WORKING
PAPERS

# ADVERTISING AND PRODUCT QUALITY:

# THE ROLE OF THE BONDING CHARACTERISTICS OF ADVERTISING

Pauline M. Ippolito

WORKING PAPER NO. 148

December 1986



BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

# ADVERTISING AND PRODUCT QUALITY

## The Role of the Bonding Characteristics of Advertising

Pauline M. Ippolito

Federal Trade Commission

Draft - February 1986
Revised - December 1986

**ABSTRACT**

This paper is about advertising and advertising's potential to fill a quality assurance role. The durability of advertising and the sensitivity of that durability to cheating are fundamental to advertising's potential as a quality signal. This is true because these features directly affect advertising's ability to "bond" performance, and bonding is a more efficient signalling mechanism than simple conspicuous expenditures. The price premium received by high quality sellers depends on advertising's strength as a bonding instrument. As a result, this price premium cannot be inferred independently of the signal used by consumers to separate different quality sellers. The difference between bonding and non-bonding signals helps to explain the literature's widely divergent results on the cost conditions under which advertising can indicate hidden quality.

# I. INTRODUCTION

When consumers cannot observe quality at purchase, firms may be tempted to provide less than promised. Yet such high quality products are routinely sold in markets that do not seem to be rife with unfulfilled promises. Somehow market mechanisms must help to discipline firms.

This paper is about advertising and how advertising can sometimes assure product quality. For consumers to rely on advertising, advertisers must find it more profitable to provide the promised quality than to cheat. The conditions under which this will hold are not well understood. In this paper I argue that there is a single fundamental force that underlies advertising's potential as a quality signal: advertising has the capacity to "bond" performance. It is the strength of this bonding ability that determines when and where advertising will be used as a quality signal.

Bonding occurs when some asset or wealth is forfeited under specified conditions. It has long been recognized as a potential solution to information problems where performance can be judged after the fact.[1] For bonding to be effective, market conditions must allow firms to acquire a bond that is sufficiently large to alter the incentives to cheat. Though it is the basis for many of the solutions that have been proposed, there has been little explicit development of the role of bonding in assuring product quality. This has contributed to the development of disconnected and often conflicting predictions for market behavior.

The traditional treatment of advertising in the literature

(though not in the signalling literature) is as a stock that decays with time and is replenished by current expenditures. That view is adopted here with one adjustment: the rate at which advertising decays is allowed to depend on whether the firm supplies the promised level of quality.[2] These features provide the essential elements of a bonding instrument. The differential decay in the event of cheating is the performance "bond". The normal decay if the firm provides the promised quality is the primary cost of that bond. Advertising can signal quality under the conditions necessary for any effective bonding: firms must be able to advertise enough to get the required "bond" at a cost that does not eliminate the demand for higher quality goods.

Many previous papers on advertising's role in assuring product quality can be framed as special cases of the model here (for example, Nelson (1970, 1974), Schmalensee (1978), Klein and Leffler (1981), and Kihlstrom and Riordan (1984)). Their assumptions about advertising's bonding effects fundamentally determine their findings. For instance, Klein and Leffler's result that signalling equilibria exist under most market conditions follows from their assumptions that make advertising a perfect bonding signal. Kihlstrom and Riordan's contrary result that equilibria exist only under very special market conditions follows from their assumptions that ensure that advertising has no bonding potential. Schmalensee's intermediate results follow from his assumptions that create some bonding characteristics for advertising.

The roles of price premiums and quality-specific sunk costs in assuring quality are also clarified by recognition of the

bonding nature of signals. In particular, prices above minimum average production costs do not in themselves assure quality. Price premiums do create incentives for high quality sellers to maintain quality, but they do nothing to dissuade low quality sellers from claiming to be high quality sellers. In this setting, consumers are assured of high quality only through the firm's "posting of a bond," that is, through the acquisition of visible non-salvagable assets. A quality-related price premium is the necessary result of this "bond." This price premium is determined by the cost of acquiring and maintaining the necessary assets and is at least as large as the price premium described by Klein and Leffler.

Advertising is not necessarily the best market device to assure that quality promises are kept. It must be compared with other potential signals such as specialized production assets (Klein and Leffler (1981)), differentially costly activities, like warranties (Spence (1974)) or other conspicuous expenditures. In particular, introductory pricing or other cash giveaways can play the same role as advertising in previous signalling models and can be constructed to be Pareto superior to advertising in these analyses. This is not so in a bonding model: non-advertising expenditures may not be as noticable or as memorable as advertising, and hence, advertising may be the preferred signalling device. Contrary to past work, the bonding model suggests that even if advertising is playing a purely signalling role, firms should engage in ongoing as well as introductory advertising, and they should demonstrate an active

concern for the execution and content of their advertising.

In short, advertising is like any conspicuous expenditure that is available to all at equal cost. It can serve as a signal only if it "bonds" performance. And the cost of using it as a signal depends exclusively on its effectiveness as a bonding instrument.

## II. ADVERTISING EQUILIBRIUM

### A. THE BASIC MODEL

The model adopted here has a variety of special features designed to focus attention on the intertemporal nature of the problem and on the role of cost and demand conditions.[3]

There are assumed to be only two possible quality levels of the good, high and low. Consumers have no direct information about the quality of competing brands or about the underlying costs of the firms.

Firms have an infinite horizon[4] and can costlessly change their quality choices at the start of each period. Thus, in this model firms can provide high quality goods for some time and then switch to low quality.[5]

The production of goods requires a fixed cost $F_q$ in each period where q = L or H for low and high quality goods. The fixed cost is incurred at the start of the period.

The technology to produce quality q goods is represented by the variable cost function C(.,q). Storage is assumed to be impossible, so C(.,q) represents the variable cost per period of producing q-quality goods.

Marginal costs are assumed positive and increasing, so $C_x > 0$ and $C_{xx} > 0$. Since C represents variable costs, C(0,q) = 0. All firms are assumed to have access to the same production technology.

In each period consumers are assumed to observe a stock of advertising that depreciates at a rate that depends on whether the firm honors its promises. While there are a variety of

behavioral assumptions that could be structured in this way, it is intuitively helpful to focus on one such model. Suppose advertising is observed and remembered by consumers, but some portion of this accumulated memory is forgotten each period. Then consumers can be treated as observing an advertising stock that decays. Moreover, if cheating by the firm causes negative information to enter the market which to some extent counters the favorable impression created by the advertising stock, then consumers can be treated as further depreciating their assessment of the advertising stock.

These two simple forces -- that there is an accumulated memory of advertising that fades and that negative information affects that perception -- are sufficient to justify a model where consumers "observe" an advertising stock that decays at a rate that depends on the firm's quality performance.

There is the potential for a high quality market and a low quality market in each period. In an advertising equilibrium a firm can enter the high quality market only if it has a sufficiently large advertising stock; otherwise, it operates in the low quality market.

The advertising stock at the beginning of period t is $a_t + A_{t-1}$ where $a_t$ is the advertising expenditure in period t (assumed to occur at the start of the period) and $A_{t-1}$ is the stock of advertising remaining from past expenditures.

The advertising stock is assumed to decay. If the firm offers the expected quality in period t, then its advertising stock $A_t$ at the end of period t is determined by some survival function s, so

$$A_t = s(A_{t-1} + a_t).$$

If the firm cheats consumers (that is, has an advertising stock large enough to indicate that it is a high quality producer, but then delivers low quality), its stock is also assumed to depreciate but according to the survival function s' which will typically reflect a greater reduction in the value of the advertising stock; thus, when the firm cheats, the advertising stock at the end of period t is

$$A_t = s'(A_{t-1} + a_t)$$

where $s'(A) \leq s(A)$ for all advertising levels A. The survival functions are assumed to be nonnegative, and their derivatives are positive and bounded by one; that is, $0 \leq s_A(A), s_A'(A) \leq 1$. Also, the extra decay attributed to cheating $s(A) - s'(A)$ is assumed to be increasing with A, that is, $d(s(A) - s'(A))/dA \geq 0$.

Maintaining a sufficiently large advertising stock is the "entry fee" into the high quality market in each period, but there is nothing in these assumptions that rules out firms gaining a reputation through advertising and then cheating to collect a short term profit.

Each market is competitive in that firms are price-takers and prices clear markets. Entry in any period occurs until expected profits are zero. Firms are assumed to be on a continuum so that there are no integer constraints on entry.

The demand conditions in the market are simple. There are two types of buyers. Potential buyers in the high quality market

are willing to pay a premium h to get high quality rather than low quality. Low quality buyers are not willing to pay any premium for high quality. There are $m_M$ high quality buyers and the $m_L$ low quality buyers, each of whom will buy one unit in equilibrium.

