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QUACKS, LEMONS AND LICENSING: A THEORY OF MINIMUM QUALITY STANDARDS

By
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QUACKS, LEMONS, AND LICENSING:
A THEORY OF MINIMUM QUALITY STANDARDS

I. Introduction

Licensing occurs in a number of professions. Doctors, barbers, real estate salesmen, contractors, accountants, and stock brokers—to name a few—must pass state examinations believed to assure a minimum level of competence. Nor are such minimum quality standards limited to professions. Drugs and other potentially hazardous products must satisfy federal safety standards. Banks' portfolios are subject to regular examination for their "soundness." And there is agitation for minimum quality standards in a number of currently unregulated markets, from baby pajamas to TV repairmen.

Is there an economic justification for regulating minimum quality? Not in traditional theory: devotees of this theory explain the existence of licensing and other minimal quality standards either as misguided economic paternalism or as a means—tacitly controlled by industry or professional representatives—to capture monopoly profits.¹

But it is not clear that traditional economic tools are adequate for investigating the licensing problem in its full complexity. Markets which have minimum quality standards tend to be characterized by informational asymmetry, in which the seller knows the quality of his service or product, but the buyer does not. It is difficult, for example, for a patient to ascertain the exact quality of a physician's

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services or for a housewife (or househusband) to verify the radiation leakage of a microwave oven. Thus, uncertainty and differences in information seem to characterize markets with licensing or other forms of minimum quality standards, and, until recently, these aspects of markets have been outside the purview of economic theory.

As George Akerlof [1971] pointed out in his brilliant study of the used car market ("the market for 'lemons'"), informational asymmetry can lead to certain types of market failure. Consider a related example: the market for physicians. If there were no licensing standards, "doctors" could range from those who are highly qualified to those who are "quacks." Doctors know their own abilities, and those who are more highly qualified have better alternative opportunities for employment. Patients, on the other hand, have difficulty in distinguishing the relative qualities of physicians. All doctors must therefore command the same fees, which will reflect the average quality of medical services.²

Doctors (or potential doctors) with above-average opportunities elsewhere may not be willing to remain (or enter) the market, since the price they receive will reflect the lower average quality of service. Their withdrawal from the market lowers the average quality of medical services, the price falls, and further erosion of high-quality physicians occurs. Depending on parameters which are studied below, the market may degenerate until only "quacks" are practicing medicine. Gresham's Law, that "bad money drives out good," reasserts itself in a different context.
This example, which is formalized below in a general framework, indicates that the efficiency of unregulated markets may be questioned when there are differences in information between buyer and seller. The ideal remedy, of course, is to eliminate informational asymmetries. In some cases, repeat purchases, product labeling, and other forms of product information may reduce or eliminate asymmetries. But in many cases, eliminating informational differences may be very expensive--too expensive relative to the potential welfare gains. Less expensive means of reducing quality deterioration should be considered. One such device might be making sellers liable for poor-quality products or services--"caveat venditor" rather than "caveat emptor." While such liability may be useful in cases in which product failure is readily evident ex post, it may be difficult or impossible to ascertain product failure in cases where the effect is long delayed and partial. A poor plumbing job might not show up for several years, and there might then be doubt as to whether it was caused by the plumber, by misuse, or by "an act of God." The plumbing jobs by physicians are presumably even more difficult to assess.

An alternative and perhaps less expensive means for averting quality deterioration may be some form of simple screening device, which would (perhaps partially) eliminate the quacks and the lemons--in fact, licensing or other forms of minimum quality standards. But it should be realized that by restricting entry in this manner, detrimental side effects may occur.
This paper studies the licensing problem. A model of markets with asymmetric information is developed, and the nature of market failure studied. Circumstances are examined under which minimal quality standards are desirable. We then consider whether quality standards dictated by an industry or profession will be socially optimal, or whether—as some writers have suggested—these standards will always be set too restrictively in order to achieve monopoly rents.

II. A Model of Markets with Asymmetric Information

This section considers a market in which sellers know the quality of the service or product they provide, but buyers do not. We define the following variables.

$$q = \text{index of quality level of a service or good}$$

$$Q = [q_l, q_h] = \text{range of quality of services which potentially could be sold in the market}$$

$$f(q) = \text{potential supply of services of quality level } q$$

$$F(q) = \int_{q_l}^{q} f(q')dq'$$

$$R(q) = \text{opportunity cost of supplying a unit of service of quality level } q.$$  

Without loss of generality, we can rescale the quantity and quality variables so that supply is uniformly distributed on the interval $[0,1]$. Thus,
(1) \[ Q = [0,1]; \]
\[ f(q) = 1; \]
\[ F(q) = q. \]

The quality index \( q \) can now be interpreted as the percentile of potential supply which has quality \( q \) or less.

Following Akerlof, we assume that the rescaled opportunity cost schedule \( R(q) \) is increasing:

(A.1) \[ R'(q) = \frac{dR}{dq} > 0. \]

In Section VI we consider markets in which opportunity costs decrease with \( q \).

IIa. Market Equilibrium

Let \( \hat{q} \) denote the maximal quality service or good which is being supplied in the market. For each possible \( \hat{q} \), we may define a supply price:

(2) \[ p_s = R(\hat{q}). \]

\( p_s \) has the property that it supports \( \hat{q} \), since potential suppliers with \( q \leq \hat{q} \) will provide their services when price is \( p_s \), whereas (by A.1) potential suppliers with \( q > \hat{q} \) will not supply their services, since their opportunity costs exceed the supply price.

