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Raising Awareness and Signaling Quality to Uninformed Consumers: A Price-Advertising Model

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Abstract

The objective of this paper is to investigate the firm's optimal advertising and pricing strategies when introducing a new product. We extend the existing signaling literature on advertising spending and price by constructing a model in which advertising is used both to raise awareness about the product and to signal its quality. By comparing the complete information game and the incomplete information game, we find that the high-quality firm will *reduce* advertising spending and increase price from their respective complete information levels. In the separating equilibrium, the high-quality firm will actually spend less on advertising than the low-quality firm, resulting in a *negative* correlation between product quality and advertising spending.

What sets our analysis apart from previous studies is that we consider advertising spending not only as a signaling device but also as an informational device. When advertising spending is just a signaling device, it is purely a dissipative expense. It can be an effective signal of quality because only the high-quality firm can afford it; thus, consumers can infer the product's quality by its advertising spending. In this case, advertising spending and product quality are positively correlated. However, when advertising also serves the purpose of raising awareness, it endogenizes the size of the market for the firm, so it is not just a dissipative expense any more.

Consider the low-quality firm's mimicking strategy in this case. When the low-quality firm is believed to be a high-quality one, it can charge a much higher price than if its true quality were known. Given that its marginal cost is lower than the high-quality firm's, its profit margin will be much larger in mimicry than in revealing its true quality. Indeed, its profit margin will be even greater than the high-quality firm's. Therefore, the low-quality firm in mimicry has a strong incentive to increase its advertising spending from its optimal level when its true quality is known. To deter the low-quality firm's mimicking tendency, the high-quality firm should decrease its advertising spending so that mimicry is not as appealing to the low-quality firm as revealing its true quality. Indeed, the high-quality firm should reduce its advertising spending so much that it advertises less than the low-quality firm in equilibrium.

Many have interpreted signaling as "burning money" or "throwing money down the drain." In the case of advertising, the claim is that its purpose is simply to show consumers that the firm can afford to squander money on advertising to signal its quality. Hence, the advertising content need not be informative. However, our results show that simply "burning money" is not enough to signal quality. *How* the money is burned is also important. When advertising raises awareness as well as signals quality, "saving money" rather than "burning money" is the correct signaling approach, although ultimately the high-quality firm will sacrifice some profit by reducing its market size. The intuition behind this result is that when information is incomplete, the high-quality firm cannot fully exploit its advantages. Whenever its advantages in quality and/or marginal costs are lessened, a firm will want to spend less on advertising.

(*New Products*; *Advertising Strategies*; *Pricing*; *Signaling Game*; *Separating Equilibrium*)

1. Introduction

In the marketing and economics literature, it has been well established theoretically that advertising spending can be a signal of product quality for experience goods (Nelson 1974, Kihlstrom and Riordan 1984, Milgrom and Roberts 1986). This implies that the seller of the high-quality product will spend more on advertising than the seller of the low-quality product. When this is true, one should observe a positive correlation between advertising spending and product quality. However, the empirical evidence does not support this finding. For example, in a cross-sectional analysis of 12 categories, Moorthy and Zhao (1995) do not find a significant positive relationship between advertising spending and product quality for any category after controlling for price and market share.[1] In this paper, we extend the existing theoretical research by introducing a new function of advertising—its informative role—and show that the correlation between advertising spending and product quality is much weakened when advertising is used both to signal quality and to raise awareness of the product.

When advertising spending is just a signaling device, as in Milgrom and Roberts (1986), it is purely a dissipative expense. It can be an effective signal of quality because only the high-quality firm can afford it; thus, consumers can infer the product's quality from its advertising spending. In this case, advertising spending and product quality are positively correlated. However, when advertising also serves the purpose of raising awareness, it endogenizes the size of the market for the firm so it is not just a dissipative expense any more. When quality is known so signaling is not needed, the firm will spend more on advertising when the quality is higher, because a higher quality is associated with a higher profit margin (given certain cost structure), making it more profitable for the firm to generate more demand by raising more awareness through advertising.