The advertising equilibrium in this model can now be described. In each period t, firms maximize profits (given a quality choice q) by producing a quantity x that equates marginal cost with the price p they will receive for their recognized level of quality. Thus, the quantity produced x(p,q) satisfies

$$p = C_x(x(p,q),q). \tag{1}$$

In the low quality market, equilibrium is achieved when profits from entry are zero. Since fixed costs are per period costs, this condition is satisfied when profits are zero in each period; thus, the price $p_L$ for low quality goods must satisfy

$$O(p_L,L) - F_L = 0 \tag{2}$$

where $O(p_L,L)$ is the maximized value of per period profits gross of fixed costs; namely, for quality q,

$$O(p,q) = px(p,q) - C(x(p,q),q). \tag{3}$$

In this model sellers in the low quality market never advertise because by assumption quality is known to be at least this high.

In the high quality market, the firm's actions in any period affect its profits in that period as well as its stock of advertising for the next period. The equilibrium price in the high quality market $p_H$ is again determined by a zero profits

entry condition. Firms consistently providing high quality products and earning zero profits must receive a price $p_H$ that covers average production costs and the cost of advertising; that is, $p_H$ must satisfy

$$O(p_H,H) - F_H - A + s(A)/(1+r) = 0 \qquad (4)$$

where $A = A_{t-1} + a_t$ is the value of the advertising stock at the beginning of the period and r is the interest rate. Note that the advertising cost is simply the sum of the opportunity cost of the advertising stock plus the depreciation; that is,

$$A - s(A)/(1+r) = rA/(1+r) + (A-s(A))/(1+r).$$

In equilibrium, the required advertising stock level for entry into the high quality market must be high enough so that firms selling in that market do not find it profitable to cheat by providing low quality products at the high quality price; that is, for each period t, the advertising stock $A = A_{t-1} + a_t$ must be such that

$$O(p_H,L) - F_L - A + s'(A)/(1+r) \leq 0. \qquad (5)$$

Intuitively, this is simply the requirement that the loss of the advertising stock's value must be greater than the short term gain from cheating.

Finally, it cannot be more profitable for high quality sellers to accept the low quality price; thus

$$O(p_L,H) - F_H < 0. \qquad (6)$$

Let $p_o$ denote the minimum average cost of production in the high quality industry; that is, $p_o$ is defined by

$$O(p_o,H) - F_H = 0.$$

Then condition (6) is simply a requirement that the minimum average cost of production for high quality exceeds that for low quality, namely, that $p_L < p_o$. Without this requirement, the market would provide high quality goods to all buyers regardless of the available information. If high quality firms advertise, the price $p_H$ will be greater than $p_o$.

An **advertising equilibrium** is a pair of prices $p_L$ and $p_H$ with $p_H > p_L$ and $p_H - p_L \leq h$ and a positive advertising stock $A = A_{t-1} + a_t$ in period t such that (2) - (6) are satisfied. In such an equilibrium, both high quality and low quality goods will be produced. High quality firms will produce $x_H(p_H,H)$ units and low quality firms will produce $x_L(p_L,L)$ units each. There will be $m_H/x(p_H,H)$ high quality firms and $m_L/x(p_L,L)$ low quality firms.

Before examining the role of the bonding characteristics of advertising, it is useful to establish two limits on the amount of advertising that might act as a signal. The first limit is imposed by consumers' willingness to pay for high quality. If $p^h = p_L + h$ denotes the maximum amount consumers are willing to pay for high quality, there is a corresponding **maximum feasible advertising level** $A^h$ beyond which signalling is not feasible; in particular, $A^h$ is the advertising level consistent with zero profits at price $p^h$ for high quality producers, given by

$$O(p^h,H) - F_H - A^h + s(A^h)/(1+r) = 0.$$

Note that the more durable advertising is for high quality firms (that is, the closer s(A) is to A), the larger this maximum feasible amount of advertising.

At the other extreme, the equilibrium amount of advertising must be large enough to dissuade low quality firms from advertising. Since it is assumed that minimum average production cost is lower for low quality producers than for high quality, low quality sellers could profitably advertise at low levels of advertising.[6]

Let $\underline{A}$ denote the **minimum feasible advertising level**, that is, the highest level below which advertising could not serve as a signal of quality, because low quality firms could match high quality firms' advertising. $\underline{A}$ therefore satisfies

$$O(p_H,L) - F_L - A + s'(A)/(1+r) > 0 \text{ for all } A < \underline{A}$$

and
$$O(\underline{p},L) - F_L - \underline{A} + s'(\underline{A})/(1+r) = 0 \qquad (7)$$

if $\underline{A}$ is finite where $\underline{p}$ corresponds to $\underline{A}$ by (4). If low quality sellers can always profitably advertise, let $\underline{A} = \infty$. Notice that the minimum advertising level $\underline{A}$ is lower, the less durable advertising is in the event of cheating (that is, the closer s'(A) is to 0).

The thresholds $\underline{A}$ and $A^h$ provide bounds on the levels of advertising for which signalling is feasible. Obviously, if the minimum advertising level necessary to discipline low quality sellers $\underline{A}$ is greater than the maximum feasible amount of advertising $A^h$, there is no advertising equilibrium. More

importantly though, these thresholds suggest the fundamental factors that increase advertising's ability to signal quality: the durability of advertising for high quality sellers (which increases $A^h$ through condition (6)) and the reduction in durability for those who deceptively provide low quality products (which reduces $A$ through condition (7)). These are the issues explored in the next section.

## B. THE BONDING CHARACTERISTICS OF ADVERTISING: CONDITIONS FOR EQUILIBRIUM

### Terminology

To understand the relationship between advertising's durability and its ability to indicate quality, it is convenient to view advertising in terms of its "bonding" potential. A perfect bonding signal is defined as a signal that retains its full value in the future for high quality sellers who perform as promised but loses its value completely for those who do not. In this case, the full value of the signal acts as a "bond." In the model, advertising is a perfect bonding signal if it does not decay for high quality sellers who honor their promises, but decays completely for those who cheat; that is, $s(A) = A$ but $s'(A) = 0$.

In contrast, a non-bonding signal is defined as a signal whose future value is not contingent on performance. In this case, the signal has no "bonding" effect, that is, none of the signal's value is at stake if the firm cheats. In the model, the durability of advertising would be independent of whether the firm provides high or low quality; this advertising is characterized by $s(A) = s'(A)$ for all A.

Thus, advertising can be a perfect bonding signal if there is no natural decay in the advertising stock and any cheating is known immediately by all consumers. Advertising can be a non-bonding signal if advertising has no durability or if cheating is never discovered by consumers.

Between these two extremes are partially bonding signals,

defined as signals whose future value is contingent on performance, but the incremental value lost if the firm cheats is less than the full advertising stock. There are two important factors that determine a signal's effectiveness in these intermediate cases. First is the portion of the signal that is at stake if the firm cheats; this bonding portion of the advertising is the incremental depreciation $s(A) - s'(A)$ for advertisers with a stock A who cheat. The second factor is the cost of this bond for high quality firms, that is, the sum of the opportunity value of the advertising stock $rA/(1+r)$ and the natural depreciation in the signal's value if the firm does not cheat $(A-s(A))/(1+r)$.

It is convenient to define the bonding effect of a signal at price $p_H$ as the amount of the signal at risk if the firm cheats. Thus, advertising has greater bonding effect at price $p_H$ if the corresponding advertising at risk $s(A) - s'(A)$ is greater, other things equal, where A is the amount of advertising determined by $p_H$ through equation (4). Obviously, the bonding portion of the advertising can vary between 0 and A depending on the durability of advertising for high quality sellers relative to that for low quality sellers.

The Bonding Characteristics of Advertising and Signalling

We can now address the role of the bonding characteristics of advertising on its ability to signal quality. Qualitatively, the fundamental relationship is simple: the greater the bonding effect of advertising in the relevant price range, the greater the range of cost conditions[7] for which advertising equilibria exist.