Given \( \hat{q} \), market supply \( y \) will be:

(3) \[ y = \int_0^{\hat{q}} f(q)dq = F(\hat{q}) = \hat{q}. \]
Average quality $\bar{q}$ of services will be:

\begin{equation}
\bar{q} = \frac{1}{2} q \frac{P(q) dq}{F(q)} = \frac{1}{2} \hat{q}.
\end{equation}

Consumers have a marginal willingness to pay (inverse demand curve) $p_d$, which is assumed to depend on average quality of services supplied $\bar{q}$ and on market supply $y$:\(^8\)

\begin{equation}
p_d = p(\bar{q}, y),
\end{equation}

with

\begin{align}
p_q &\equiv \frac{\partial p}{\partial \bar{q}} > 0; \\
p_y &\equiv \frac{\partial p}{\partial y} \leq 0.
\end{align}

Using (3) and (4), we can see that demand price $p_d$ is a function of $\hat{q}$:

\begin{equation}
p_d = p\left(\frac{1}{2} \hat{q}, \hat{q}\right).
\end{equation}

Equilibrium can now be defined as a level of $\hat{q}$ which equates supply price with demand price.\(^9\) Let $\hat{q}_e$ denote an equilibrium. Then, from (2) and (6), $\hat{q}_e$ will satisfy

\begin{equation}
R(\hat{q}_e) = p\left(\frac{1}{2} \hat{q}_e, \hat{q}_e\right).
\end{equation}

From (3), equilibrium supply $y_e = \hat{q}_e$, and from (4), equilibrium average quality will be $\bar{q}_e = \frac{1}{2} \hat{q}_e$. Equilibrium price will be given by
\[(8) \quad p_e = p(\hat{q}_e, y_e) = R(\hat{q}_e) .\]

For $\hat{q}_e$ to represent a stable equilibrium, we have the further condition that the schedule $p_d(\hat{q})$ must intersect the schedule $p_s(\hat{q})$ from above. Thus, at $\hat{q} = \hat{q}_e$,

\[(9) \quad R' - \frac{1}{2} p q - p y > 0 .\]

IIb. An Example

Let

\[(10) \quad p(\bar{q}, y) = \alpha + \beta \bar{q} - \gamma y ; \quad R(q) = \delta q^2 .\]

Substituting for $y$ and $\bar{q}$ from (3) and (4) enables us to rewrite the equilibrium condition (7) as:

\[(11) \quad \delta q_e^2 = \alpha + (\beta/2 - \gamma)\hat{q}_e ,\]

with solution

\[(12) \quad \hat{q}_e = (\beta/2 - \gamma) + \sqrt{(\beta/2 - \gamma)^2 + 4\alpha \delta} .\]

In the case where $\alpha = \beta = \gamma = \delta = 1$, for example, we find

\[(13) \quad \hat{q}_e = .78 \]

\[y_e = .78 \]

\[q_e = .39 \]

\[p_e = .61 .\]
Figure 1 presents a graphical illustration of equilibrium \( \hat{q}_e \). Comparative static results can be derived visually.

IIC. Market Failure

We wish to compare the equilibrium \( \hat{q}_e \) which prevails in markets with asymmetric information to the level of \( \bar{q} \) which is "socially optimal." We use the criterion of "net benefits" suggested by Dupuit and used by Michael Spence [1975] and others to address related questions. Let

\[ W = \int_0^y p(\bar{q}, y')dy' - \int_0^{\hat{q}} R(q)dq \]

(14)

denote net benefits—total willingness to pay for \( y \) units of service at average quality level \( \bar{q} \), less opportunity costs of supply. Substituting for \( y \) and \( \bar{q} \) from (3) and (4) and differentiating (14) with respect to \( \hat{q} \) gives:

\[ \frac{dW}{d\hat{q}} = \frac{1}{2} \int_0^{\hat{q}} \left[ p(\bar{q}, y')dy' + p(\bar{q}, \hat{q}) - R(\hat{q}) \right]. \]

(15)

At \( \hat{q} = \hat{q}_e = y_e \), (8) implies that

\[ \frac{dW}{d\hat{q}} \bigg|_{\hat{q}_e} = \frac{1}{2} \int_0^{\hat{q}_e} p(\bar{q}, y')dy' > 0, \]

(16)

when \( \hat{q}_e > 0 \), using (A.2). Assuming that welfare is unimodal in \( \hat{q} \), we have therefore shown
FIGURE 1

DETERMINATION OF EQUILIBRIUM $\hat{q}_e$

$(\alpha = \beta = \gamma = \delta = 1)$

\[ R(\hat{q}) = \delta \hat{q}^2 \]

\[ = \hat{q}^2 \]

\[ p = \alpha + (\beta / 2 - \gamma) \hat{q} \]

\[ = 1 - (1/2) \hat{q} \]
Theorem I. Open markets ($\hat{q}_e > 0$) with asymmetric information will underprovide quality relative to that which is socially optimal.

The intuition underlying this result is straightforward. The marginal seller in equilibrium has an opportunity cost equal to the value of an extra unit of service of average quality. But the marginal seller sells a unit of above-average quality. Therefore, the social value of his service or good exceeds its opportunity cost, and the margin should be pushed to higher quality levels.

