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THE ADVERTISING OF CREDENCE GOODS AS A SIGNAL OF PRODUCT QUALITY*

by

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The advertising of credence goods is analysed in a similar way to the way Milgrom and Roberts analysed the advertising of experience goods. The existing literature on credence goods has not considered the possibility that some consumers have the expertise to assess the product's quality and the possibility that the producer can advertise. I assume these two points and show that there exists a unique equilibrium that survives the 'intuitive criterion'. Also, it is shown that through encouraging producers to accept new technologies advertising may increase social welfare instead of just being a pure social cost.

'Credence goods' were first mentioned by Darby and Karni (1973), when they said that credence qualities are expensive to judge even after the purchase. In short, if a product is a credence good, it is costly for non-experts to assess the real value or quality of the product even after they purchase and use it.

One may feel that we can hardly find a real credence good because we can make at least some judgement on services or products after experiencing them. So, complete credence goods are difficult to find.

On the other hand, it is also true that for an average consumer it is difficult to figure out the long-term real value of any given product. One famous example of a credence good is the medical service because an average customer would not be able to judge if the removal of her appendix was appropriate or not. The car repair service is another well-known example due to the similarities to medical service. However, consumers in this day and age should also worry about the possible BSE infection of beef, the fertilizers used on spinach, and the safeness of the child seats that their children sit on.

It is no exaggeration that almost all products have some credence qualities, and therefore it is meaningful to analyse credence goods.

There have not been many papers on credence goods. Emons (1997, 2001) and De Jaegher and Jegers (2001) are some of the papers that have dealt with them. One characteristic of these papers is that it was assumed that all consumers were non-experts who would never figure out the quality of the product even after using it repeatedly.

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In this paper, we consider a slightly different situation where the consumers are not identical, in the sense that some portion of the consumers have the expertise to judge the product quality with little extra cost. We can assume that it is less likely for people who have a doctor in their family to buy over-priced or over-advertised drugs. Also, we can find some consumers around us who really do some research on healthy and organic food, and it can be assumed that these people are experts on good meat and vegetables.

Another assumption that we make is that the producer of a credence good is able to advertise its product. In reality we often see the advertising of credence goods such as hospitals, car repair shops, plumbing services and some medicines whose long-term effects we are not so sure about.

Obviously, the consumers who have the expertise do not need any information through advertising, and the consumers who do not have the expertise cannot get any information from advertising because of the lack of expertise. Therefore, advertising in this case cannot carry any information, but rather works as a cash-burning quality signal as it did for the experience goods in Milgrom and Roberts (1986).

In this paper we shall find that there exists a unique equilibrium that survives the 'intuitive criterion', and that this equilibrium is the separating equilibrium, with only the high quality producer advertising.

Later in the paper, we do a welfare analysis. We compare the social welfare levels of the equilibria with and without the possibility of advertising. The result is ambiguous. In other words, there are multiple equilibria when advertising is not available, and the unique equilibrium with advertising can provide a higher or a lower social welfare depending on which of the multiple equilibria will occur when advertising is not available. This ambiguous result itself is meaningful in the sense that advertising is not necessarily a pure social cost. In addition, we show that in some particular situations advertising will always increase social welfare by encouraging producers to accept new technologies. In other words, advertising will increase the profit difference between high and low quality producers, and as a result it can make producers more willing to accept a new technology that can improve their quality whenever they come across new technologies, even if accepting the technologies is costly.

1 Basic Model (One Period)

We are going to consider a case where N consumers buy a maximum of one unit of the product per period from a monopoly producer.

When a consumer uses the product, her utility from it will be u^L if the product has a low quality, and u^H if the product has a high quality, whether she can identify this or not ($0 < u^L < u^H$). The *ex ante* probability that the product has a high quality is ϕ.

We assume that there are two types of consumers: x of the consumers are 'informed', in the sense that they have the expertise or skills to judge the quality of the product even before using it, while the rest, $1 - x$, are 'uninformed' and unable to tell the quality even after they use it.

