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# THE ADVERTISING OF WELL-KNOWN QUALITY PRODUCTS*

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## *Abstract*

The cash-burning model of quality signaling is one of the well known models to explain the phenomenon of advertising. However, it has been pointed out that the model does not explain the advertising of an already well-known quality product.

This paper shows that even the advertising of a well-known quality product can be explained by the cash-burning model with some additional assumptions. In this paper we will consider a durable good market with two competing firms. One firm is an incumbent with a well-known quality product, while the other firm is an entrant with an unknown quality product to the consumers. We will show that the incumbent has an incentive to advertise its well-known quality product in order to protect its market share from the new product.

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Advertising has been a very important economic phenomenon. In much of the economic literature advertising has usually been treated as something that can affect the demand function directly. In other words, a successful advertising will automatically increases the demand of the consumers, probably due to some psychological effects which make the advertised product more desirable to the consumers even without any actual improvement in the quality. It is very hard to deny that there exist these psychological effects in advertising, but it is same as arguing, "if you see an advertisement for a low quality product, you might just want to buy that low quality product even though you know that you can buy a non-advertised high quality product at a lower price". This argument basically implies that the consumers are quite irrational and this may make some economists uncomfortable.

There have been some other attempts to explain advertising. One of them was the work done by Milgrom and Roberts (1986). They argued that an advertising may be used as a cash-burning signal. In their model they analyzed an "experience good", whose quality can be detected by the consumers only after they actually buy and use the product. During the introductory period of a new experience good whose unknown quality may be high or low, the

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firm who produces a high quality product would want to inform the consumers of its quality and sell its product at a higher price. Obviously, once the consumers know the quality of the product, the high quality product can bring a higher profit by setting a higher price than the low quality product. This gives the company the chance to use advertising as a signal of quality by spending such a large amount of money on advertising that the low quality firm could never increase its profit by imitating and advertising to such a large extent. The message that such an advertising carries would be "We have a high quality product and we are very confident that once you use our product you will continue to use it repeatedly. Otherwise, we must be very stupid to spend this much money on advertising".

One thing, however, that has not been achieved by that model is an explanation of the advertising of an already established (well-known and used by most consumers already) product which we often encounter in our lives.

One natural explanation would be that there exist a stream of new consumers in each period and such advertising is targeted at these new consumers, who have not yet learned the product's quality. However, it seems that the number of the new consumers is not always large enough to justify the high advertising costs. For example, we can see the advertisements for many pharmaceutical products like 'Tylenol', even though they have been in the market for a long time. It is unlikely that there are many consumers who do not know the products.

Imagine consumers who already know a product well enough but have not seen any advertisements for that product for some periods, while they have kept seeing advertisements for a new product. It is quite likely that one would begin to wonder if the new product is actually better than the old one. The fact that the old product is not advertised anymore would seem to be the admittance of its inferiority.

In this model, we will show that there can be a case in which incumbent firms advertise as a signal to the consumers, hoping to prevent the infiltration of newly introduced products. Actually, the incumbent's advertising carries the message, "You, consumers don't have to bother yourself in trying to figure out the quality of the new product, because the new one is not better than the old one".

This is basically a model where two parties (firms) try to signal their private information to a third party (consumer), and because there have not been many models concerning three-party signaling, one might also find this model interesting.

## I. *The Model and the Assumptions*

We will consider a $T$-period model with $N$ consumers.

Consider a situation in which a product of an incumbent monopoly firm (we will call it 'product A' or 'A') has been sold in the market for a while and the quality of A is well-known to everybody. Every consumer has to buy one unit of this product during $T$ periods, even though different consumers may need this product in different periods. We will assume that in each period the same number of consumers, that is, $N/T$ consumers per period, would purchase the product. Now a new product is developed by a potential entrant, just before period 1 (we will call the new product 'product B' or 'B'). No consumer knows the quality of product B, while both the incumbent and the entrant firms know the qualities of product A and B. In each period $N/T$ consumers will make their purchasing decisions between A and B, if

product B enters the market.

One thing these assumptions indicate is that we are thinking about durable goods, because each consumer buys the product just once during the $T$ periods. It might also apply to the case of over-the-counter medicines that one purchases once in a while.