Consider the low-quality firm's mimicking strategy

[1]In Moorthy and Zhao (1995), advertising spending is regressed against objective quality, price, and market share at the brand level for each category, in which data on objective quality are collected from *Consumer Reports.* The regression results show that none of the estimates for objective quality is significant at the 5% level.

when quality is not known. When the low-quality firm is believed to be a high-quality one, it can charge a much higher price than when its true quality is known. Given that its marginal cost is lower than the high-quality firm's, its profit margin will be much larger in mimicry than in revealing its true quality. Indeed, its profit margin will be even greater than the high-quality firm's. Therefore, the low-quality firm in mimicry has a strong incentive to increase its advertising spending from its optimal level when its true quality is known. To deter the low-quality firm's mimicking tendency, the high-quality firm should decrease its advertising spending so that mimicry is not as appealing to the low-quality firm as revealing its true quality. Indeed, the high-quality firm should reduce its advertising spending so much, it advertises less than the low-quality firm in equilibrium.

Not surprisingly, our finding on pricing is consistent with the signaling literature (Bagwell and Riordan 1991) in that the high-quality firm should raise prices to signal its quality. The reasoning is that if the firm's quality and, hence, its marginal cost are high, any decrease in sales as a result of higher prices will hurt the low-quality firm with a lower marginal cost more than the high-quality firm. Therefore, at sufficiently high prices, the low-quality firm would prefer to select an optimal low price to reveal its true quality, instead of charging a high price to masquerade as a high-quality firm. Note that when signaling quality, although the high-quality firm distorts price and advertising spending in different directions—upward in price and downward in advertising spending—the impacts are the same: The demand is reduced with such a signaling strategy, making mimicry less appealing to the low-quality firm.

This paper contributes to a larger literature that includes a wide variety of signals for quality, in particular, warranty and money-back guarantee (Moorthy and Srinivasan 1995).

2. Model

A firm has just developed a new product whose quality is either high (*H*) or low (*L*) and decides to introduce it to the market for the first time. The new product is experiential by nature. That is, one needs to consume

it to learn its quality. Because consumers cannot verify the firm's claims before making a purchase, any claims made by the firm about quality in the advertisements will not be credible (Nelson 1974). We consider two decisions the firm must make to introduce the new product: advertising spending (*a*) and price (*p*). Because the paper focuses on the firm's pricing and advertising strategy, quality levels *H* and *L* are exogenously determined.

Initially, no consumers have any knowledge about the existence of the firm's product or its quality. Although there are different ways with which consumers can become aware of the product's existence, for simplicity the model assumes that the only informational exposure is via the firm's advertisements. The number of people who become aware of the firm is determined by advertising spending. The model postulates that the fraction of consumers who will be informed is

$$f(a) = \frac{a}{1 + a}.$$

Note that this functional form satisfies $f'(\cdot) \geq 0$ and $f''(\cdot) \leq 0$, with the boundary conditions $f(0) = 0$ and $f(\infty) = 1$. Consumers who have been exposed to the firm's advertising will decide whether to buy the new product or not, based on their *perceptions* of product quality and the prices charged. Uninformed consumers will not buy at all.

There is a continuum of consumers of unitary mass who are heterogeneous in their willingness to pay for quality. Their preference for quality is described by an index, θ, which is assumed to be uniformly distributed over [0,*R*]. For a product perceived to be of quality *q*, sold at price *p*, the consumer with an index θ will derive net utility

$$u = \theta q - p \qquad (1)$$

if she purchases. Each consumer purchases one unit in this product class, provided she can derive positive utility. Otherwise the consumer does not buy.

3. Equilibrium Analysis

We first establish the benchmark result by considering the case when consumers know product quality before purchase.

3.1. When Consumers Know Quality

In this base model of the *complete information game*, signaling is not an issue, because consumers know the firm's quality when they become aware of the product's existence.

The demand is determined jointly by the firm's advertising spending and product price. Given the consumers' utilities shown in (1), the firm's demand is

$$d(p, a) = \frac{a}{1 + a}\left(R - \frac{p}{q}\right). \qquad (2)$$

With demand function (2), the firm's profit is

$$\pi(p, a) = \frac{a}{1 + a}\left(R - \frac{p}{q}\right)(p - c(q)) - a, \qquad (3)$$

where $c(q)$ is the firm's marginal cost of producing quality q, $q \in \{H, L\}$.

Maximizing (3) with constraints $a \geq 0$ and $p \geq 0$ yields the firm's strategy under complete information, p_L^c and a_L^c for the *L*-type and p_H^c and a_H^c for the *H*-type.[2] Using the first-order conditions, we can establish that

$$p_H^c = \frac{1}{2}(HR + c_H) \quad \text{and} \quad p_L^c = \frac{1}{2}(LR + c_L), \qquad (4)$$

where $c_H \equiv c(H)$ and $c_L \equiv c(L)$, and the optimal advertising level is

$$a_H^c = \frac{HR - 2\sqrt{H} - c_H}{2\sqrt{H}} \quad \text{and} \quad a_L^c = \frac{LR - 2\sqrt{L} - c_L}{2\sqrt{L}}.$$

It is trivial to confirm that the second-order conditions are also satisfied.