On the producer side, the quality of the product is exogenously given. We shall assume that the marginal cost is zero regardless of the quality, and denote advertising costs by c, which the producer can choose. There are no fixed costs, and the only costs to be considered are the zero marginal cost and advertising cost. The producer has to choose the price and advertising cost (p, c); then the consumers will decide whether they will buy the product or not.

First, we construct a separating equilibrium, where the high quality producer sets a high price and advertises, and the low quality producer sets a low price and does not advertise. However, there may be lots of other separating equilibria, not to mention pooling and other equilibria, and we will try to reduce the number of the equilibria by using the 'intuitive criterion' of Cho and Kreps (1987).

Let $\pi^L(b, p, c)$ denote the profit from the low quality product when the uninformed consumers believe that the quality is high with a probability of b and the producer sets the price and advertising cost at p and c respectively. Likewise, let $\pi^H(b, p, c)$ denote the profit from a high quality product. Of course, the belief b will be decided by p, c.

One obvious fact here is that at any equilibrium the producer will not set the price lower than u^L. In addition, as soon as we consider a separating equilibrium, we can see that the price will be $p = u^L$ if the product has a low quality. No consumer will pay more than u^L once they know that it is of low quality, and the low quality product will not be advertised in a separating equilibrium.

Even though the producer can choose the price, it is difficult to signal the product's quality only by the price. The reason for this is that the low quality producer has the same marginal cost as the high quality producer, and the low quality producer has the incentive to imitate the high quality producer's price if it is high. Of course, the high quality producer would want to set a price near u^H if possible, and something other than the price, such as the advertising cost c, would be a great help in signalling quality.[1]

Before we actually analyse the separating equilibrium, let us consider the size of the informed consumer, x. If x is large enough to satisfy $u^L N > u^H(1$

[1]This argument is related to the papers concerned with price as a quality signal. Usually, price cannot be an effective quality signal when the costs are the same regardless of the quality. Judd and Riordan (1991) showed that price can be a quality signal, even when the cost structures are the same regardless of the quality, if the consumers are not identical. We can interpret this as saying that advertising is a way of signalling the quality when the cost structures are the same and the consumers are identical.

$-x)N$, the low quality producer will never try to pretend to be the high quality producer. This is because the low quality producer cannot sell the product to informed consumers at a price higher than u^L, and if x is large the low quality producer can do better by selling the product to everybody at the price u^L than by selling the product to only the uninformed consumers at a higher price. It is clear that we would not see any advertising if $u^L N > u^H(1 - x)N$. Throughout this model we assume that $u^L N \le u^H(1 - x)N$.

Now, consider the case where the high quality producer sets the price at $p \ge u^L$ and the advertising cost at c. For this to be a separating equilibrium the low quality producer should not be able to increase its profit by imitating the high quality one: $\pi^L(1, p, c) \le \pi^L(0, u^L, 0)$; in other words

$$\hat{p}(1-x)N - c \le u^L N$$

Therefore, the advertising cost as a function of p should be $c(p) \ge [p(1 - x) - u^L]N$ to signal the product quality, and the profit of the high quality producer in that case would be

$$\pi^H[1, p, c(p)] = pN - c(p) \le \left(px + u^L\right)N = pxN + \pi^L\left(0, u^L, 0\right)$$

Lemma 1: The separating equilibrium where the high equality producer chooses $p = u^H$ and $c = [u^H(1 - x) - u^L]N$ is the only separating equilibrium which satisfies the 'intuitive criterion'.

Proof: It is enough to show that $(p, c) = (u^H, c(u^H))$ is the only pure strategy separating equilibrium which satisfies the intuitive criterion, because if there is no pure strategy surviving this criterion, there can be no mixed strategy separating equilibrium surviving it. First, advertising for a given p should be $c(p) \ge [p(1 - x) - u^L]N$ for it to be a separating equilibrium. If $c(p) > [p(1 - x) - u^L]N$, the high quality producer can increase its profit by decreasing c slightly and setting it at $c - \varepsilon$ $(c(p) - [p(1 - x) - u^L]N > \varepsilon > 0)$, while the low quality one cannot do better than $\pi^L(0, u^L, 0)$ by setting $(p, c(p) - \varepsilon)$. So, $c(p)$ should be $[p(1 - x) - u^L]N$. Then, the profit of a high quality producer is $(px + u^L)N$ and strictly increases with p. The highest p the firm can set is u^H. If $p < u^H$, the high quality producer can increase its profit by increasing p slightly and increasing c accordingly, but the low quality one cannot do better than $\pi^L(0, u^L, 0)$ by imitating it. ■