Let's look at the relationship between the qualities of product A and B.

Let $q_A^i$ and $q_B^i$ denote the qualities of product A and B felt by individual $i$, then,

$$q_B^i = q_A^i + l + \sigma^i. \tag{1}$$

Here, $\sigma^i$ is the independent individual preference of $i$, while $l$ is the preference common to all consumers. We will assume that $l$ may have three values $-1$, 0, and 1. We will define that 'product B is worse than A' when $l=-1$ (worse product), 'B is equal to A' when $l=0$ (equal product), and 'B is better than A' when $l=1$ (better product). Also, we will let $\phi_W$ be the ex ante probability that the new product B is a worse product, $\phi_E$ be the ex ante probability for B to be an equal product, and $\phi_B$ be the ex ante probability for B to be a better product.

We will assume that both of the firms know the value of $l$ even from the time when B has not been introduced to the market yet. On the other hand, we will assume that the consumers only know the probabilities that B is worse, equal, and better, but do not know the actual value of $l$ ex ante.

The fact that $l$ may have only one of three values may seem too strict, but at the end of the next section we will show that the main result of this paper still holds, when we allow $l$ to have values near those three values above.

On the other hand, the individual preference, $\sigma^i$, is uniformly distributed in $[-h, h]$, where $h$ is a constant satisfying $0<h<1$. The assumption that $\sigma^i$ is uniformly distributed has been adopted for the sake of convenience, and again at the end of the next section we will consider the possibilities of loosening these assumptions.

Now we will look at the consumer side.

We will assume that even though all the consumers assess the quality differently as assumed above, they have the same utility function for a given quality. Also, we will assume that all the consumers are risk averse.

$$u(q), \quad u'(q)>0, \quad u''(q)<0.$$

Let's consider the case where a consumer is informed of the value of $l$ but not of $\sigma^i$. We can immediately see that her expected utility from the product would be

$$E[u(q_B^i)] = \int_{-h}^{h} \frac{1}{2h}\, u(q_A^i + l + \sigma^i)\, d\sigma^i.$$

In this case, the difference in utilities between A and B will be

$$E[u(q_B^i)] - u(q_A^i) = \int_{-h}^{h} \frac{1}{2h}\, u(q_A^i + l + \sigma^i) - u(q_A^i)]\, d\sigma^i \equiv v(q_A^i, l).$$

In the equation above, $v(q_A^i, l)$ can be defined because $E[u(q_B^i)] - u(q_A^i)$ is a function of $q_A^i$ and $l$ for a given $h$.

From the assumptions we made, it is easy to see that $v(q_A^i, l)<0$, when $l=-1$ or $l=0$, and $v(q_A^i, l)>0$ when $l=1$.

What this means is that when the consumer does not know her $\sigma^i$, she will choose B only

when B is better than A and she will choose A otherwise.

In addition to the assumptions until now, we need to make some more assumptions as follows. Some of the following assumptions may look rather restrictive, and one may wonder if some assumptions are essential to get the result of this paper. We will discuss the necessity of these assumptions at the end of next section after analyzing the model.

First, when a firm advertises, the advertising cannot reach all the consumers and some consumers do not recognize that the product is being advertised. Furthermore, if a consumer does not see the advertisement of the new product, she will not even notice the existence of the new product B. However, once the consumer sees the advertising, she will notice not only the existence of the product but also the advertising cost of the product. What we mean by this is as follows. If a consumers sees a specific advertisement, she can see how many famous singers or movie stars were on that advertisement. Also, she can see which page of the newspaper the advertisement was on or what time the TV commercial was on. In addition, she can see the size of the advertising on a newspaper and the length of the TV commercial. In some cases, the newspapers literally tell you how much it cost to make that specific advertisement. We assume that from these facts a consumer with some common senses can correctly guess the amount of money the firm spent on that advertisement.

We will denote the proportion of consumers who missed the advertising of product A in a given period by $\alpha$ $(0<\alpha<1)$, and the proportion who missed the advertising of product B in a given period by $\beta$ $(0<\beta<1)$. We will assume that $\alpha$ and $\beta$ are fixed regardless of the advertising costs.