Theorem I is a formalization of the market failure suggested by Akerlof's "lemons" example. Figure 2 shows graphically the difference between welfare maximization and market equilibrium for the example considered in IIb. The area under the dotted line is total benefits. Net benefits is the area under this dotted line, less the area under the $R(q)$ curve up to the chosen level of $\hat{q}$. Welfare is maximized at $\hat{q}_s$.

Note from (12) that complete market degeneration ($\hat{q}_e = 0$) occurs only if $\alpha = 0$ and $(\beta/2 - \gamma) \leq 0$. When markets cease to exist because of information asymmetry, it may or may not be socially optimal for them to be open. When $\alpha = 0$, $\hat{q}_s < 0$ if $(\beta - \gamma) < 0$. Therefore, markets should be open when they are, in fact, closed only when $\beta > \gamma \geq \beta/2$.

IID. Two-Part Pricing and Health Insurance: An Example

Consider the special case of (10) where $\alpha = \beta = \gamma = \delta = 1$. Market equilibrium is given by (13), with net benefits .62 divided between consumers' surplus (.30) and producers' surplus (.32).
MARKET EQUILIBRIUM AND SOCIALLY OPTIMAL \( \hat{q} \)

\( \alpha = \beta = \gamma = \delta = 1 \)

(Increase in benefits in going from \( \hat{q} = \hat{q}_e \) to \( \hat{q} = \hat{q}_s \) is area A)

\[
\frac{dW}{d\hat{q}} = \alpha + (\beta - \gamma)\hat{q} = 1
\]

\[
p = \alpha + (\beta/2 - \gamma)\hat{q}
\]

\[
= 1 - (1/2)\hat{q}
\]
In this case, the optimal level of $q$ is $\hat{q}_s = 1$, yielding benefits of .67. There is, of course, no way that $\hat{q}_s = 1$ can be supported by a single price market equilibrium. But now consider two-part price systems, in which the consumer pays a fixed fee, plus a price per unit of service.

At $\hat{q} = 1$, we see from (2) that the supply price must be $p_s = 1$. To demand $\hat{q} = 1$, the demand price is $p_d = 1/2$ from (5).

Thus, social equilibrium $\hat{q}_s = 1$ can be achieved by the following two-part pricing scheme:

Consumers pay a fixed fee $F = 1/2$ and a price $p_d = 1/2$ per unit of service. They will demand 1 unit of service and pay a total of 1 unit $(1/2 + 1/2)$.

Suppliers will receive a payment $p_s = 1$ per unit of service, provide 1 unit of service at this price, and receive a total payment of 1 unit.

The two-part system achieves the social optimum of $\hat{q}_s = 1$, with net benefits .67. But simple calculation shows that, at the two-part pricing equilibrium, producers' surplus rises from .32 to .67, while consumers' surplus drops from .30 to zero! In this example, moving to the socially optimal quality level involves a severe redistribution of income in favor of sellers. 11

It might be noted that many health insurance schemes have two-part pricing: Blue Cross/Blue Shield and other plans typically require a fixed monthly payment, with partial coverage of medical service fees.
The coverage creates a wedge between effective supply and demand prices and thereby increases total services beyond those which would be utilized at a single-price equilibrium. We have indicated that this wedge may in fact be desirable, quite apart from its insurance role. But our analysis also indicates that the increased net benefits may often come at the expense of consumers: doctors benefit greatly, but consumer welfare decreases.

III. Minimum Quality Standards

We examine now the effects of introducing a minimum quality standard, or "licensing" standard. We do not inquire as to the mechanism whereby these standards are enforced, nor do we explicitly consider the alternatives to licensing. What we do examine are situations in which licensing may be socially beneficial (before implementation costs), the determinants of the optimal licensing standards, and the possible divergences in standards which a profession or industry would set from those which are optimal.

Our model views licensing as setting a level of quality \( L < Q \), below which supply is eliminated. That is, if a licensing level of \( L \) is set, then supplies of goods within the quality range \([0,L]\) are prohibited. Since quality was scaled according to percentile of total, \( L \) also has the interpretation of eliminating a fraction \( L \) of total potential supply of the good. The fraction eliminated is that with the lowest quality of service or good.
Note that the imposition of $L$ will reduce the supply of lower-quality goods. But through raising average quality, and therefore price, entry will occur at higher quality levels than before. Thus, the effect of imposing $L$ on the market supply is not a priori known.

If a minimum quality $L$ is set, then we can easily modify (3) and (4) to

\begin{equation}
\hat{q} = \int_{L}^{\hat{q}} f(q) dq = F(\hat{q}) - F(L) = \hat{q} - L \tag{17}
\end{equation}

\begin{equation}
\bar{q} = \int_{L}^{\hat{q}} q f(q) dq/[F(\hat{q}) - F(L)] = \frac{1}{2} (\hat{q} + L) \tag{18}
\end{equation}

where, as before, $\hat{q}$ is the highest quality level supplied in the market. Equilibrium continues to require supply and demand prices to be equal, or for $\hat{q}_e$ to satisfy

\begin{equation}
p(\hat{q}_e, y_e) = R(\hat{q}_e) \quad \text{or} \quad p[\frac{1}{2} (\hat{q}_e + L), \hat{q}_e - L] = R(\hat{q}_e) \tag{19}
\end{equation}

Clearly, (19) defines $\hat{q}_e$ as a function of the minimum quality standard $L$. For $\hat{q}_e$ to be a stable equilibrium, given $L$, condition (9) must also hold with $\bar{q}$ and $y$ suitably redefined by (17) and (18).