According to Lemma 1, at the separating equilibrium we can expect to see advertising at the level $c = [u^H(1 - x) - u^L]N = (u^H - u^L)N - u^H xN$, if the product is of a high quality. We can easily observe that there would be a greater presence of advertising as the quality difference $u^H - u^L$ is larger and as there are more uninformed consumers, which means a small x. These are very intuitive conclusions because if the quality gap is big and many consumers are uninformed, the low quality producer can gain a lot of profit once it is recognized as a high quality producer. Therefore, there needs to be very expensive signalling to prevent the low quality producer from imitating the high quality producer.

In Lemma 1 we saw that only one separating equilibrium survives the intuitive criterion. We can extend this result to other equilibria.

Lemma 2: In any equilibrium which survives the intuitive criterion, the high quality producer sets the price at $p = u^H$.

Proof: First, for a given p a low quality producer would not choose an advertisement level $c(p) > [p(1 - x) - u^L]N$ in any equilibrium, because this will result in a profit less than $\pi^L(0, u^L, 0)$.

Second, given that the low quality producer will not set $c(p) > [p(1 - x) - u^L]N$, a high quality producer will not set $c(p) > [p(1 - x) - u^L]N$ in any equilibrium, as we saw in Lemma 1.

Assume that there is an equilibrium where the high quality producer sets $p < u^H$ and advertises at a level $c \le [p(1 - x) - u^L]N$ with a strictly positive probability. Now consider a price and advertising cost pair $(p + 2\varepsilon, c + 2(1 - x)N\varepsilon + xN\varepsilon)$. Compared with (p, c), the high quality producer can increase its profit by $xN\varepsilon$ by using this new price and advertising cost, if the consumers believe that it is a high quality producer with probability one. On the other hand, a low quality producer would experience a profit loss if it imitates this strategy. Therefore, a strategy profile where the high quality producer sets $p < u^H$ cannot survive the intuitive criterion, and a high quality producer will always set $p = u^H$. ■

Consumers will never pay the price $p = u^H$ unless they believe that it is a high quality product with probability one. Therefore, Lemma 2 implies that the only possible equilibrium is a separating equilibrium, and from Lemma 1 we know that there is a unique separating equilibrium in this game.

Proposition 1: There exists a unique equilibrium which survives the intuitive criterion, and it is the separating equilibrium where a high quality producer sets $p = u^H$ and $c = [u^H(1 - x) - u^L]N$, and a low quality producer sets $p = u^L$ and $c = 0$.

Before we go to the next section, we want to mention the case where $u^L \le 0$. The first claim of Lemma 2 still holds in this case, which means that if it is a high quality product the price should be $p = u^H$ in any equilibrium that survives the intuitive criterion. Because a low quality producer cannot sell its product at a positive price in a separating equilibrium, the advertising level would be $c = u^H(1 - x)N$ in the separating equilibrium.

However, unlike the case of $u^L > 0$, there exists another equilibrium in this case. A high quality producer can charge $p = u^H$ with zero advertising, and the informed consumers will purchase at this price while the uninformed will not. The producer's profit in this case will be $\pi = u^H xN$, which coincides with the profit of the separating equilibrium with advertising.

2 Advertising and Social Welfare

To see how advertising affects social welfare, we will compare the separating equilibrium in Section 1, where the high quality producer always advertises, with other equilibria where no advertising is available.

Because u^L is bigger than the marginal cost, the social optimum can be achieved when the product is purchased by all the consumers whether it has a high quality or not. We can easily see that the social welfare loss in the unique equilibrium with advertising is the expected advertising cost itself, $\phi[(1 - x)u^H - u^L]N$.

Now, let us consider the equilibria where no advertising is allowed. First, the next lemma shows some restrictions on price setting in the equilibrium.