Second, we will assume that after each period the consumers of the next period ask the people who have purchased the new product in the previous periods about the quality of the new product.

Here, we will assume that there exist communication groups or neighborhoods among consumers, and the quality of information a consumer can get from the members of the same communication group is higher than that from consumers of different groups.

This means that if consumers belong to the same group and one of them purchases the new product B in a certain period, the other members of the group who make purchasing decisions after that period can observe the quality of B and figure out the exact individual utility they will get from it, $q_B^i$. In the real world we can think of these groups as next door neighbors or family members who can share or talk about products that they have purchased without any significant cost of communication. For example, if your next door neighbor bought a new toy to her child, you can directly see how much your child likes that new toy, because your child can have a chance to play with it when you visit the neighbor. This kind of detailed information cannot be earned from somebody who you visit once or twice a year.

However, one can get some information even from somebody in a long distance. For example, a lady who lives in New York can tell her sister in L.A that a certain toy that she bought recently is dangerous to the children. We will assume that incomplete communication exists between groups. Formally, what we mean by this is that even though a person (he) in a group who has already purchased the new product B cannot tell someone (she) in another group what her $\sigma_i$ would be when she uses the new product, he can tell her whether he liked B more than A or not. If one talks with several people from different groups who have already used the new product, one will have a good chance to figure our $l$. We will assume that this survey of $l$ is perfect and that everybody will find out the value of $l$ immediately after the first

period, through either inter-group or intra-group surveys.

Because these inter-group surveys cannot deliver any information on $\sigma_i$ to a consumer of a different group, she will not be able to know whether she will actually prefer A or B through inter-group surveys when A and B are equal, $l=0$.

For the convenience of the modeling process, we will assume that each group has $T$ members and that one member from each group makes a purchase in each period.

Third, we will assume that the price is fixed at the same level for both products A and B. We can think of a case where the dominant incumbent firm has a strategy that if any entrant cuts the price, it will lower its price to the marginal cost thereafter. As a result, an entrant will not try to set a price lower than the existing price of the incumbent.

We will also assume that all the firms have the same constant marginal cost.

Also, we will assume that this fixed price is lower than $\min\{q_A^i\}$, so that all the consumers will purchase A at this price unless they think that B is better than A.

Another restriction that we want to impose is that $\phi_B$ is big enough to satisfy

$$\frac{(1-\beta)\alpha\phi_E}{(1-\beta)\phi_B+(1-\beta)\alpha\phi_E}v(q_A^i, 0)+\frac{(1-\beta)\phi_B}{(1-\beta)\phi_B+(1-\beta)\alpha\phi_E}v(q_A^i, 1)>0, \text{ for all } q_A^i \quad (2)$$

Of course, $v(q_A^i, 1)$ is positive and $v(q_A^i, 0)$ is negative. However, unless the consumer is extremely risk adverse, the inequality (2) can be satisfied for a $\phi_B$ which is not so small. One would wonder where this inequality came from but we will see that this assumption is necessary in order to support the consumer behavior of the equilibrium in the next section.

For notations we will use w as the net profit of the firm from each product sold, and $F$ as the fixed cost of entry divided by $N/T$. $c_B$ is the advertisement cost of the entrant per consumer of one period, or in other words, the total advertising cost of the entrant divided by $N/T$. Likewise, $c_A$ is the advertising cost of the incumbent per consumer of one period. We will assume that both advertising levels are fixed and externally given, and both of the firms can advertise only at those levels. In addition, we will assume that the two firms decide whether they will advertise or not simultaneously at the beginning of each period.

If the entrant decides not to enter, it can avoid the fixed cost of the entry $F$.

In this model the only decision that the incumbent firm can make is whether to advertise or not. On the other hand, the entrant should decide first if it wants to enter the market with the fixed cost. Then, the entrant should decide if it wants to advertise or not. We will assume that both incumbent and entrant know the qualities of A and B before they make any of these decisions.

We will denote the incumbent's first period choice as $s_A^l$ where $s_A^l \in \{0, 1\}$, $l=-1, 0, 1$.