To determine the effect of changing $L$ on $\hat{q}_e$, we differentiate both sides of the equilibrium condition (19) with respect to $L$, and solve for $\frac{d\hat{q}_e}{dL}$ yielding
\begin{equation}
\frac{d\hat{q}_e}{dL} = \frac{\frac{1}{2} p_q - p_y}{R'(\hat{q}_e) - \frac{1}{2} p_q - p_y} > 0,
\end{equation}

using (9) and (A.2).

We are now in a position to examine the effects on social welfare of changing $L$. From (14) it can be seen that

\begin{equation}
W = \int_{0}^{\hat{q}-L} p(\bar{q}, y') dy' - \int_{L}^{\hat{q}} R(q) dq.
\end{equation}

We assume that $W$ is a concave function of $L$. Differentiating $W$ with respect to $L$ gives

\begin{equation}
\frac{dW}{dL} = \left\{ p(\bar{q}_e, \hat{q}_e - L) + \int_{0}^{\hat{q}_e - L} \frac{1}{2} p_q (\bar{q}_e, y') dy' - R(\hat{q}_e) \right\} \frac{d\hat{q}_e}{dL}
- p(\bar{q}, \hat{q}_e - L) + \int_{0}^{\hat{q}_e - L} \frac{1}{2} p_q (\bar{q}_e, y') dy' + R(L).
\end{equation}

Using (19) and combining terms gives

\begin{equation}
\frac{dW}{dL} = \left[ \int_{0}^{\hat{q}_e - L} \frac{1}{2} p_q (\bar{q}_e, y') dy' \right] \left( \frac{d\hat{q}_e}{dL} + 1 \right) + R(L) - R(\hat{q}_e).
\end{equation}
IIIa. Are Minimum Quality Standards Desirable?

As \( W \) is concave in \( L \), we need only show that (23) is positive at \( L = 0 \) to conclude that some level of minimum quality \( L > 0 \) is desirable. In general, it is difficult to sign (23). But further light is shed on the problem by the example (10). In this case,

\[
\frac{dW}{dL} \bigg|_{L=0} = \left[ \int_0^{q_e} \frac{1}{2} \beta dy' \right] \left[ \frac{\gamma + (\beta |2) \gamma - (\beta |2)}{2 \delta q_e + \gamma - (\beta |2)} + 1 \right] - \delta q_e^2
\]

\[
= \beta q_e \left( \frac{\gamma + \delta q_e}{2 \delta q_e + \gamma - (\beta |2)} \right) - \delta q_e^2.
\]

Since \( L = 0 \) in (24), we may substitute directly for \( q_e \) from (12).

At \( \alpha = \beta = \gamma = \delta = 1 \), we compute \( dW/dL = .064 > 0 \). For this set of parameter values, social welfare is increased by the imposition of a minimal quality standard \( L > 0 \).

Varying \( \alpha, \beta, \gamma, \) and \( \delta \) separately about 1, we find that \( dW/dL \) will rise or fall. Our results are summarized in the following:

**Proposition:** Minimal quality standards (or licensing) will tend to be more advantageous in markets with:

(a) greater sensitivity to quality variations

\[ (\beta = p_q > 0); \]

(b) low elasticity of demand (more exactly, \( p_y = -\gamma < 0 \));

(c) low marginal cost of providing quality (\( R' \) small);

(d) low value placed on low quality service (\( \alpha \) small).
For markets with suitably low sensitivity to quality, high elasticity of demand, high marginal cost of quality, and/or relatively high value placed on low quality service, minimal quality standards may not be desirable: \( dW/dL \leq 0 \) at \( L = 0 \). However, even perfectly competitive markets \( (p_y = 0) \) can benefit from licensing if quality is sufficiently important to consumers, relative to its cost of provision.\(^ {13,14} \)

IV. Minimum Quality Standards Set by Professional Groups

If a professional group or industry could set the minimum quality standard \( L \), would it set it optimally? To answer this question, we first must characterize the objective of the group. Although a number of alternative objectives may be proposed, we focus on a simple one:

(A.3) A professional group or industry seeks to maximize producers' surplus (i.e., net benefits accruing to the group).

Producers' surplus \( \Pi \) is total group revenues, less opportunity costs:

\[
\Pi = p(q_e, y_e) y_e - \int L \, R(q) dq,
\]

where \( q_e \) and \( y_e \) are functions of \( L \) as before.

Differentiating (25) with respect to \( L \) gives:

\[
\frac{d\Pi}{dL} = \frac{1}{2} p(q_e, y_e) y_e \left( 1 + \frac{dq_e}{dL} \right) + p_y(q_e, y_e) y_e \left( \frac{dq_e}{dL} - 1 \right) + p(q_e, y_e) \left( \frac{dq_e}{dL} - 1 \right) - R(q_e) \left( \frac{dq_e}{dL} \right) + R(L).
\]
Consider now the profit-maximizing licensing level \( L = L_p \), which sets \( \frac{d\Pi}{dL} = 0 \). Using (19) and suppressing arguments where clear,

\[
(27) \quad \frac{d\Pi}{dL} = p_q y_e - [R(\hat{q}_e) - R(L_p)] + \left( \frac{1}{2} \right) p_q y_e \left( \frac{\frac{d\hat{q}_e}{dL}}{1 - \frac{d\hat{q}_e}{dL}} - 1 \right) = 0,
\]

where \( \hat{q}_e, \tilde{q}_e \), and \( y_e \) are equilibrium values, given \( L_p \).