To establish this result, it suffices to show that whenever an advertising equilibrium exists for particular market conditions, an advertising equilibrium would also exist if advertising had a greater bonding effect at the high quality price. More precisely, suppose $(p_L, p_H, A^a)$ is an advertising equilibrium for cost conditions $C = (C(x,L), F_L; C(x,H), F_H)$ and advertising characterized by durability functions $s^a(A)$ and $s^{a'}(A)$. Suppose also that the durability functions $s^b(A)$ and $s^{b'}(A)$ represent advertising with a greater bonding effect at $p_H$; then the advertising $A^b$ corresponding to $p_H$ in this case is defined by

$$O(p_H,H) - F_H - A^b + s^b(A^b)/(1+r) = 0, \qquad (8)$$

and by definition its greater bonding effect at $p_H$ requires that

$$s^a(A^a) - s^{a'}(A^a) \leq s^b(A^b) - s^{b'}(A^b). \qquad (9)$$

It suffices to show that $(p_L, p_H, A^b)$ is an advertising equilibrium for advertising characterized by the durability functions $s^b$ and $s^{b'}$. Clearly conditions (2), (4) and (6) are satisfied by definition of $p_L$, $p_H$ and $A^b$. Thus, it remains to show that condition (5) holds for the durability function $s^{b'}$. Using the definition of $A^b$ from (8), the greater bonding effect from (9), and properties (4) and (5) of the equilibrium $(p_L, p_H, A^a)$, we have

$$\begin{aligned} O(p_H,L) - F_L - A^b + s^{b'}(A^b)/(1+r) &= O(p_H,L) - F_L - O(p_H,H) \\ &\quad + F_H + (s^{b'}(A^b) - s^b(A^b))/(1+r) \\ &\leq O(p_H,L) - F_L - O(p_H,H) + F_H \end{aligned}$$

$$+ (s^{a'}(A^a) - s^a(A^a))/(1+r)$$

$$= O(p_H,L) - F_L - A^a + s^{a'}(A^a)/(1+r)$$

$$\leq 0.$$

This establishes condition (5) for $s^{b'}$. So, $(p_L,p_H,A^b)$ is an advertising equilibrium for advertising with durability $s^b$ and $s^{b'}$. This establishes the basic relationship: the greater the bonding effect of advertising in the relevant price range, the larger the set of cost conditions for which advertising equilibria exist.

While this analysis demonstrates that the bonding nature of advertising is directly related to the range of market conditions that will support an advertising equilibrium, it does not indicate the strength of this relationship. Before giving the general relationship, this can be clarified by considering the extreme cases of advertising that acts as a non-bonding signal and as a perfect bonding signal.

Equilibrium Requirements When Advertising Is a Non-Bonding Signal

Consider first the case where advertising is a non-bonding signal in the relevant price range, that is, where $s(A) = s'(A)$ for all advertising levels $0 \leq A \leq A^h$. In this case it is easy to show that there is no advertising equilibrium if the marginal cost of high quality goods is greater than the marginal cost of low quality goods in the relevant price range. To see this, note that at any advertising equilibrium, conditions (4) and (5) must be satisfied; so the cost conditions must satisfy

$$O(p_H,L) - F_L \leq O(p_H,H) - F_H. \qquad (10)$$

Intuitively, condition (10) is simply the requirement that when advertising has no bonding effect, revenues net of production costs must be lower for low quality goods than for high quality goods at an advertising equilibrium. Otherwise, low quality sellers could match advertising by high quality sellers and earn profits by cheating.

Figure 1 illustrates this result in the case where the marginal costs of production are higher for high quality products than for low quality products in the relevant price range. The single hatched area above $p_L$ ((A) + (B) + (C)) is the revenue net of production costs for dishonest low quality sellers at price $p_H$ (that is, $O(p_H,L) - F_L$), and the cross-hatched area (A) is the revenue net of production costs for high quality sellers (that is, $O(p_H,H) - F_H$). For an advertising equilibrium to exist, condition (10) requires that the area (A) + (B) + (C) must be less than the area (A). But this is impossible, because the areas (B) and (C) are positive for these cost conditions. Thus, if high quality products have a higher marginal cost of production than low quality products in this case, there can be no advertising equilibrium.

Where advertising has no bonding effect then, advertising will not signal quality for a large class of cost conditions, including the most usual cost conditions. This is essentially the Kihlstrom-Riordan result generalized to the case where quality choices by the firm are not fixed. If advertising functions only in a non-bonding way, the potential for advertising to act as a signal of quality is quite limited.

Equilibrium Requirements When Advertising Is a Perfect Bonding Signal

In contrast consider the other extreme where advertising is a perfect bonding signal; that is, where $s(A) = A$ and $s'(A) = 0$. In this case advertising equilibria will exist under very general cost conditions. To see this, for any particular cost conditions, consider the potential equilibrium $(p_L, p_H, A)$ where $p_L$ is defined by condition (2), $p_H$ is any price in $(p_o, p^h]$, and A is the corresponding advertising level as defined by condition (4). Then $(p_L, p_H, A)$ will be an advertising equilibrium as long as condition (5) is satisfied; thus, the advertising must satisfy

$$O(p_H, H) - F_H - (r/1+r)A = 0 \qquad (4')$$

$$O(p_H, L) - F_L - A \leq 0. \qquad (5')$$

These conditions will hold as long as low quality sellers do not have such a large cost advantage that they can profitably absorb the full advertising expense A (from (5')) while high quality sellers only absorb the opportunity cost of the advertising expense $(r/1+r)A$ (from (4')). At prices $p_H$ near $p_o$, of course, low quality sellers will have such a cost advantage, since $p_L < p_o$ (see footnote 6). But this cost advantage would have to persist at every price $p_H$ in $(p_o, p^h]$. As long as consumers are willing to pay a non-trivial premium for high quality, this will not be the case for a very broad range of cost conditions.

In the case illustrated in figure 1, for instance, conditions (4') and (5') require that

$$r[(B) + (C)] \leq (A)$$

where (A), (B) and (C) are the areas marked on the figure. This condition will hold unless the low quality cost advantage represented by areas (B) and (C) is greater than the discounted advertising stock value represented by area (A)/r.

For advertising that has a full bonding effect, then, the potential for advertising to signal quality is much greater. The bonding effect of the advertising gives high quality sellers a substantial cost advantage in advertising, which allows them to cover their production cost disadvantage under a wide variety of circumstances.[8]

Equilibrium Conditions For the General Case

These results for the extreme cases of advertising that is a perfect bonding or a non-bonding signal are special cases of the following proposition that gives necessary and sufficient conditions for the existence of advertising equilibria.

**PROPOSITION.** (Conditions for Advertising Equilibria) Assume that the minimum average production cost for low quality goods is less than for high quality goods, that is, $p_L < p_o$ where $p_L$ is defined by condition (2).

(1) An advertising equilibrium $(p_L, p_H, A)$ exists if and only if there is a price $p_H$ in $(p_o, p^h]$ at which low quality sellers do not have a production cost advantage sufficient to cover the corresponding "bonding advertising" $[s(A) - s'(A)]/(1+r)$.

More precisely, an advertising equilibrium exists if and only if there is a price $p_H$ in $(p_o, p^h]$ at which the cost

conditions satisfy

$$[O(p_H,L) - F_L] - [O(p_H,H) - F_H] \leq [s(A)-s'(A)]/(1+r) \quad (11)$$

where the amount of advertising A is determined by equation (4) for price $p_H$.

(2) $(p_L,p_H,A)$ is an advertising equilibrium if and only if $p_H$ is a price in $(p_o,p^h]$ at which the cost conditions satisfy (11), $p_L$ is defined by condition (2), and A is defined by condition (4).

(3) An advertising equilibrium exists if and only if the minimum feasible advertising level $\underline{A}$ is less than the maximum feasible advertising level $A^h$ (or equivalently, if and only if $\underline{p} \leq p^h$).

PROOF: See Appendix.

The fundamental criterion that determines whether advertising can signal quality is given by condition (11). It requires that at feasible prices the production cost advantage[9] of low quality sellers (left side of equation (11)) is less than the bonding portion of the corresponding advertising (right side of equation (11)). This is a very natural condition, since the bonding portion of the advertising is what gives high quality sellers a cost advantage over low quality sellers. Intuitively, for advertising to signal quality, the production cost advantage of low quality sellers cannot be large enough to dominate the advertising cost advantage of high quality sellers at all feasible prices. If it is, advertising cannot signal quality.

This result follows directly from the essential difference

between bonding and non-bonding signals. In all cases, signals can survive maximizing behavior only if signalling agents have a cost (or productivity) advantage that allows them to spend resources on a signal that other agents find uneconomic to match. Since advertising can be purchased by all at equal prices, this cost advantage cannot come from the actual purchase of the signal (unlike the typical Spence (1974) signal). Thus, for non-bonding advertising, this differential cost requirement transfers directly to the underlying cost conditions: conspicuous expenditures that are insensitive to performance can serve as signals only to the extent that signalling agents have a production cost advantage compared to other agents. For even partially bonding advertising, however, the differential cost requirement does not pass through as directly to the underlying cost conditions: the bonding portion of the signal itself creates a cost differential, since the cost of the signal is then contingent on the agent's performance.[10]

## Solutions Under Special Cost Conditions

The conditions under which advertising can signal quality thus depend inherently on advertising's bonding effect. To appreciate this relationship in terms of the underlying cost conditions, it is instructive to consider some special cases in more detail.

### CASE 1. High Quality Goods Have a Higher Marginal Production Cost.

Consider first the case that is probably of most empirical

importance, where high quality products have a higher marginal cost of production than low quality products, that is, where $C_x(x,H) > C_x(x,L)$ at all output levels x associated with prices in $(p_o,p^h]$. This is the case shown in figure 1. According to the proposition above, advertising can signal quality if there is some price $p_H$ in $(p_o,p^h]$ at which condition (11) is satisfied. This requires that the production cost advantage of low quality sellers be less than the value of the bonding portion of the advertising at this price.