As we have defined already, $l$ is the quality difference common to all the consumers. Therefore, $s_A^{-1}$ means the incumbent's choice when A is better than B. $s_A^l=0$ means that the incumbent decides not to advertise, while $s_A^l=1$ means that the incumbent decides to advertise.

Similarly, we will denote the entrant's first period choice as $(e^l, s_B^l)$ where $s_B^l \in \{0, 1\}$, $l=-1, 0, 1$, and $e^l \in \{0, 1\}$. Here, $e^l=0$ means that the entrant will not enter the market, while $e^l=1$ means that the entrant will enter the market. Same as the incumbent's case, $s_B^{-1}$ means the entrant's choice on advertising B when A is better than B.

## II. *The Equilibrium*

The main result of this paper is that for some $c_A$ and $c_B$ there is an equilibrium where the incumbent's product A will be advertised.

Before showing the existence of the equilibrium, we will describe it first.

In that equilibrium the firms' behavior will be as follows. The entrant enters the market and advertises when product B is equal to or better than A, while the incumbent advertises only when product A is equal to B. If we use the notation, it will be $(s_A^{-1}, s_A^0, s_A^1)=(0, 1, 0)$, $(s_B^{-1}, s_B^0, s_B^1)=(0, 1, 1)$, $(e^{-1}, e^0, e^1)=(0, 1, 1)$.

Also in this equilibrium, a first period consumer will buy the product A if she has not seen any advertisements for product B because she will not even notice the existence of B. If she sees the advertisement of product A, she will buy product A whether she sees the advertisement of product B or not. If she sees only the advertisement of product B, she will buy product B. Then, after the first period consumers will take part in casual surveys among their neighbors who have bought product B in the previous periods, and will find out whether product B is worse than, equal to, or better than A as we have assumed. From the second period on, consumers will make their purchasing decisions by comparing $q_A^i$ and $q_B^i$, if they know their $\sigma^i$'s. However, they may know only $l$ but not their $\sigma^i$'s if nobody from their group has bought B in the pervious periods. In this case, they will consider $v(q_A^i, l)$ and buy the new product B only when B is better, or in other words, when $l=1$. When $l=-1$ or $l=0$, they will buy product A.

If there is an equilibrium as described above, it should satisfy the incentive constraints shown as the following inequalities. We will show the existence of the equilibrium in the case of the advertising of a well-known product by showing that there exist the advertising levels $c_B$ and $c_A$ that satisfy the incentive constraints of the firms when the number of periods, $T$, is big enough.

We will first show the firms' incentive constraints, assuming that the consumers follow the equilibrium behavior described above. After that we will show why these constraints justify the consumer behavior in the equilibrium.

For convenience, we will ignore the firms' discount factors by assuming $\delta=1$. We will maintain the assumption that a consumer will figure out $l$, immediately after the first period, whether someone in her group has purchased it or not. On the other hand, she can learn her $\sigma_i$ only when someone from her group has purchased the product in previous periods.

• *Condition for the entrant not to advertise when* $l=-1$:

$$(1-\beta)w-c_B\leq F \tag{3}$$

This means that even selling to all the consumers who saw the advertisement in the first period, $(1-\beta)$, won't be enough to cover the advertising cost and to give the entrant a positive profit. If product B is used by some people in the first period, and if everybody who used it agrees that it is worse, no consumer will buy B after the first period in this equilibrium. Therefore, if the advertising cost cannot be recuperated in the first period, the entrant with a worse product will not advertise.

• *Condition for the entrant to advertise when* $l=0$:

$$\alpha(1-\beta)\left\{1+\frac{1}{2}(T-1)\right\}w-c_B\geq F \tag{4}$$

In the equilibrium that we are dealing with, a consumer will purchase A, if nobody in her group has purchased the new product B in the first period and B turns out to be an equal product after the first period. However, it may be possible that she has a member in her group who purchased B in the first period because he did not see the advertisement of A but saw the advertisement of B, which may happen to a first period consumer with probability $(1-\beta)\alpha$. In this case, with a probability $\frac{1}{2}$ the second period consumer may find herself to prefer B to A. As a result, B would be purchased by $\frac{1}{2}(1-\beta)\alpha$ consumers in each period for $T-1$ periods from the second period on. If inequality (4) is satisfied, the advertising cost $c_B$ can be covered by this $T-1$ periods sale and the entrant can make a positive profit.