We wish now to see whether \( \frac{dW}{dL} \) at \( L = L_p \) is positive, zero, or negative. Given the concavity of \( W \), determining this sign will indicate whether the socially optimal minimum level \( L \) is greater, equal, or less than the level \( L_p \) chosen by the group or industry.

Solving (27) for \([R(\hat{q}_e) - R(L_p)]\) and substituting into (23) gives:

\[
(28) \quad \frac{dW}{dL} \bigg|_{L_p} = \frac{1}{2} \left[ \hat{q}_e - L_p \right] \int_{0}^{y_e} p_q (\hat{q}_e, y') dy' - p_q (\hat{q}_e, y_e) y_e \left( \frac{\frac{d\hat{q}_e}{dL}}{dL} + 1 \right)
\]

\[+ \quad p_y y_e \left( 1 - \frac{d\hat{q}_e}{dL} \right),\]

where, since \( L = L_p \), \( \hat{q}_e \) here is the same as in (27).

To ascertain the sign of (28) we first show that \((1 - \frac{d\hat{q}_e}{dL}) > 0\) at \( L = L_p \) if \( R(q) \) is strictly convex. Convexity implies:

\[
(29) \quad [R(\hat{q}_e) - R(L_p)] < R'(\hat{q}_e)(\hat{q}_e - L) = R'(\hat{q}_e)y_e.
\]
Substituting this into (27) yields:

\[
(p_q - R'(\hat{q}_e)) + \left( \frac{1}{2} p_q + p_y \right) \left( \frac{d\hat{q}_e}{dL} - 1 \right) < 0.
\]

From (20)

\[
\frac{d\hat{q}_e}{dL} - 1 = \frac{p_q - R'}{R' - \frac{1}{2} p_q - p_y},
\]

whose denominator is positive by (9). Substituting into (30) and rearranging terms gives:

\[
(p_q - R'[R'/(R' - p_q - p_y)]) < 0.
\]

By (A.1) and (9), \( R'/(R' - \frac{1}{2} p_q - p_y) > 0 \), implying \((p_q - R') < 0.\)

But from (31), this in turn implies:

\[
1 - \frac{d\hat{q}_e}{dL} > 0
\]

at \( L = L_p \). So it follows that

\[
p_y e (1 - \frac{d\hat{q}_e}{dL}) < 0,
\]

i.e., the second term in (31) is negative if \( p_y < 0 \), and \( R(q) \) is strictly convex. (If \( R(q) \) is strictly concave, (29) and hence (34) have the opposite sign.)
Now the first term in (28) will be negative if

\[(\frac{1}{y_e}) \int_0^{y_e} p_q(\bar{q}_e, y') dy' \leq p_q(\bar{q}_e, y_e) \cdot \]

What is the import of condition (35)? It says that the average marginal willingness to pay for quality, over levels of consumption from 0 to \(y_e\), must not exceed the marginal willingness to pay for quality at the current or marginal level of consumption. Michael Spence [1975] encounters and discusses exactly the same condition in assessing quality choice under certainty by a monopolistic firm. For the additive demand example, (35) is satisfied with equality.

We can summarize our results by

**Theorem II:** If condition (35) holds, and \(R\) is a strictly convex function of \(q\), then the minimum quality standard chosen by a professional group or industry with downward sloping demand \((p_y < 0)\) will exceed the socially optimal level.

Note that condition (35) is sufficient but not necessary to show that professional groups will choose too restrictive standards, if \(R(q)\) is convex.

The intuition behind Theorem II is reasonably clear. In choosing \(L_p\), the professional group or industry seeks to maximize its net gains. Since price times quantity is its total revenues, it will choose \(L_p\) to affect favorably both quality and supply. As with any monopoly, extra profits can be achieved by a lower level of total supply than is socially
optimal. Since \( \frac{dy_e}{dL} = (\frac{d\sigma_e}{dL}) - 1 < 0 \) at \( L_p \) when \( R \) is convex, lowering \( L \) would have socially beneficial effects with respect to supply. But \( L_p \) also determines average quality. If all consumers value extra units of quality by the same amount, regardless of their consumption, as is the case with linear demand (10), then average and marginal values of quality will coincide, and (35) will be satisfied with equality. In this case, only the "monopoly" aspects of the \( L_p \) choice will remain, and we conclude \( L_p \) is chosen too high if \( R \) is convex, and too low if \( R \) is concave.\(^{15,16}\)

V. Quality Levels Which Are Subject to Choice

Our analysis thus far has assumed that the quality levels of individual sellers are fixed; average quality changes solely because sellers of different quality levels offer or withdraw their services according to the market price. We now turn our attention to the case where quality levels can be altered through actions by sellers. For example, the safety of a microwave oven might be increased through added shielding, or the quality of an accountant's services might be enhanced by further education in economics. Such increases in quality levels typically require further expenditures by sellers.

Two polar environments can be described. In the first, buyers have the ability to observe the actions of sellers and may thereby infer the quality level of the product. Such environments, in which uncertainty about quality is eliminated by observing a "signal," have been studied extensively by Spence (1973b) and others.
The second environment is one in which actions by sellers cannot be observed by buyers. For example, it is difficult for the average airline passenger to ascertain the level of aircraft engine maintenance, or for a housewife to observe the degree of sterilization in the bottling of milk. Because this environment retains the fundamental element of our previous analysis—asymmetric information on product quality—it is the one on which we shall focus.