In terms of the areas in figure 1, the areas (B) plus (C) represent the production cost advantage of low quality sellers; that is, the revenues net of production costs that low quality sellers get above those of high quality sellers if both sell at price $p_H$. So advertising can signal quality if (and only if) there is some price $p_H$ in $(p_o,p^h]$ at which

$$(B) + (C) \leq \text{Bonding Advertising} = [s(A) - s'(A)]/(1+r)$$

where A corresponds to $p_H$ through (4).

Obviously, if advertising has no bonding effect ($s(A) - s'(A) = 0$), there is no price at which this relationship will hold, since the areas (B) and (C) are positive at all prices in $(p_o,p^h]$. Thus, as shown above, advertising that has no bonding effect cannot signal quality in this case.

Even if advertising has some bonding effect, however, this effect may not be large enough for advertising to indicate quality. The amount of bonding advertising is limited by consumers' willingness to pay for high quality; thus, the maximum amount of bonding advertising that is feasible is $[s(A^h) -$

$s'(A^h)]/(1+r)$. Certainly if low quality sellers' cost advantage at $p_o$ is greater than this amount, advertising cannot signal quality.

More generally at price $p_o$, there can be no advertising, so there is no bonding advertising at $p^o$; thus, (B) + (C) > bonding advertising at $p_o$. At higher prices, the amount of bonding advertising increases, so potentially[11] there is a price threshold at which (B) + (C) is equal to the corresponding amount of bonding advertising. This price threshold is the price $\underline{p}$ necessary to generate the minimum amount of advertising $\underline{A}$ that low quality sellers find uneconomic to match. If $\underline{p} < p^h$, advertising equilibria exist. There is nothing in the assumptions here to guarantee that advertising can also signal quality at all prices in $(\underline{p},p^h]$. This depends on the increase in the bonding portion of the advertising relative to the increase in the low quality cost advantage at prices in $(\underline{p},p^h]$.

In the case where high quality products have a higher marginal cost of production then, advertising can signal quality only if the bonding effect of advertising is sufficient to dominate the production cost advantage of low quality sellers.

CASE 2. Low Quality Goods Have a Higher Marginal Production Cost.

Consider instead the case where low quality products have a higher marginal cost of production; that is, $C_x(x,L) > C_x(x,H)$ in the relevant range. Since the problem is of interest only if the minimum average production cost for low quality is below that for high quality, recall that we have assumed that $p_L < p_o$. Note in

particular that this implies that low quality goods have a lower fixed cost of production. This is the case illustrated in figure 2.

In terms of the areas in figure 2, at price $p_H$ the revenue net of production costs for low quality sellers is the sum of areas (A) and (B); for high quality sellers it is the sum of areas (A) and (C). Thus, the production cost advantage for low quality sellers is (B) - (C).

For an advertising equilibrium to exist, then, from condition (11) there must be a price $p_H$ in $(p_o, p^h]$ at which

$$(B) - (C) \leq \text{Bonding Advertising.}$$

The amount of bonding advertising is monotonically nondecreasing with price $p_H$ under our assumptions, beginning at zero at price $p_o$. The corresponding low quality cost advantage (B) - (C) is monotonically decreasing with $p_H$ beginning at the positive quantity (B) at price $p_o$.[12] Thus, there is potentially some price $\underline{p}$ at which (B) - (C) = Bonding Advertising. If $\underline{p} \leq p^h$, there are advertising equilibria at all prices $p_H$ in $[\underline{p}, p^h]$. If $\underline{p} > p^h$, there is no advertising equilibrium. In the case of advertising with no bonding effect, this price $\underline{p}$ is the price at which the variable cost advantage of high quality sellers (C) equals the fixed cost advantage of low quality sellers (B). For advertising with a bonding effect, the price threshold $\underline{p}$ is lower.

In the case where low quality products have a higher marginal production cost, then, the potential for advertising to signal quality is greater. At prices sufficiently above $p_o$, low

quality producers may have a production cost disadvantage in this case which creates the potential for high quality sellers to advertise enough that low quality sellers cannot profitably match it -- even when advertising has no bonding effect to create an advertising cost differential between them.

## C. QUALITY-ASSURING PRICE PREMIUMS AND BONDING

It is well known that in otherwise competitive markets that have imperfect quality information, high quality products will not usually be sold for minimum average production cost ($p_o$ in the model here).[13] The incentives for high quality sellers to lower quality to take the one time gain from cheating would lead to a collapse of the market at this price.

This section explores the relationship between the bonding characteristics of advertising and the size of the quality-related price premium, that is, the price premium above minimum average production cost that is received by high quality sellers. In general the greater the bonding effect of advertising, the smaller the price premium required in a signalling equilibrium.

To establish this result, recall that the minimum high quality price is the price $\underline{p}$ (defined in equation (7)). From condition (11), it is clear that $\underline{p}$ is the smallest price p for which the production cost advantage to cheating equals the present value of the bonding advertising which would be lost by cheating; that is, $\underline{p}$ is the smallest price p for which

$$[O(p,L) - F_L] - [O(p,H) - F_H] = [s(A) - s'(A)]/(1+r) \quad (12)$$

where A is the advertising that corresponds to p (defined by equation (4)). The minimum quality-related price premium is $\underline{p} - p_o$.

The bonding effects of advertising reduce the size of this price premium. This follows directly from condition (12): Let f(p) represent the production cost advantage of low quality

sellers at price p (LHS of (12)). Let g(p) represent the amount of bonding advertising possible at price p (RHS of (12)). Thus,

$$f(p) = [O(p,L) - F_L] - [O(p,H) - F_H]$$
$$g(p) = [s(A) - s'(A)]/(1+r)$$

where A corresponds to price p through condition (4). Note that $\underline{p}$ is the lowest price for which $f(\underline{p}) = g(\underline{p})$.

If the high quality price $p_H$ were equal to the minimum average production cost $p_o$ for high quality goods, no advertising would be possible. Thus, no bonding advertising is possible and $g(p_o) = 0$. Further at $p_o$, low quality sellers have a production cost advantage since by assumption, $p_L < p_o$; that is, $f(p_o) = O(p_o,L) - F_L > O(p_L,L) - F_L = 0$. So at $p_o$, the production cost advantage for deceptive low quality sellers is greater than the feasible amount of bonding advertising; that is, $f(p_o) > g(p_o)$.

Now suppose that g'(p) represents advertising with greater bonding effect; that is, $g'(p) > g(p)$ for all p in $(p_o,p^h]$. It is sufficient to show that the minimum quality-related price $\underline{p}'$ corresponding to this advertising with greater bonding effect is lower than the price $\underline{p}$ corresponding to the original advertising. By the argument above, we know that at $p_o$ the bonding effects of g'-advertising are less than the production cost advantage of low quality sellers, that is, $f(p_o) > g'(p_o) = 0$. In contrast, at $\underline{p}$ the bonding effects of g'-advertising exceed this production cost advantage since $g'(\underline{p}) > g(\underline{p}) = f(\underline{p})$. Therefore, the continuity of the functions implies that there is some price $\underline{p}'$ in $(p_o,\underline{p})$ at which $f(\underline{p}') = g'(\underline{p}')$. Thus, $\underline{p}' < \underline{p}$. This establishes that advertising with a greater bonding effect leads to a smaller

quality-related price premium.

Figures 3 and 4 illustrate this argument for the special cases considered above in figures 1 and 2: where the marginal cost for high quality goods exceeds that for low quality ($C_x(x,H) > C_x(x,L)$) and where the marginal cost for low quality exceeds that for high quality ($C_x(x,L) > C_x(x,H)$), respectively. In the figures, f(p) is the production cost advantage for low quality sellers at price p[14] and $g_i(p)$ is the bonding advertising possible at price p. Increases in the index i correspond to advertising with greater bonding effect. Note that in figure 3, for advertising with low bonding effect (represented by $g_0$ or $g_1$), there will be no minimum quality-related price, because the production cost advantage of low quality sellers always exceeds the feasible bonding advertising. In figure 4, there will always be a price that would assure quality, but it may be greater than the maximum amount consumers are willing to pay. As illustrated in the figures, as the bonding effect of advertising increases, the minimum quality-related price $\underline{p}$ falls in both cases.