We can easily see that if the entrant advertises when B is equal to A, it will surely advertise when B is better.

• *Condition for the incumbent not to advertise when* $l=1$:

$$\{(1-\alpha)+\alpha\beta\}w-c_A\leq\beta w \tag{5}$$

If A is advertised when it is worse, A would be sold to $[(1-\alpha)+\alpha\beta]$ consumers in the first period because the number of consumers who will see only the advertisement for B would be $\alpha(1-\beta)$. However, no consumers will buy A after the first period once it is known that B is better. The right hand side of (5) denotes the profit of the incumbent when it does not advertise, which derives from the fact that some of the first period consumers would miss the advertising of B and purchase A without even realizing the existence of B. If inequality (5) is satisfied, the advertisement cost level $c_A$ is too high for the incumbent firm with a worse product to advertise its product A.

• *Condition for the incumbent to advertise when* $l=0$:

$$\left[\{(1-\alpha)+\alpha\beta\}T+\frac{1}{2}\alpha(1-\beta)(T-1)\right]w-c_A\geq\left\{\beta T+\frac{1}{2}(1-\beta)(T-1)\right\}w \tag{6}$$

If A is advertised, the consumers who have seen the advertisement for product A, and those who have seen neither the advertisement for A nor that for B, will purchase A. On the other hand, if A is not advertised, all consumers who have seen the advertisement for B will use B in the first period. After the first period, among the consumers whose groups have a member who used B in the first period, half of them will find themselves preferring A due to observing one of their members who bought B in the first period and will buy A in the following periods, while the other half will find themselves preferring B. As a result, the profit of the incumbent firm who advertises will be as shown on the left hand side of (6). The right hand side is the profit when the incumbent does not advertise A. If inequality (6) is satisfied, the incumbent firm will get a higher profit by advertising its product when A and B have an equal quality.

For the number of periods, $T$, large enough we can always find $c_B>0$ which satisfies (4). On the other hand, a $c_B$ that satisfies (3) can be found if $(1-\beta)w\leq F$.

$$(1-\beta)w-F\leq c_B\leq\alpha(1-\beta)\left(1+\frac{1}{2}(T-1)\right)w-F \tag{7}$$

Obviously, we can find $c_B$ as long as $T$ is large enough to satisfy $\alpha\left(1+\frac{1}{2}(T-1)\right)\geq 1$ or in other words, $T\geq 1+\frac{2(1-\alpha)}{\alpha}$.

We can also find $c_A>0$ which satisfies (5), (6).

$$[(1-\alpha)+\alpha\beta-\beta]w=[(1-\alpha)(1-\beta)]w\leq c_A$$
$$\leq[((1-\alpha)+\alpha\beta-\beta)T-\frac{1}{2}(1-\alpha)(1-\beta)(T-1)]w=\frac{1}{2}[(1-\alpha)(1-\beta)(T+1)]w \tag{8}$$

Obviously, we can find $c_A$ as long as $T$ is large enough to satisfy $\frac{1}{2}(T+1)\geq 1$ or in other words, $T\geq 1$.

Even though we are not going to go through it, it is easy to see that we would be able to find $c_B$ and $c_A$ for $\delta<1$ when $\delta$ is big enough, because the profit functions of the firms are continuous in $\delta$ and the incentive constraints will still hold for $\delta$ near 1.

Let's consider the consumer side. We assumed that if they do not see the advertisement for B, they would not even know the existence of the new product and will buy A as a result. There can be three cases which a consumer in the first period may face when she saw the advertisement for B. We will call them case 1, 2, and 3. In case 1, the consumer sees only the advertisement for A. In case 2, the consumer sees only the advertisement for B. In case 3, the consumer sees both advertisements.