Lemma 3: When the possibility of advertising does not exist, there cannot be two prices in any equilibrium which are used with strictly positive probabilities by both high and low quality producers.

Proof: Assume that there exist two prices p_1 and p_2 ($p_1 < p_2$) that are used with strictly positive probabilities by both high quality and low quality producers in a certain equilibrium. Then, the two prices should be indifferent for both types of producer.

First, we should have $p_2 < u^H$, because the low quality producer sets this price with a strictly positive probability. On the other hand, the price will never be lower than u^L in any equilibrium. Therefore, $u^L \leq p_1 < p_2 < u^H$, and the informed consumers always buy a high quality product at p_2 but never buy a low quality product at p_2. If the low quality producer is indifferent between setting its price at p_1 and at p_2, while no informed consumers buy at p_2, the high quality producer cannot be indifferent between these two prices while selling to all the informed consumers at p_2. ■

Here, I want to make one assumption mainly for convenience. We restrict ourselves to equilibria where the consumers do not choose mixed strategies. For example, in any equilibrium, if one uninformed consumer purchases the product, all other uninformed consumers should also purchase it. After all, it may not be a particularly appealing idea that the consumers are randomizing precisely in a certain ratio when they are indifferent between buying and not buying. This assumption, which does not seem to be too harmful, will greatly simplify our analysis. On the other hand, we will keep allowing the producers to randomize when they set prices.

As we know from Lemma 3 different types of producers cannot share more than one price and so, assuming that the consumers cannot randomize, we can classify all the equilibria into three groups.

First is the pooling equilibrium. If both high and low quality producers set the price at p such that $p \le \phi u^H + (1 - \phi)u^L$, all the uninformed consumers will purchase the product and the informed ones will purchase it when it has a high quality. If we consider the intuitive criterion, another restriction on the price is $p \ge xu^H$. The high quality producer can get the profit of xu^H at any time by setting the price at $p = u^H$ and selling only to informed consumers. Therefore, it will never set a price such as $p < xu^H$ in any equilibrium.

The social welfare loss in this case will be $(1 - \phi)xu^L N$, because the informed consumers will not buy the product at a price higher than u^L, while it is socially optimal for all the consumers to buy the product regardless of the quality.

Since it is impossible in general to ascertain which is the smaller of the two social welfare losses with and without advertising, $\phi[(1 - x)u^H - u^L]N$ and $(1 - \phi)xu^L N$, we cannot conclude whether or not the existence of advertising contributes to social welfare in this case.

Second is the separating equilibrium. In the separating equilibrium the low quality producer will set $p^L = u^L$.

If $xu^H > u^L$, there can be an equilibrium where the high quality producer sets $p^H = u^H$ and sells only to informed consumers. In this case the uninformed consumers will know that this product has high quality, but because of the high price they will be indifferent between purchasing and not purchasing and we can consider an equilibrium where they do not purchase. This separating equilibrium will not survive the intuitive criterion if $xu^H < u^L/(1 - x)$. If the high quality producer sets $p^H = u^L/(1 - x)$ instead of $p^H = u^H$, the low quality one has no incentive to imitate and the profit will be higher than xu^H.

In this case of $xu^H \ge u^L/(1 - x)$, the social welfare loss will be $\phi(1 - x)u^H N$, and it is definitely more than the loss when advertising is available, $\phi[(1 - x)u^H - u^L]N$.

Now consider the separating equilibrium when $xu^H < u^L/(1 - x)$. The high quality producer's price should be low enough so that the low quality one has no incentive to imitate it. As a result, it should be $p^H \le u^L/(1 - x)$. However, if we apply the intuitive criterion again, all separating equilibria with $p^H < u^L/(1 - x)$ will be eliminated and only $p^H = u^L/(1 - x)$ will survive.

In this separating equilibrium all the consumers purchase the product all the time and there is no social welfare loss. Therefore, the separating equilibrium without advertising is socially better than the equilibrium with advertising, if $xu^H < u^L/(1 - x)$.