Finally for the sake of comparison, it is easy to show that the minimum quality-related price $\underline{p}$ in the case where advertising is a perfect bonding signal is the Klein-Leffler quality-assuring price. In the notation here, the Klein-Leffler price is the lowest[15] price above minimum average cost that provides firms supplying high quality products with a stream of quasi-rents, the present value of which just balances the cost advantages of cheaters; that is, the lowest price that satisfies

$$\sum_{i=0}^{\infty} [O(p,H) - F_H]/(1+r)^i = [O(p,L) - F_L]. \qquad (13)$$

Note that this Klein-Leffler quality-assuring price is defined independently of the firm-specific capital investment that will assure the price. If advertising is the capital investment used, the amount of advertising necessary is given by $A = O(p,L) - F_L$. But then rearranging (13), this quality-assuring price is defined as the lowest price for which

$$A = [O(p,L) - F_L] = [(1+r)/r]\ [O(p,H) - F_H]. \qquad (14)$$

But if $(p_L, p, A)$ is an equilibrium, it must satisfy conditions (4) and (5). From (4)

$$0 = O(p,H) - F_H - A + s(A)/(1+r)$$
$$= rA/(1+r) - A + s(A)/(1+r) = s(A)/(1+r) - A/(1+r).$$

So $s(A) = A$. Similarly from (5), we have

$$O(p,L) - F_L - A + s'(A)/(1+r) = s'(A)/1+r \leq 0.$$

Since by assumption we are considering only cases where $s'(A) \geq 0$, $s'(A) = 0$. So advertising must be a perfect bonding signal if it is to assure the price specified in the Klein-Leffler analysis.

This result simply reflects the behavioral assumptions built into the Klein-Leffler analysis: that the salvage value of the firm-specific asset is zero if the firm cheats and the memory/actuality of that investment is infinitely lived if the firm is honest. In the general case where cheating is not necessarily perfectly detected by consumers or where consumers

forget past advertising or the asset otherwise decays, there is still a natural parallel between the ideas of a quality-related price defined in the advertising equilibrium here and one generated by necessary quasi-rents for high quality. However, the necessary quasi-rent stream cannot be defined independently of the durability characteristics of the asset that will inform consumers of its presence. The need to reinvest in the signal itself and the fact that the signal is not completely destroyed by cheating both act to increase the quasi-rent stream necessary to separate high from low quality sellers. These durability factors should influence the choice of asset used to signal quality.

## III. MARKET CHARACTERISTICS THAT INFLUENCE ADVERTISING'S BONDING EFFECTS

The model above focuses on the importance of advertising's relative durability for high versus low quality producers on advertising's potential as a quality signal. It deliberately abstracts from the behavioral assumptions that might underlie this durability. In this section I will briefly discuss some market features that might be captured in this durability notion.

There are a variety of factors that may affect the lasting effects of advertising for firms who provide the promised quality. For instance, characteristics of the market that influence memory loss by consumers should be important. These might include the frequency of purchase (consumers should be more attentive to advertising if currently in the market) and the dominance of the product in consumers' minds (possibly influenced by the potential loss from cheating or the cost of the product). The average length of time in the consuming group for a particular product should be positively related to durability, since it improves the memory of past advertising.[16]

The extent to which consumers are aware of all advertising by the firm should have a similar effect. For instance, success in targetting advertising to the consuming group should increase the value of advertising for each dollar spent and thus reduce the initial decay. National advertising should have more bonding ability than local advertising, since it reduces the decay inherent in consumer mobility. Finally, the density of the market among the consuming group should effectively improve

information on the volume of advertising (if friends and relatives all obtain different observations on expenditures, the group information should be better, either directly by discussing the advertising or indirectly by discussing opinions of likely quality).

The type of quality at issue may also influence advertising's durability for honest sellers. If quality refers to a defect rate for a product, those who purchase a defective unit may misinterpret it as an indication of low quality even when the overall defect rate is low. Thus, some of the value of the advertising may be lost despite the provision of high quality. This contrasts with overall design choices that affect quality for every unit of the good. In this case, the likelihood of mistakes in judgment are lower.

A number of factors should also determine changes in advertising's value if the firm cheats. Most important among these are characteristics of the market that would improve the flow of information to consumers about cheating. The degree to which consumer can themselves accurately judge quality after purchase is most often mentioned in this context. Nelson's use of experience goods rather than inspection or credance goods is based on this recognition. However, other aspects of the market like the presence of third-party sources of <u>ex post</u> information (evaluation magazines and press accounts of litigation or government recalls[17], for instance) could also serve this purpose in the event of cheating. Similarly, adjustments in the perceived advertising stock would be diminished by lags before cheating can be observed and by sparseness of the consuming group

(if friends and relatives are not consumers, negative information should form and disseminate more slowly).

Factors that affect consumer attentiveness to negative information should also be important. Certainly the size of the potential loss from cheating should be positively related to the incremental decay rate. Consumers should be more attentive to negative information and react more quickly to it when the potential loss is large. Similarly, the breadth of the agreement on what constitutes quality should affect the decay rate; if there is considerable difference of opinion about quality itself, information on cheating will be blurred, presumably muting the consumer reaction to it. The nature of quality can have the same effect. If quality is a measure of the defect rate, information about low quality might be more difficult to gather than in cases of a design defect which affects all units of the good.

In some settings, the extent to which advertising is targetted to only the consuming group may increase decay in the event of cheating. Where generations of consumers regularly move through the market, for instance, advertising that is not narrowly targetted to the consuming group may positively influence future consumers (who are less likely to receive negative information in the event of cheating) and thus dampen the decay rate if the firm cheats. Narrowly targetted advertising would be a better quality-assuring device in this setting.

Finally, note that concern about the durability of advertising's effects implies that firms should have an interest

in the content and placement of advertising as well as its amount if advertising is serving as a signal of quality. The content and targetting affect the ability to attract consumers, their ability to remember the advertising, and the specificity of the advertising if the firm cheats.[18]

Overall this brief discussion illustrates that there are strong *a priori* reasons to believe that advertising's durability will vary significantly across products. The cost of using advertising as a quality signal will vary with it.

## IV. INTRODUCTORY PRICING VERSUS ADVERTISING

The idea that otherwise unproductive advertising will be used as a signal of quality is questioned by many. Introductory pricing or other giveaway programs[19] in particular are often mentioned as superior signalling devices, because they use fewer resources to accomplish the same signalling function. In this section I explore this issue briefly.[20]

Suppose that instead of advertising to assure high quality, a firm considers an introductory pricing or giveaway policy. Suppose in addition that consumers can see the magnitude of the introductory program as well as they would see an equivalently costly advertising program and that the memory of the program is perfectly durable for high quality sellers. In this case the analysis of advertising as a quality signal would carry over directly to the introductory pricing program.[21] Moreover, the introductory pricing program would be Pareto superior, since the group of consumers receiving the cash or other giveaway items would prefer it, and firms and other consumers would be indifferent between the two methods.

The assumption that the memory of the initial pricing program does not fade for high quality firms is important for introductory pricing alone to be able to signal quality. In this case there is no need to reinvest in the signal itself and the analysis carries through directly. However, if the memory of the initial program does fade, some form of continued price cutting would be necessary to reinvest in the signal. Obviously this price cutting cannot be in the form of sustained across-the-board

price cuts. The firm cannot keep the necessary price premium that assures high quality and covers costs, and still effect the across-the-board price cuts necessary to reinvest in the signal.[22]

One pricing mechanism that might circumvent this problem is for the firm to do appropriately-sized giveaway or coupon programs each period to random consumers[23] to replenish the price-cut signal without reducing the price premium necessary to prevent cheating. Here again it is necessary for the continuing coupon program to be as visible to consumers as the continuing advertising would have been. Under these assumptions a pricing program would again be Pareto superior to advertising as a quality signal. Consumers who benefitted from the giveaway would prefer the policy, and firms and other consumers would be indifferent.

There are several points worth noting about pricing programs used for high quality signalling. First, a reduced pricing program does not generate a full information equilibrium, even under the assumption here that consumers will only purchase one unit per period regardless of price. There are two reasons for this. Firms may not be able to target coupon or giveaway programs only to high quality consumers and there is a loss in providing high quality goods to those who do not value them more highly than their cost of production. Further, in an introductory pricing equilibrium as in an advertising equilibrium, firms will produce beyond the point of minimum average production cost. Thus, as in most imperfect information situations, there are costs to overcoming the information

problem, even when pricing alone is used.

A more serious issue is the critical assumption that a pricing program is just as visible to consumers as an equally costly advertising program. If this assumption is not valid, the superiority of a pricing signal is no longer assured.

In practice, we know that advertisers put considerable effort into creating advertising that targetted consumers will notice and remember. Because firms can alter the content and placement of advertising with these consumers in mind, advertising may be an effective way of informing consumers of firm expenditures, since its durability may be higher than that of an introductory pricing program. In this sense, advertising may be comparatively efficient as a signalling device. This issue is not reflected in any of the models in the area, but as an empirical matter it may prove to be of fundamental importance in explaining advertising's use as a quality signal.