Regarding the firm's advertising spending level, we can establish the following result:

LEMMA 1. *If* $H/c_H > L/c_L$, *then* $a_H^c > a_L^c$.

This means that when the high-quality firm is more efficient in producing quality, it will advertise more than the low-quality firm. It is assumed throughout the paper that $H/c_H > L/c_L$ is satisfied. This assumption will make the signaling issue relevant.

3.2. When Quality Is Uncertain

In this section we investigate the firm's advertising and pricing strategies in the more general model, in which

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[2]Superscript *c* denotes *complete* information.

consumers are uncertain about the firm's quality even after exposure to its advertising. The question that arises is: What is the firm's optimal strategy when the firm needs both to raise awareness and signal quality?

Generally, the methodology for addressing this question entails construction of a signaling game with both advertising spending and price as potential signals (Gibbons 1992). Consumers start out with a prior probability distribution about the firm's quality when they are aware of its existence, and the issue is what their beliefs will be in equilibrium after they have observed the firm's advertising expenditure and price. When the equilibrium is such that both the high-quality firm and the low-quality firm will spend the same amount on advertising and charge the same price, then consumers will not be able to update their earlier beliefs about the firm's quality, resulting in a *pooling equilibrium.* On the other hand, when the equilibrium is such that a high-quality firm advertises and/or prices differently from a low-quality firm, then consumers will be able to infer the firm's quality from its signals. In this case, the equilibrium is a *separating equilibrium.* Usually, the only sustainable equilibrium is the separating equilibrium, so we concentrate on that in this paper.

At this point, we make a simplifying assumption that is used widely in the literature, either implicitly or explicitly: Consumers who are exposed to a firm's advertisements observe all of its advertising spending. This assumption enables consumers who are exposed to the firm's advertising to make the same inference about its product quality.[3]

In the separating equilibrium, the high-quality firm will signal its quality by choosing such a strategy that the low-quality firm would rather reveal its true quality than mimic the high-quality firm's strategy. At the same time, the high-quality firm's strategy should be such that it is better off by signaling its quality than by being perceived to be of low quality. Hence, we can set up the high-quality firm's profit maximization problem as

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[3]Qualitatively, this assumption is not crucial to our results as long as consumers' observed advertising is monotonic to the firm's total advertising, i.e., consumers will observe more advertising when the firm spends more on it.

$$\pi_H^s \equiv \max_{P_H, a_H} \frac{a_H}{1 + a_H} \left(R - \frac{p_H}{H} \right) (p_H - c_H) - a_H, \quad (5)$$

$$\text{s.t.} \quad \frac{a_H}{1 + a_H} \left(R - \frac{p_H}{H} \right) (p_H - c_L) - a_H \leq \pi_L^c, \quad (6)$$

$$\pi_H^s \geq \pi_H^L, \quad (7)$$

where π_L^c is the low-quality firm's profit in the complete information game, and π_H^L is the high-quality firm's profit if it is believed to be the low-quality one and is determined by

$$\pi_H^L = \max_{p, a} f(a) \left(R - \frac{p}{L} \right) (p - c_H) - a. \quad (8)$$

Constraint (6) says that the low-quality firm is not willing to mimic the high-quality firm's strategy in the separating equilibrium, and constraint (7) says that the high-quality firm will signal rather than be mistaken for a low-quality firm. The low-quality firm's strategy in the separating equilibrium is simply its complete information optimal strategy (p_L^c, a_L^c).

Next, we characterize the high-quality firm's advertising and pricing strategies in the separating equilibrium. When a separating equilibrium exists,[4] the high-quality firm's advertising spending and price (see the appendix) are,[5] respectively,

$$a_H^s = \frac{(HR - 2\sqrt{H} - c_L) - \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2\sqrt{H}}$$

and

$$p_H^s = \frac{HR + c_L + \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2}.$$

Hence, we have the following proposition regarding the separating equilibrium:

PROPOSITION 1. *In the separating equilibrium, the high-quality firm's strategy is (p_H^s, a_H^s) and the low-quality firm's strategy is (p_L^c, a_L^c). The consumers' belief is that the product*

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[4]It does not always exist, for example, when L is sufficiently close to H.