Intuitively, it is clear what will happen in such markets. Any firm undertaking quality improvements will bear the full cost of those improvements. But all firms will benefit from whatever increase occurs in the average quality, and therefore price, of all goods. As the number of competing firms becomes large, the change in average quality approaches zero, and no benefits will accrue to the firm undertaking quality-improving expenditures. Thus, each firm will find the optimal level of investment in quality improvement to be zero, and our original analysis remains valid.

If the government can monitor sellers' actions, it may well want to impose minimum levels or standards that exceed those which would prevail in a free market. Indeed, many quality standards are directly addressed to specific kinds of actions, such as degrees acquired or safety devices installed.

The analysis can be formalized if we redefine quality as:

\[ Q = Q(q, E), \]

where \( q \) is original quality, and \( E \) is a nonnegative vector of actions undertaken by the seller. Associated with any action vector \( E \) is a cost:
\[ C = C(q, E) \, . \]

We shall associate larger vectors \( E \), both with higher quality and with higher cost, implying:

\[
\frac{\partial Q}{\partial E_i} > 0 ;
\]

\[
\frac{\partial C}{\partial E_i} > 0 \quad \text{for all } i .
\]

Finally, we shall assume that if no actions are undertaken, quality remains at its original level and costs are zero. Thus,

\[
Q(q, 0) = q ;
\]

\[
C(q, 0) = 0 .
\]

In an unregulated market, average quality and supply will be given by:

\[
\bar{q} = \int_0^{\hat{q}} Q[q, E^*(q)]dq/\hat{q} ;
\]

\[
y = \hat{q} ,
\]

where \( E^*(q) \) is the privately optimal action undertaken by sellers of original quality level \( q \), and \( \hat{q} \) is the index of the maximal quality seller, determined in equilibrium by:

\[
p(\bar{q}, y) = R(\hat{q}_e) + C(\hat{q}_e, E^*(\hat{q}_e)) ,
\]

with \( \bar{q} \) and \( y \) given by (38) with \( \hat{q} = \hat{q}_e \).

From (38), it can be observed that, for an individual seller (with measure zero) of quality level \( q \), \( \partial \bar{q}/\partial \bar{E}(q) = 0 \), implying:
Thus, an individual seller's actions do not affect market price. Each seller will choose $E^*(q)$ to maximize his producer's surplus:

\[(41) \quad p^*(q, y) - R(q) - C(q, E) \, .\]

But (36) and (40) imply that the derivative of (41), with respect to any $E_i$, is negative, implying $E^*(q) = 0$ for all $q$. From (37), we are back to the initial description of equilibrium, when quality was not subject to choice.

Optimal quality regulation will depend upon the regulatory agency's ability to observe $Q$ and/or $E$. Three situations are briefly considered. The first environment is where the agency monitors $Q$ only, and may require $Q$ to exceed a particular level $L$ as before. The second environment is where the government monitors $E$ only and may require $E$ to exceed a particular level $E$ for all $q$. A third environment is where the government may require both $Q$ and $E$ to exceed minimum standards.

In the first environment, it is immediately obvious that sellers whose original quality level exceeds $L$ will have no motivation to undertake quality-improving actions. Sellers with original quality level less than $L$, however, may find that it is privately optimal to improve their quality up to the standard $L$. Since private and social benefits will generally differ, it is not clear whether such quality-improving actions are socially desirable. It would appear that the introduction of quality choice by sellers could result in a socially optimal $L^*$ greater or less than the optimal level when qualities of sellers are fixed.
In the second situation, the government can set a vector of minimum action standards \( \mathbf{E} \). This environment seems consistent with a number of markets in which minimum safety standards, etc. are imposed. The socially optimal \( \mathbf{E}^* \) will exceed zero (i.e., regulation will be required) if consumers' willingness to pay for higher average quality exceeds the total costs of inducing that higher quality through standards \( \mathbf{E} \). In the case where \( W \) is concave in a scalar variable \( E \), it is easily shown that a necessary and sufficient condition for \( \mathbf{E}^* > 0 \) is that:

\[
\frac{dW}{dE}\bigg|_{E=0} = \int_0^{q_e} \left[ \frac{d\hat{q}_e}{dE} \frac{d\hat{q}_e}{dE} - \frac{dC(q, 0)}{dE} \right] dq > 0 ,
\]

where \( \hat{q}_e \) and \( \frac{d\hat{q}_e}{dE} \) are derived from (39) and (38), when \( E = 0 \) for all \( q \).

Analysis of the third situation, where the agency could regulate both \( Q \) and \( E \), is straightforward but tiresome. Examples can be constructed in which both \( E \) and \( L \) should be set at positive levels. However, if raising \( E \) is particularly costly, it may be optimal to set \( E^* = 0 \), with \( L^* > 0 \). Conversely, one can also construct examples where \( E^* > 0 \), but \( L^* = 0 \).

In sum, allowing for quality levels to be chosen by sellers extends the model but does not alter the basic nature of our results. Suboptimal quality levels continue to characterize markets with asymmetric information. Quality standards based either on the actual quality of the product or upon quality-improving actions that sellers may undertake may have a socially useful role in alleviating market failure.
VI. Licensing in Markets Where Opportunity Cost Decreases with Quality

The previous analysis has been based on the Akerlofian assumption that opportunity costs increase with the level of quality: \( R'(q) > 0 \). While this seems to describe a number of markets, other markets would appear to exhibit decreasing opportunity costs. For example, in order to enter some markets, certain (possibly nongovernment-imposed) requirements must be satisfied, such as a minimum level of education. If persons of higher quality find it easier (i.e., less expensive) to meet these requirements, we may well find that the opportunity cost of entering a market is decreasing with quality (\( R'(q) < 0 \)).