In general then, it is usually possible to construct introductory and continuing price or giveaway programs that mimic the signalling role of advertising. These pricing programs are Pareto superior to advertising as a quality signal <u>if</u> target consumers can observe and remember these policies just as effectively as they would comparable expensive advertising programs. In fact, these pricing arguments apply to the use of any firm-specific sunk costs to assure product quality. Thus, advertising or other visible expenses will be used to signal quality only if, over time, they are more effective than pricing programs in informing consumers of firm expenditures, that is,

only if they are superior as bonding instruments.

## V. CONCLUSION

In this paper I have focused on the importance of the bonding characteristics of advertising in determining when advertising's signalling potential will survive competitive pressures. There is a fundamental difference between advertising that functions through a bonding effect and advertising that functions strictly as a conspicuous expenditure.

All signalling mechanisms require that other agents will not find it profitable to match the signalling agent's behavior. For signalling mechanisms that are available to all at equal cost[24], like advertising, this requires that either the signal has a bonding effect (which creates a signalling cost advantage contingent on delivery of promised quality) or the signalling agent has an underlying production cost advantage (which allows him to spend on a signal that others will not match).

Many of the conflicting results in the literature on advertising's potential as a quality signal reflect implicit assumptions about the bonding nature of advertising. Klein and Leffler's (1981) assumption that advertising is a perfect bonding signal leads to their conclusion that advertising can signal quality under most cost conditions. Kihlstrom and Riordan's (1984) assumption that advertising has no bonding effect leads to their contrary conclusion that advertising can signal quality only under very limited cost conditions. In general, the greater the bonding effects of advertising, the broader the market conditions for which advertising equilibria exist. Similarly, the price premium necessary for high quality products varies

directly with advertising's bonding characteristics.

These results follow from a very simple fact: bonding mechanisms are more efficient signalling devices than purely conspicuous expenditures. Signals that operate through a bonding effect impose much of their cost only if a firm cheats. In contrast, signals that operate strictly through conspicuous acquisition of a costly signal impose their costs fully on those who deliver quality as well as on those who cheat.

While advertising that has a high bonding effect is less costly than other advertising, all advertising used to signal quality uses resources. As such, advertising signals must be compared to other potential quality signals. Certainly if high quality production requires sufficiently large quantities of brand or firm-specific sunk assets, advertising will not be used to signal quality. Introductory pricing and other giveaway programs are also potential signal candidates.

The results developed here suggest that if introductory pricing or giveaway programs are just as visible to consumers and just as easily remembered by them as comparably-expensive advertising programs, advertising will not be used as a quality signal. Pricing programs can usually be designed to dominate advertising in this case. The crucial assumption in this result is that the relevant pricing programs will be noticed and remembered by consumers as effectively as an equally costly advertising program. This seems a questionable assumption for many cases. Certainly advertising has the advantage that firms can alter the content and placement of advertising to improve

exposure and memory with target consumers.

Overall, advertising is unlikely to signal quality unless advertising is more durable and its durability is more sensitive to whether the firm honors its promises than other signalling options. These durability characteristics can be influenced by many different factors: repeat purchase behavior, time in the consuming group, consumers' ability to evaluate quality after purchase, other information sources, the nature of the advertising itself, availability of media to reach the targetted group, etc. Regardless of the source, it is advertising's durability characteristics that matter: advertising can signal quality only because it can bond performance, and it can bond performance only because its effects last and are affected by cheating.

## FOOTNOTES

* I would like to thank Jack Calfee, Richard Ippolito and Alan Mathios for comments on an earlier draft of this paper. This paper does not represent the views of the Federal Trade Commission.

[1] For example, bonding has been suggested as a potential solution to assure the desired behavior by law enforcers (Stigler and Becker (1974)), by management (Jensen and Meckling (1976), and by unions (Ippolito (1985)).

[2] There are many behavioral assumptions (dealing with repeat purchase, turnover of the consuming group, information flows after purchase, etc.) that could be accommodated by this treatment of advertising.

[3] The notation and structure of the model are parallel to those of Kihlstrom and Riordan (1984) whenever possible to facilitate comparison of results. The presence of a low quality market is not actually necessary to most of the analysis.

[4] This assumption could be replaced with the weaker assumption of a finite but sufficiently uncertain horizon. See Klein and Leffler (1981) or Telser (1980) for a discussion of the issue. It is not necessary for each firm to have this horizon if its advertising stock can be sold to another firm, through the sale of a brand name, for instance.

[5] This paper focuses on firms' incentives to continually provide high quality rather than the problem of introducing high quality goods that cannot be altered. The information requirements for consumers in the introductory case seem

substantially less plausible than in the repeated market setting discussed here. See Milgrom and Roberts (1986) for a monopoly model of the introductory quality case.

[6] At $p_O$, for instance, the profitability of deceptive low quality firms is $O(p_O,L) - F_L - A + s'(A)/(1+r) > 0$ for $A = 0$, since $p_O > p_L$. So for some low but positive advertising levels, deceptive low quality firms could earn positive profits.

[7] The discussion presented here will focus on the relationship between the cost conditions and the existence of advertising equilibria. Parallel arguments could be made relating demand conditions to advertising equilibria.

[8] This general result explains the simulation results in Klein and Leffler that showed the existence of an equilibrium under most cost conditions considered. In their model, advertising (or any other signalling expenditure that revealed the existence of their price premium) was perfectly durable and decayed completely in the event of cheating; in the terminology here, advertising was a perfect bonding signal.

[9] As a matter of terminology, the <u>production cost advantage</u> of low quality sellers at price $p_H$ is defined as the (positive) excess in revenues net of total production costs for low quality sellers over high quality sellers if both sell at price $p_H$; that is, $[O(p_H,L) - F_L] - [O(p_H,H) - F_H]$.

[10] This categorization is somewhat related to Spence's (1976) categorization of signals as falling into two classes: contingent contracts and exogenously costly signals. As in the bonding/non-bonding distinction, the difference in the signal

types comes from consumers' ability to later judge performance and to affect the cost of the signal based on this ex post judgment of quality.

[11] It is, of course, possible that at all prices the amount of bonding advertising is less than the low quality cost advantage. Advertising cannot signal quality in this case.

[12] Since (B) does not vary with $p_H$ and

$$(C) = \int_{p_O}^{p_H} x(p,H) - x(p,L)\ dp,$$

the derivative of (B) - (C) can be computed easily to be $d[(B)-(C)]/dp_H = x(p_H,L) - x(p_H,H) < 0$.

[13] See Klein and Leffler (1981), Shapiro (1983) and Wolinsky (1983), for instance. One possible exception is the case where production inherently requires sufficiently large sunk specialized assets.

[14] In the case illustrated in figure 1, $f(p) = (B) + (C)$ which is positive at $p_O$ and strictly increasing with price p. In contrast, in the case illustrated in figure 2, $f(p) = (B) - (C)$ which is positive at $p_O$ and strictly decreasing with increasing prices p.

[15] In the Klein and Leffler analysis, the quality-assuring price is treated as being the unique price that satisfies (13). This is accurate under their assumptions that high quality products have both a fixed and marginal cost disadvantage. In the more general case considered here, the price satisfying (13) is not necessarily unique.

[16] For instance, one would expect that advertising in the baby carriage market is far less durable than that in the auto

market because of the length of time the typical consumer is in the market.

[17] The papers by Jarrell and Peltzman (1985) showing large average reductions in stock value following government recalls of flawed products and by Peltzman (1981) showing similar results for firms charged with deceptive advertising may be related to this effect.

[18] This point is contrary to the usual argument that firms' concern about the content of advertising is indirect evidence against the signalling theory of advertising. See Kotowitz and Mathewson (1986), for instance.

[19] Introductory pricing programs have an effect on marginal production decisions in the periods of reduced pricing. Some types of giveaway programs do not. For instance, suppose the manufacturer gives consumers a chance to win a prize, where the prize does not depend on the quantity sold. In this case the analysis of the lump sum giveaway is directly parallel to the advertising analysis presented. This discussion does not distinguish between the two, though as a technical matter the analysis is somewhat more complex if introductory pricing is used.

[20] Milgrom and Roberts (1986) also explore the possibility of a price signal but in a monopoly model of introductory pricing for a fixed but unknown quality product. The signalling results in their model are fundamentally affected by the monopoly and fixed quality assumptions, so that their model does not relate directly to the discussion here.

In a model in which consumers can also observe the quantity that firms produce, Allen (1984) describes signalling equilibria that rely only price and quantity. These equilibria are shown to dominate those based on non-price competition. The results extend to some cases where consumers do not observe quantity, but in a model where firms are not price-takers. See Rogerson (1986) for a similar analysis.

[21] Note that this is similar to the analysis of Kihlstrom and Riordan's (1984) no-advertising equilibrium but in the case where quality can be changed each period and fixed costs are per period costs. If the giveaway program is treated as occurring at the start of the period (as the advertising was), the high quality buyers who do not get a free or reduced price good can still purchase high quality goods as in any other period. This is a natural assumption if the firm uses coupons to reduce price, for instance, rather than an across-the-board price cut. The firm can then offer the high quality good at the high quality price for those who do not get the reduced price. This eliminates one inefficiency of introductory pricing cited by Kihlstrom and Riordan where some high quality consumers did not get high quality goods in the first period.