[5]Superscript s stands for *separating.*

quality is high when the observed strategy is (p_H^s, a_H^s), and low otherwise.

This separating equilibrium is sustainable, because it satisfies the intuitive criterion (Cho and Kreps 1987).[6] The intuitive criterion means that a firm will be worse off when deviating from the equilibrium strategy, regardless of the consumers' beliefs when observing the deviation. In contrast, no pooling equilibrium in this game satisfies the intuitive criterion.[7]

Next, we explore some properties of the separating equilibrium. We first state the following proposition (proved in the appendix).

PROPOSITION 2. *In the separating equilibrium, under the condition $H/c_H < L/c_L$, the H-type firm will increase its price and lower its advertising spending from their respective complete information levels, i.e., $p_H^s > p_H^c$ and $a_H^s < a_H^c$.*

The high-quality firm's pricing strategy is consistent with established findings (Bagwell and Riordan 1991, Desai and Srinivasan 1995, Wolinsky 1983) that the firm will signal its quality by pricing higher than the equilibrium price under complete information. However, its advertising strategy is in direct contrast to the established findings in the literature that heavy advertising spending is a signal of product quality (Nelson 1974, Milgrom and Roberts 1986).[8]

What drives this result? To separate from the L-type firm, the direction of distortion for the H-type firm must point away from the low-quality firm's desired position in mimicry. Consider price first. The L-type firm, because of its lower marginal cost, would like to price lower than p_H^c when it is believed to be of H-type. Then, the direction of the H-type firm's distortion in price should be an increase from p_H^c. Next consider advertising. It is useful to understand how the low-quality firm would advertise in mimicry. When masquerading as the H-type firm, the L-type firm enjoys

an increased profit margin, for it can charge a higher price now. To take advantage of the higher profit margin, the L-type firm benefits from expanding the market by increasing advertising spending. Therefore, not only will increased advertising spending be ineffective in deterring mimicry from the L-type firm, it will actually attract mimicry. Thus, the correct separating strategy is to decrease advertising spending so that the L-type firm cannot reap the full benefit of masquerading as an H-type firm.

Now we compare the strategies of the high-quality firm and the low-quality firm in the separating equilibrium. It is trivial to check that $p_H^s > p_L^s$. Does the H-type firm advertise more than the L-type firm in the separating equilibrium? Now, because the H-type firm will reduce its advertising spending from the complete information level, the relationship between advertising spending and product quality will be weakened. Indeed, we can obtain a stronger result (proved in the appendix) that $a_H^s < a_L^s$, regardless of the relationship between quality and marginal cost.

PROPOSITION 3. *In the separating equilibrium, the high-quality firm will spend less on advertising and charge a higher price than the low-quality firm, regardless of the relationship between quality and marginal cost.*

This proposition is in contrast to the results of the signaling game when advertising serves the sole purpose of signaling quality. In that game, only the high-quality firm advertises to signal its quality, and the low-quality firm does not advertise in the separating equilibrium. Thus, there is a positive relationship between product quality and advertising spending. However, when advertising serves the dual purpose of signaling quality and raising awareness, the relationship is *negative*.

4. Conclusions

Many have interpreted signaling as "burning money" or "throwing money down the drain." In the case of advertising, the claim is that its purpose is simply to show consumers that the firm can afford to squander money on advertising to signal its quality. Hence, the advertising content need not be informative. However, our results show that simply "burning money" is not

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[6]The proof is available from the author upon request.

[7]Under favorable off-equilibrium path beliefs, for example, when consumers change their equilibrium path belief, which is their prior belief in the pooling equilibrium, to the belief that the product quality is high when they observe an *upward* deviation in either price or advertising spending, then the pooling equilibrium cannot be sustained. A formal proof is available upon request from the author.

[8]This proposition holds for a general functional form of $f(a)$ as long as it is increasing in a.

enough to signal quality. How the money is burned is also important. When advertising raises awareness as well as signals quality, "saving money" rather than "burning money" is the correct signaling approach, although ultimately the high-quality firm will sacrifice some profit by reducing its market size. The intuition behind this result is that when information is incomplete, the high-quality firm cannot fully exploit its advantages. Whenever its advantages in quality and/or marginal costs are lessened, a firm will want to spend less on advertising. Put succinctly, increased advertising spending will attract mimicry instead of deterring it.

