in evaluating profit data for consumer goods industries. If reputation (goodwill) is not included in the set of assets a firm owns, the calculations of its rate of return will exceed the market rate of return. This is misleading, as would be the conclusion based upon it that the firm enjoyed some degree of market power.

A welfare analysis of information remedies and minimum quality standard has been made. There are welfare gains from improving consumers' abilities to evaluate product quality and communicating this information; these must be balanced against the costs of such a program. Assuming that it is costly to improve consumer information, we see that it is not optimal to provide perfect information.

Optimal minimum quality standards are also studied. In general, it is optimal to exclude from the market items that some consumers would like to purchase; i.e., the standard should be binding. This is because there are welfare gains to consumers who like high quality items that arise from raising the standard. These gains arise because a higher minimum quality standard reduces the premiums for high quality goods.

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