In cases 1 and 3 they will know that the two products are equal because A would be advertised only when the qualities are equal. In these cases, the consumers who we assumed to be risk averse will purchase A instead of B because the expected utility from B is lower than that from A. In case 2, B is equal to A if the consumer has missed the advertisement for A, while B is better if A was not actually being advertised. In this case, if the probability that B is better, $\phi_B$ is not too small, they will buy B, and we have already assumed this at (2) by $\frac{(1-\beta)\alpha\phi_E}{(1-\beta)\phi_B+(1-\beta)\alpha\phi_E}v(q_A^i,\,0)+\frac{(1-\beta)\phi_B}{(1-\beta)\phi_B+(1-\beta)\alpha\phi_E}v(q_A^i,\,1)>0.$

The consumers from the second period on will make their purchasing decision by comparing $q_A^i$ and $q_B^i$ if they know their $\sigma^i$'s, while they will purchase B only when B is better if they do not know their $\sigma^i$'s.

The existence of this equilibrium indicates that we can see a positive amount of incumbent advertising when the two products are equal.

We need to define $T^*$ as below for the next proposition.

$$T^*=\max\left\{\frac{2F}{\alpha(1-\beta)w}-1,\,1+\frac{2(1-\alpha)}{\alpha}\right\}$$

**Proposition 1**: In the model described here with the fixed cost $F\geq(1-\beta)w$, if the number of periods $T$ satisfies $T>T^*$, then for a discount factor $\delta$ large enough, there exists an equilibrium with strictly positive advertising costs $(c_B,\,c_A)$ where

(i) product A will be advertised if and only if A and B are equal,

(ii) product B will be advertised and introduced to the market if and only if B is equal or better, and

(iii) consumers will buy B in the first period if and only if they see only the advertisement of B.

In other words, proposition 1 says there can be an equilibrium such as $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 0)$ and $(s_B^{-1}, s_B^0, s_B^1, e^{-1}, e^0, e^1) = (0, 1, 1, 0, 1, 1)$.

Proof) $(c_B, c_A)$ can be found as long as the inequalities from (3) to (8) are satisfied. First, we can find $c_B$ that satisfies (3) if $F \geq (1-\beta)w$. Second, we can find $c_B$ that satisfies (4) if $T \geq \frac{2F}{\alpha(1-\beta)w} - 1$. Third, $\{(1-\alpha)+\alpha\beta\}w \leq \beta w$ and $\left[\{(1-\alpha)+\alpha\beta\}T + \frac{1}{2}\alpha(1-\beta)(T-1)\right]w \geq \{\beta T + \frac{1}{2}(1-\beta)(T-1)\}w$ always hold, therefore, (5) and (6) would be satisfied automatically. Fourth, we have already seen that $T \geq 1 + \frac{2(1-\alpha)}{\alpha}$ would satisfy (7) and (8).

Even though proposition 1 is concerned with the possible existence of the equilibrium, if we modify the assumption in the inequality (2), we can argue that it is the only pure strategy equilibrium that survives a modified intuitive criterion of Cho and Kreps (1987).

The modified intuitive criterion is as follows.

In Cho and Kreps, there are two players. Let's call them P1 and P2. The situation is that the type of P2 is unknown to P1 and P2 can signal its type to P1. In that case some sequential equilibria can be eliminated by the intuitive criterion when a certain type of P2 can never gain from deviating from that sequential equilibrium while some other types may gain from deviating from it. The difference between the case of Cho and Kreps and our situation is that we have another player P3 whose type is not known to P1 either. Naturally, in our model P1 is the consumer and P2 and P3 are the firms who can signal their product qualities through advertising. What we want to modify here is that we will apply the intuitive criterion repeatedly. In other words, after a certain equilibrium is eliminated by applying the intuitive criterion regarding the type of P2, we will apply the intuitive criterion regarding the type of P3. In other word, we will apply the intuitive criterion repeatedly.

This concept that we may call a repeated application of intuitive criterion will become clearer when we actually applies it in the next proposition.

Before going to the next proposition we need a bit of modification of (2), and that is

$$\frac{\phi_E}{\phi_B+\phi_E} v(q_A^i, 0) + \frac{\phi_B}{\phi_B+\phi_E} v(q_A^i, 1) > 0, \text{ for all } q_A^i \tag{9}$$

Once again this inequality (9) can be easily satisfied if the consumer's risk aversion is not so strong and $\phi_B$ is not so small.

Now we can talk about the next proposition.