The results indicate that an advertising blitz when introducing a new product is not necessarily a good strategy, for the signal it sends may be counterproductive. A firm with a truly high-quality product is wise to let price send the signal and initially to conduct a modest advertising campaign.[9]

Appendix

PROOF OF PROPOSITION 1. Ignoring condition (7), the high-quality firm's problem is

$$\max_{p,a} f(a_H) \left(R - \frac{p_H}{H} \right) (p_H - c_H) - a_H,$$

$$\text{s.t.} \quad f(a_H) \left(R - \frac{p_H}{H} \right) (p_H - c_L) - a_H \le \pi_L^c, \tag{9}$$

where

$$\pi_L^c = \frac{(LR - 2\sqrt{L} - c_L)^2}{4L},$$

is the low-quality firm's profit in the complete information game. After constructing the Lagrangian, we obtain the first-order conditions in p_H, a_H, respectively, as

$$\frac{\partial \mathcal{L}}{\partial p_H} = \left(R - \frac{2p_H}{H} + \frac{c_H}{H} \right) + \lambda \left(R - \frac{2p_H}{H} + \frac{c_L}{H} \right) = 0,$$

and

$$\frac{\partial \mathcal{L}}{\partial a_H} = f'(a_H) \left(R - \frac{p_H}{H} \right) (p_H - c_H) - 1$$
$$+ \lambda \left[f'(a_H) \left(R - \frac{p_H}{H} \right) (p_H - c_L) - 1 \right] = 0.$$

Hence, we have

$$p_H^s = HR - (1 + a_H) \sqrt{H},$$

after discarding an implausible root. Substituting this value into the constraint

$$f(a_H) \left(R - \frac{p_H}{H} \right) (p_H - c_L) - a_H = \pi_L^c,$$

we have

$$a_H^s = \frac{(HR - 2\sqrt{H} - c_L) - \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2\sqrt{H}}.$$

Hence, we have

$$p_H^s = \frac{HR + c_L + \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2}.$$

Because the consumers' index is uniformly distributed, satisfying the monotone hazard rate condition (Fudenberg and Tirole 1998), and $f(a)$ is concave in a, the objective function is quasiconcave in each of its arguments. Thus, the second-order conditions are also satisfied; that is, (p_H^s, a_H^s) is indeed the global maximum solution. □

PROOF OF PROPOSITION 2. To compare a_H^s and a_H^c, we evaluate

$$a_H^s - a_H^c = \frac{(c_H - c_L) - \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2\sqrt{H}}.$$

Using the fact that $a_H^c > a_L^c$ under the condition $H/c_H > L/c_L$, we need only evaluate the sign of $(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2 - (c_H - c_L)^2$, or

$$L(HR - 2\sqrt{H} - c_L)^2 - H(LR - 2\sqrt{L} - c_L)^2 - L(c_H - c_L)^2$$
$$= L(HR - 2\sqrt{H} - c_H)^2 + 2L(HR - 2\sqrt{H} - c_H)(c_H - c_L)$$
$$- H(LR - 2\sqrt{L} - c_L)^2$$
$$> 2L(HR - 2\sqrt{H} - c_H)(c_H - c_L) > 0.$$

Now compare p_H^s with p_H^c by evaluating

$$p_H^s - p_H^c = \frac{HR + c_L + \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2}}{2} - \frac{HR + c_H}{2}$$
$$= \frac{1}{2} \left[\sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2} - (c_H - c_L) \right].$$

Because we have already proved that the term in brackets in the

above expression is positive when $H/c_H > L/c_L$, we have $p_H^s > p_H^c$. □

PROOF OF PROPOSITION 3. Compare a_H^s with $a_L^s = a_L^c$ by evaluating

$a_H^s - a_L^s$

$$= \frac{(HR - 2\sqrt{H} - c_L) - \sqrt{(HR - 2\sqrt{H} - c_L)^2 - 4H(a_L^c)^2 - 2\sqrt{H}a_L^c}}{2\sqrt{H}}.$$

Let

$$X = HR - 2\sqrt{H} - c_L \quad \text{and} \quad Y = 2\sqrt{H}a_L^c.$$

Then

$$a_H^s - a_L^s = \frac{X - Y - \sqrt{X^2 - Y^2}}{2\sqrt{H}}$$

$$= \frac{\sqrt{X - Y}(\sqrt{X - Y} - \sqrt{X + Y})}{2\sqrt{H}} < 0. \quad □$$

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