Another example in which higher prices elicit lower-quality suppliers is held to be the market for blood. At a zero price, supply comes from voluntary donors only, who typically have disease-free blood. As the price paid increases, supply increases, but quality tends to fall, as the paid donors have tended to have a higher rate of hepatitis.

Our previous analysis can readily be adapted to this situation. Let \( \hat{q} \) now denote the minimum quality seller in the market. Average quality and supply will be related to \( \hat{q} \) by:

\[
\bar{q} = \frac{(1 + \hat{q})}{2} ;
\]

\[
y = (1 - \hat{q}) .
\]

The market equilibrium \( \hat{q}_e \) will be determined by the equivalent of (7),

\[
p[(1 + \hat{q}_e)/2, 1 - \hat{q}_e] = R(\hat{q}_e) .
\]
Welfare is given by:

\[
W(\hat{q}) = \int_0^{1-\hat{q}} p[(1+\hat{q})/2, q]dq - \int_{\hat{q}}^1 R(q)dq ;
\]

and

\[
\frac{dW}{dq} \bigg|_{q=\hat{q}_e} = \int_0^{1-\hat{q}_e} \frac{1}{2} p_\hat{q}(q, q) dq > 0 ,
\]

using (45). As before, we find that \( \hat{q}_e \) is below the socially optimal level: there is an underprovision of quality in the market equilibrium. But in contrast with the case where \( R'(q) > 0 \), we find that the market equilibrium supply is greater than optimal.

Licensing again is introduced by a standard \( L \). The optimal level of licensing is the \( L^* \) which maximizes (46), with \( L \) replacing \( \hat{q} \).

From (47), it follows that \( \hat{q}_e > \hat{q}_e \): \textit{Licensing will always be desirable.}

We also see that, in contrast with the \( R'(q) > 0 \) case,

a) a first-best optimum can be achieved by licensing, and

b) licensing always results in a smaller supply.

Note that the persons who are eliminated by the imposition of a licensing standard are those with high opportunity costs. Since these people have an opportunity cost that exceeds their marginal social benefit, the case for licensing (rather than simple certification) seems stronger here than when \( R'(q) > 0 \), and the persons eliminated by licensing have low opportunity costs.18

Finally, we observe that because licensing always restricts supply in markets where \( -R'(q) < 0 \), it follows that professional groups will
gain from setting licensing standards that are high. Of course, whether (35) holds remains ambiguous, so it will not always follow that licensing standards set by groups will be too restrictive. But as the demand for the product becomes relatively inelastic \((p_y << 0)\), the monopoly effect will tend to dominate, and the group will be led to set licensing standards above those that are socially optimal.

In sum, the case for licensing seems considerably stronger for markets in which increasing price attracts lower- rather than higher-quality suppliers. And it should be noted that alternative approaches to licensing that may be effective when opportunity costs increase, such as two-part tariffs or random licensing, are highly undesirable when opportunity costs decrease with quality.

VII. Conclusion

This paper has developed a simple model of markets with informational asymmetries between buyer and seller. Sellers are assumed to know more about the quality of the product than buyers, a situation that seems to characterize a number of important markets. Our principal conclusions have been:

1) Markets with informational asymmetries reach equilibrium at suboptimal quality levels. There is an under- or oversupply of goods relative to the social optimum, depending upon whether opportunity costs increase or decrease with the sellers' quality level.
2) Minimum quality standards in such markets may be socially desirable. They will always be desirable when opportunity costs decrease with suppliers' quality level. When opportunity costs increase, markets that are most likely to benefit from minimum quality standards are those that exhibit relatively inelastic demand, have high demand sensitivity to average quality, have low costs associated with providing quality, and exhibit low willingness to pay for goods or services of the lowest quality level.

3) If a professional group or industry is allowed to set minimum quality standards (self-regulation), these standards may be set too high or too low. On balance, however, there is some reason to expect too high standards to be the more likely case.

4) Two-part tariffs or random licensing may be desirable in markets with increasing seller opportunity costs.

We should reiterate that our analysis has been conducted within a limited scope. We have focused on one possible form ofremedying market failure: the imposition of minimum quality standards. There are a number of alternatives, some of which have been mentioned briefly. These include certification rather than licensing, seller liability, two-part tariffs, and random licensing rather than licensing based on quality. We are not comparing licensing to these alternatives; rather, we are asking: If the government has the ability to license, should it use this ability? We have concentrated our study on minimum quality standards simply because they are so much in evidence. Comparison with alternative schemes must await further analysis.
It should also be noted that our model leaps to extremes that are uncharacteristic of most real markets. Consumers almost always have some knowledge of the quality of the service or product they are buying, either from past experience, word of mouth, seller "signalling," or whatever. Clearly, such partial information on the part of consumers reduces the degree of information asymmetry. But some asymmetry is bound to remain in certain markets. I suspect, but have not proved, that as long as some asymmetry exists, the nature (if not the extent) of our results will continue to hold.