[22] This is essentially a requirement that the firm have two controls to achieve the desired outcome.

[23] By assuming a random giveaway program, the analysis would carry over directly, since the consumer's willingness to pay for high quality goods would not be affected. If the reduced prices are conditional on past purchases, this would not be the case and the analysis would have to be modified somewhat.

[24] Signals that are more productive for some agents can generally be viewed as signals with differential costs by normalizing costs to an output basis.

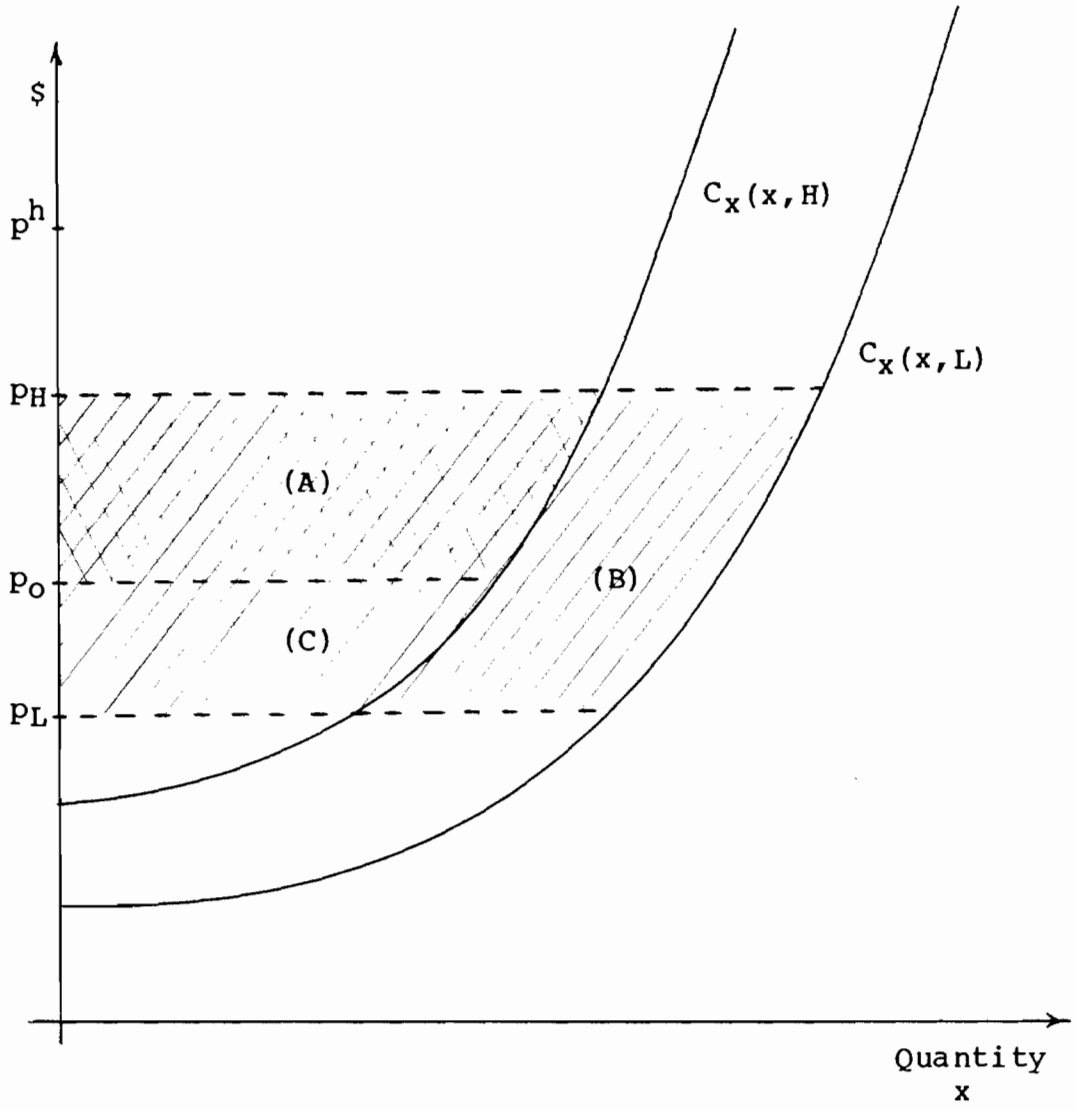


FIGURE 1. Cost conditions when high quality products have a higher marginal production cost than low quality products.

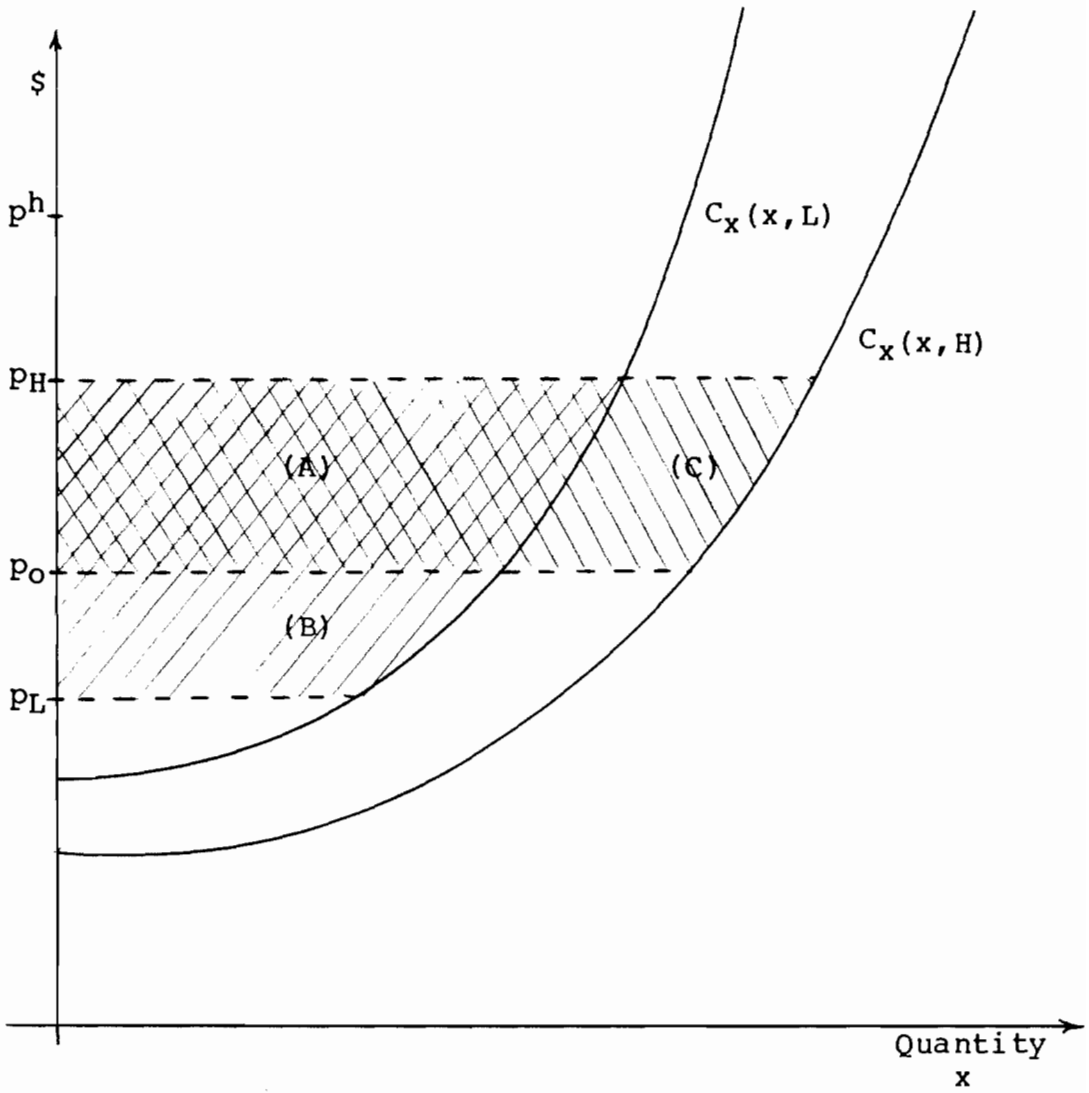


FIGURE 2. Cost conditions when low quality products have a higher marginal production cost than high quality products.