**Proposition 2**: If the inequality (9) is satisfied, the equilibrium in proposition 1 is the unique pure strategy equilibrium that survives the repeated application of the intuitive criterion of Cho and Kreps (1987).

Proof) What the incumbent has to choose is $(s_A^{-1}, s_A^0, s_A^1)$. On the other hand, the entrant

has to choose $(s_B^{-1}, s_B^0, s_B^1, e^{-1}, e^0, e^1)$. Because there will be no more information that the firms can signal to the consumers from the second period on, it will be enough for us to consider only the first period.

First, it never makes sense for the entrant to enter without advertising. If the entrant enters without advertising, it cannot sell to anyone while there will be a fixed cost, $F$. Therefore, in any equilibrium the entrant should advertise whenever they enter the market. So, in any equilibrium $s_B^l = e^l$ for $l = -1, 0, 1$.

Next, for the entrant $e^{-1} = 1$ is dominated by $e^{-1} = 0$. Even if the entrant with worse B advertises after entering the market, it will never recover the advertising cost because of the inequality (3).

Because B will not enter the market when B is worse, there is no reason for the incumbent to spend money on advertising A in that case. Therefore, $s_A^{-1} = 0$ is the dominant strategy for the incumbent.

Now consider the case where B is equal or better. Then, there are four possibilities as long as the entrant is concerned. $(s_B^{-1}, s_B^0, s_B^1) = (0, 0, 0)$, $(s_B^{-1}, s_B^0, s_B^1) = (0, 0, 1)$, $(s_B^{-1}, s_B^0, s_B^1) = (0, 1, 0)$, and $(s_B^{-1}, s_B^0, s_B^1) = (0, 1, 1)$.

First, $(s_B^{-1}, s_B^0, s_B^1) = (0, 0, 0)$ cannot survive the intuitive criterion. As we showed, the entrant will never advertise when $l = -1$. Therefore, the consumers know that it is either $l = 0$ or $l = 1$, whenever they see the advertisement of B. From (9) we can see that the consumers will buy B in this case.

Second, $(s_B^{-1}, s_B^0, s_B^1) = (0, 0, 1)$ cannot be an equilibrium because the consumers will always purchase B whenever they see the advertisement of B, then the entrant will have an incentive to advertise even when $l = 0$.

Third, $(s_B^{-1}, s_B^0, s_B^1) = (0, 1, 0)$ cannot be an equilibrium, either. No consumer will purchase B if B is not advertised when $l = 1$.

Therefore, in an equilibrium that survives the repeated application of intuitive criterion, it should be $(s_B^{-1}, s_B^0, s_B^1) = (0, 1, 1)$.

Let's consider the incumbent's choices. We already know that it should be $s_A^{-1} = 0$. Then, the incumbent has four possibilities, $(s_A^{-1}, s_A^0, s_A^1) = (0, 0, 0)$, $(s_A^{-1}, s_A^0, s_A^1) = (0, 0, 1)$, $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 0)$, and $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 1)$.

First, $(s_A^{-1}, s_A^0, s_A^1) = (0, 0, 1)$ cannot be an equilibrium case. Here, the incumbent advertises only when A is worse than B. The consumers will buy B instead of A whenever they see the advertisement of A.

Second, $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 1)$ cannot be an equilibrium, either. Because of the inequality (9), the consumers will end up purchasing B instead of A whenever they see the advertisement of A in this case.

Third, $(s_A^{-1}, s_A^0, s_A^1) = (0, 0, 0)$ cannot survive the repeated application of intuitive criterion. In this case from the inequalities (5) and (6), the only case that the incumbent may gain from advertising is when $l = 0$. Therefore, the consumers will believe that $l = 0$ and buy A, if they see the advertisement of A in this case. As a result, this equilibrium cannot survive.

In the end, the only possibility is $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 0)$.

Therefore, the only possible equilibrium is $(s_A^{-1}, s_A^0, s_A^1) = (0, 1, 0)$ and $(s_B^{-1}, s_B^0, s_B^1, e^{-1}, e^0, e^1) = (0, 1, 1, 0, 1, 1)$.