A final and important question we have not directly addressed is the competitive supply of information. We have assumed that the "machine" that sorts above-L from below-L sellers is controlled either by a regulatory agency or by the profession itself. But would a private market using such a machine provide an optimal degree of sorting? We cannot offer a definitive analysis. But work by Arrow (1971), Hirschleifer (1971), and Stiglitz (1974) casts doubt on the efficiency of information provision by private markets. Even if sorting mechanisms do not exhibit increasing returns to scale (as most types of testing would seem to do), it is unlikely that optimal sorting will occur in a competitive equilibrium. Because of the public-good aspect of information, efficiency would require that sellers bear the costs of sorting. But an incentive problem exists when certification is sold to producers. Producers clearly can make higher profits if their goods are certified of higher quality. Some of these extra profits could be passed along to certifiers. Unless there is a certifier of certifiers, excess profits will be available in the short
run by diverging from "honest ratings." Excess profits may be eliminated when the market discovers (and discounts) exaggerated ratings. But further exaggerations may then occur, placing the existence of a sorting equilibrium in doubt. It is of interest to note that, in this environment, only information-providing firms that make excess profits while providing correct information will have a motive to maintain a long-term "reputation."
FOOTNOTES

1 See, for example, Moore [1961], Friedman [1962], Stigler [1971], and the review article by Posner [1974]. It is interesting to note that licensing serves many of the same purposes that apprenticeship did for centuries before: see Pirenne [1937].

2 If patients cannot distinguish the quality of doctors, they will view doctors as perfect substitutes, and all must command the same fees. Of course, our model makes an extreme assumption: presumably, patients in the real world can make partial inferences about doctors' quality by observing degrees framed on the wall, word of mouth, malpractice records, etc.

3 If there were no independent verification or regulation of product labeling, it is not clear that it would eliminate information asymmetries, since it may not be in the sellers' interests to be honest about their products. Darby and Karni [1973] consider fraud in a somewhat different context.


5 Consistent with Akerlof's example, we are taking the potential supply of services or goods at each quality level as given. This supply is either offered for sale or not, depending on the market price. In section V, we consider the effects of quality depending upon decisions by sellers.

6 By redefining \( q = F(q)/F(q_{\text{h}}) \).

7 The analysis could be generalized to the case where expected opportunity costs increase with \( q \), with the expectation taken over sellers of quality level \( q \).

8 More generally, a "certainty equivalent" measure could be used instead of the mean \( \bar{q} \) if the market dislikes risk. As long as this function is increasing in \( \bar{q} \) (and in \( L \) of the next section), our results will continue to hold.

9 As Weiss [1976], Stiglitz [1976], and Stiglitz and Weiss [1978] have recently pointed out, market equilibrium with asymmetric information need not have supply equaling demand. There are, however, a number of environments consistent with our (normal) equilibrium concept, and
we shall limit ourselves to these situations. The simplest case is where buyers presume the population of sellers to be fixed (invariant to prices) in the short run, even though the population of sellers may depend upon prices in the long run.

10 More generally, recognizing \( q \in [0,1] \),

\[
q_e = \max \left\{ \min \left[ \left( \frac{8/2 - \gamma}{2\delta} + \sqrt{\frac{(8/2 - \gamma)^2 + 4\alpha \delta}{2\delta}} \right), 1 \right], 0 \right\}.
\]

11 Experimenting with the example (10), it can be shown that both consumers and producers will benefit only when demand is extremely inelastic \((\gamma > 0)\). If \( \beta > \gamma \), then consumers' surplus will actually be negative at the optimal two-part price, indicating that some subsidization of insurance would be needed if consumers were to participate.

12 This assures that derivatives will point toward the optimal \( L \). While concavity is satisfied for the linear case (10), it remains open as to whether it has empirical validity.

13 It should be noted that, even if licensing is socially desirable, it cannot be a "first best" solution to the problem when opportunity costs increase in \( q \). This is because, even with licensing, the marginal seller will continue to compare a price reflecting average (not above-average) quality with opportunity costs.

14 The logic behind licensing in this case can be used to show that even random licensing, which eliminates a proportion of sellers of all quality levels, may be desirable. Such a supply restriction will raise price and attract new entrants of higher quality. There are circumstances in which such a licensing procedure may be more desirable than eliminating the worst-quality sellers, when opportunity costs increase with \( q \). And it should be noted that such a licensing procedure does not require additional information (sorting ability) on the part of the regulatory agency.

15 Note \( R(q) \) is the cost function associated with the transformed quality index. If \( R \) were convex in the original index, and \( df(q)/dq < 0 \), the transformed cost function will also be convex. The condition \( df/dq < 0 \) can be interpreted as "a good man is hard to find."

16 To the extent that the "higher quality" practitioners of a profession tend to dominate group decisions, one might suspect that group preferences would be toward even stricter quality standards, since the
newly displaced group members would have little influence and the upper echelon would benefit.

17 Note the similarity between this result and the "Prisoners' Dilemma." Akerlof also alludes to this similarity, and Heal [1976] considers an extension to the case of repeat sales.

18 Of course, licensing may be preferred to certification in either the increasing or decreasing opportunity case if it is difficult or impossible to communicate quality information to the public. For example, a drug which has complicated side effects might better be banned than offered for sale carrying a technical warning label, if consumers cannot properly assess the warning.

19 Heal [1976] formalizes the point that, if there are repeat sales, the Akerlof problem will be reduced.

20 It has been suggested that bond-rating agencies, whose services are paid by the issuers of bonds, fit this description. Indeed, it could be argued that some degree of monopoly power in markets with asymmetric information may be desirable, in that sellers will then perceive price to depend upon their quality decisions.
REFERENCES