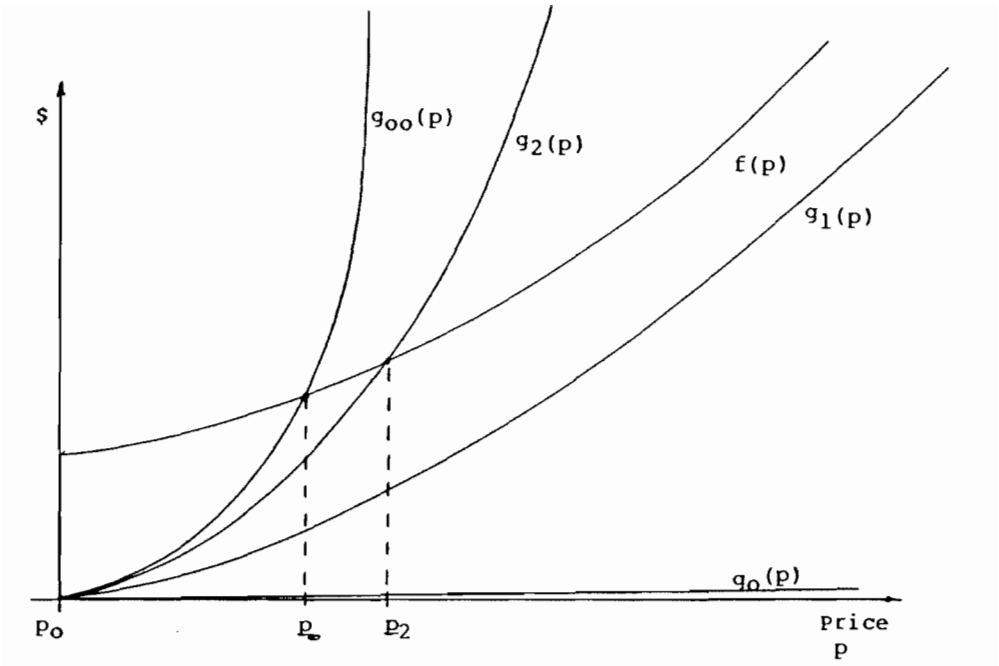


FIGURE 3. Minimum quality-assuring price p when $C_x(x,H) > C_x(x,L)$

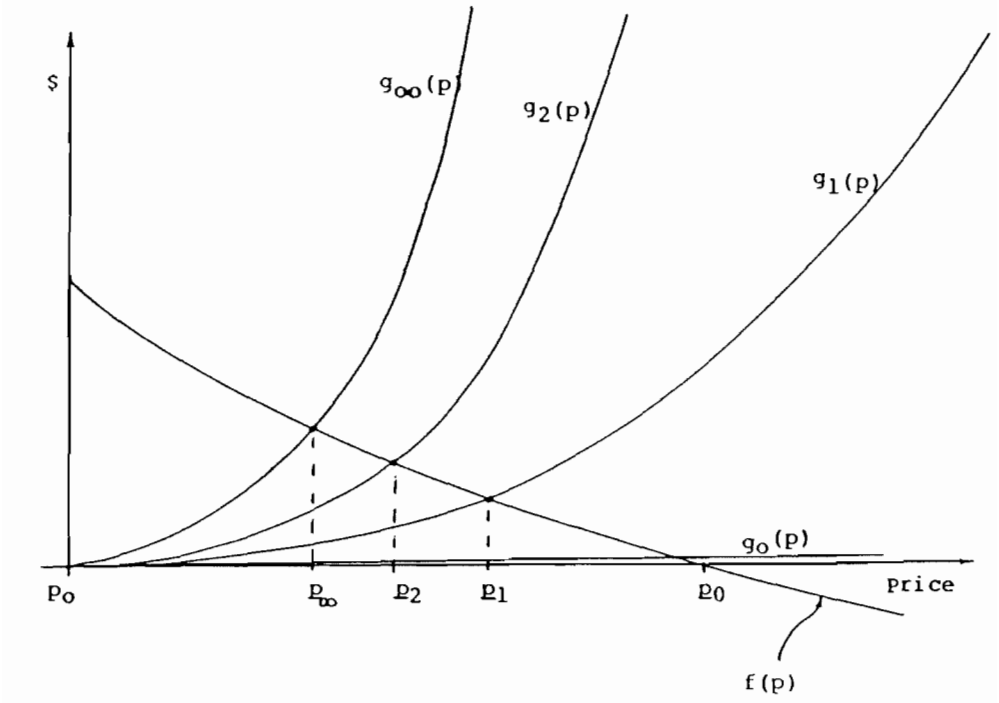


FIGURE 4. Minimum quality-assuring price p when $C_x(x,L) > C_x(x,H)$

## APPENDIX

**PROOF OF PROPOSITION.**

(1) First suppose that $(p_L, p_H, A)$ is an advertising equilibrium. Then, by definition, $p_L < p_H \leq p^h$ and $A > 0$ such that conditions (2) - (6) are satisfied. Since $A > 0$, then $p_H$ is in $(p_o, p^h]$. Further using condition (4) in condition (5), it must be true that at the price $p_H$, the cost conditions satisfy

$$[O(p_H, L) - F_L] - [O(p_H, H) - F_H] \leq [s(A) - s'(A)]/(1+r).$$

This completes the proof that at an advertising equilibrium, the cost conditions satisfy condition (11).

Suppose now that there is a price $p_H$ in $(p_o, p^h]$ at which the cost conditions satisfy condition (11). Let A be defined by condition (4) and let $p_L$ be defined by condition (2). Then it suffices to show that $(p_L, p_H, A)$ is an advertising equilibrium.

By assumption, $p_L < p_o$. So $p_L < p_H \leq p^h$. Conditions (2) - (4) and (6) are clearly satisfied, so it suffices to show that condition (5) is satisfied. Using (4) in condition (11), (5) follows directly.

This proves the necessary and sufficient conditions of part (1) of the proposition.

(2) Proof follows directly from proof of (1).

(3) Suppose an advertising equilibrium $(p_L, p_H, A)$ exists. Then we must show that $\underline{p} \leq p^h$. Consider the function $h(p) = O(p, L) - F_L - A + s'(A)/(1+r)$ where A corresponds to p through condition (4). At $p_H$, $h(p_H) \leq 0$ by condition (5). At $p_o$, $h(p_o) > 0$ (see footnote 6). Therefore, since h is a continuous

function, there is some price p in $(p_O, p_H]$ for which $h(p) = 0$. The smallest such price is $\underline{p}$ by definition. So $\underline{p} \leq p^h$.

Suppose now that $\underline{p} \leq p^h$. Then it is straightforward to show that $(p_L, \underline{p}, \underline{A})$ is an advertising equilibrium where $p_L$ is defined by condition (2).

This proves that an advertising equilibrium exists if and only if $\underline{p} \leq p^h$.

The proof for $\underline{A} \leq A^h$ is equivalent. Q.E.D.

## REFERENCES


Allen, Franklin, "Reputation and Product Quality," Rand Journal of Economics, Autumn 1984, 15, 311-327.

Becker, Gary and Stigler, George, "Law Enforcement, Malfeasance, and Compensation of Enforcers," Journal of Legal Studies, January 1974, 3, 1-18.

Farrell, Joseph, "Moral Hazard as an Entry Barrier," Draft, 1985.

Ippolito, Richard A., "The Economic Function of Underfunded Pension Plans," Journal of Law and Economics, October 1985, 28, 611-651.

Jarrell, Gregg and Peltzman, Sam, "The Impact of Product Recalls on the Wealth of Sellers," Journal of Political Economy, June 1985, 93, 512-536.

Jensen, Michael and Meckling, William, "The Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," Journal of Financial Economics, October 1976, 3, 305-360.

Kihlstrom, Richard E., and Riordan, Michael H., "Advertising as a Signal," Journal of Political Economy, June 1984, 92, 427-450.

Klein, Benjamin, and Leffler, Keith B., "The Role of Market Forces in Assuring Contractual Performance," Journal of Political Economy, August 1981, 89, 615-641.

Kotowitz, Yehuda and Mathewson, Frank, "Advertising and Consumer Learning," in Empirical Approaches to Consumer Protection Economics, Pauline M. Ippolito and David T. Scheffman, Eds., Federal Trade Commission, Washington, D.C., 1986.

Milgrom, Paul, and Roberts, John, "Price and Advertising Signals of New Product Quality," Journal of Political Economy, August 1986, 94, 796-821.

Nelson, Phillip, "Information and Consumer Behavior," Journal of Political Economy, March/April 1970, 78, 311-329.

Nelson, Phillip, "Advertising as Information," Journal of Political Economy, July-August 1974, 81, 729-754.

Peltzman, Sam, "The Effects of FTC Advertising Regulation," Journal of Law and Economics, December 1981, 24, 403-447.

Rogerson, William P., "The Dissipation of Profits by Brand Name Investment and Entry When Price Guarantees Quality," The Center for Mathematical Studies in Economics and Management Science, Discussion Paper No. 697, April 1986.