Before we move on to conclusion, let's take another look at the assumptions that we made

in the previous section. Especially, let's check if some of the rather restrictive assumptions that we made were really necessary and if they can be replaced by other assumptions.

Basically, what we needed in assumptions in order to get the result of incumbent advertising were as follows.

First, when the two products are equal some consumers should end up buying product B. For this reason, we have assumed that the advertising would not be seen by $\alpha$ and $\beta$ portion of consumers respectively.

This does not mean that we cannot modify this assumption. Actually, we can imagine other assumptions that would have a similar effect as our assumption. For example, we can assume that some consumers who are not happy with the incumbent product may change to the new product when the two products are equal.

Second, we assumed that the consumers do not purchase the product repeatedly because if the consumers use the product every period, they would have incentives to experiment the new product B, even when they believe that B has an inferior quality.

However, our model can be used in explaining the advertising of a repeatedly purchased product in some special cases. If $h$ is very small in $\sigma^i \in [-h, h]$ and the consumers are strongly risk averse, then they would not experiment, even if they purchase the product repeatedly.

Third, the market shares of the two products in the first period should have a lasting effect on the market shares in the following periods. For this we made assumptions that make the information on the products' qualities gathered in the first period valuable for the consumers in the following periods. Particularly, the assumptions of the consumer communication groups are related to this point. We assumed that there are inter- and intra-group communications and that the inter-group communication can deliver better information.

Without the inter-group communications all the consumers will buy A when the two products are equal and the first period advertising would become futile. Intra-group communication is needed for our results because the consumers should be able to figure out the low quality product and stop purchasing it eventually. Surely, it does not have to be intra-group communication. It can be something such as being able to observe the past market share. Then, the consumers would have the power to tell the better product from the second period on, when the two products are not equal.

We have consider the necessity of the three assumptions which are probably most restrictive among the assumptions of this model. We cannot exclude the possibility that we may find another set of assumptions that can play the same roles as the assumptions of this paper, but we can say that the result of this paper will not hold if we just drop any of the assumptions we made without replacing it with another one.

Next, let's relax the restriction on $\sigma^i$. We can see that $\sigma^i$ does not have to be uniformly distributed in $(-h, h)$. What is actually important in proposition 1 is that $E(\sigma^i)$ should be small enough and $Var(\sigma^i)$ should be big enough for consumers not to purchase B when they find that B and A are equal.

What is more important is that it does not have to be the case that $l=0$ when the two products are equal. If $l$ has a value near 0, the risk averse consumers will not change to B when they do not know their $\sigma^i$'s but know that A and B are equal. If some of the consumers get to know their $\sigma^i$'s, a $\frac{l+h}{2h}$ portion of them will switch to A. Here, it does not matter whether $l$ is positive or negative as long as it is close enough to 0. In this section, we have looked at only

the case of $l=0$ and $\frac{l+h}{2h}=\frac{1}{2}$, but it is easy to see that the results of proposition 1 and 2 hold as long as $l$ is close to 0 even though it is not really 0. Furthermore, when B is worse or better, it does not have to be $l=-1$ and $l=1$ as long as they are far away from 0 especially compared with $-h$ and $h$.

This can explain the phenomenon that some incumbent products with qualities slightly worse than the new products are continued to be advertised, if we understand this as the case where $l>0$ even though $l$ is fairly near zero.

In conclusion, the results of this section hold for the general cases where there are three different common preference levels, in other words $l$'s; and the quality differences are big compared with the individual preference differences, in other words $\sigma^i$'s.

## III. *Conclusion*

In this paper we have shown that it is possible to use the cash-burning quality signalling model of advertising to explain the phenomenon of the advertisement of an already well-known quality product.

The cash-burning model which explains advertising as a signalling method of the product's quality is a charming alternative to the conventional explanation which regards advertising simply as a psychological phenomenon of rather irrational consumers. However, it has been pointed out that this cash-burning model cannot explain the phenomenon of the advertising of well-known quality products which we can often observe in reality, and this was a great short coming of the model.

Even though this paper was limited to the case of durable goods, the main contribution of this paper is that it was the first successful trial in applying the cash-burning model of advertising to a case where there is an on-going advertising, even after the first initial period.

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