Third is the hybrid equilibrium where some prices will be set by both types of producers while other prices are set by only one type of producer. From Lemma 3, we already know that there can be at most one price that can be set by both types of producer. Let p^* be the price set by both types of producer. If there is a price that is set only by the low quality producer, it will be $p^L = u^L$. Because the low quality producer should be indifferent between p^* and $p^L = u^L$, we have $p^* = u^L/(1 - x)$. If it happens that $xu^H = u^L/(1 - x)$, the high quality producer may set $p^H = u^H$. Otherwise, the high quality producer cannot set a price other than p^*.

Another possible hybrid equilibrium is the case where the low quality producer sets only one price at $p^* \geq u^L/(1 - x)$, and the high quality producer is setting at $p^H = u^H$ as well as at p^*. Here, we have $p^* \geq u^L/(1 - x)$ because the low quality producer would rather set $p^L = u^L$ otherwise.

This can happen only when $p^* = xu^H \geq u^L/(1 - x)$.

If we compare the social welfare losses in these hybrid equilibria with that of the equilibrium with advertising, we cannot tell which is bigger in general.

In conclusion, the advertising for credence goods can be either a socially good phenomenon or a socially bad phenomenon depending on which equilibrium occurs when advertising is not allowed.

The fact that we cannot say that advertising is always a pure social cost is already meaningful. However, we can consider the following modified situation where the availability of advertising would always increase social welfare.

Assume that the producer may discover a new technology with probability ϕ, and that the technology would increase the value of the product from u^L to u^H, if the producer accepts it with a sunk cost of F. However, the producer can choose not to accept the technology and remain as a low quality producer. Of course, there is a probability $1 - \phi$ that the producer will not discover this technology and has to produce low quality products anyway. The decision concerning whether to accept this technology or not depends on the comparison of F and the profit difference between the high and the low quality producers.

The uninformed consumers cannot tell either if the producer has found the technology or if it has invested in the technology to increase the product's quality. They know only the probability ϕ and the sunk cost F. On the other hand, the informed consumers can tell the quality of the product precisely.

When advertising is available, we know from Section 1 that there is a unique equilibrium that survives the intuitive criterion. In that equilibrium the profit difference between the high and low quality producers is $xu^H N$.

On the other hand, when advertising is not available, there can be many equilibria as we have seen above. In these equilibria the profit difference between the high and low quality producers cannot be larger than $(xu^{\mathrm{H}} - u^{\mathrm{L}})N$, $[xu^{\mathrm{L}}/(1-x)]N$ and $x^2u^{\mathrm{H}}N$.

Let us define $\Delta\pi \equiv \max[xu^{\mathrm{H}} - u^{\mathrm{L}}, xu^{\mathrm{L}}/(1-x), x^2u^{\mathrm{H}}]N$, and see the next proposition. If we remember the assumption $u^{\mathrm{L}}N > u^{\mathrm{H}}(1-x)N$ that we made in Section 1, we can see that $xu^{\mathrm{H}}N > \Delta\pi$.

Proposition 2: In this model, if the sunk cost in implementing the new technology satisfies $xu^{\mathrm{H}}N > F > \Delta\pi$, the social welfare level when advertising is available will be higher than the social welfare level when advertising is not available.

Proof: We have already explained that if $F > \Delta\pi$ the producer will get a higher profit by not accepting the new technology when advertising is not allowed. On the other hand, the producer will accept the new technology when advertising is allowed as long as $xu^{\mathrm{H}}N > F$. Without advertising, even the uninformed consumers will know that the product has a low quality and the price should be $p = u^{\mathrm{L}}$, and the social surplus will be $u^{\mathrm{L}}N$. On the other hand, if the technology is accepted whenever the producer discovers it, we know that the expected social surplus, subtracting the expected advertising cost $\phi[(1-x)u^{\mathrm{H}} - u^{\mathrm{L}}]N$ and the expected sunk cost ϕF from the expected revenue of the producer $[\phi u^{\mathrm{H}} + (1-\phi)u^{\mathrm{L}}]N$, is $[\phi(xu^{\mathrm{H}} - F) + u^{\mathrm{L}}]N$. Obviously, $[\phi(xu^{\mathrm{H}} - F) + u^{\mathrm{L}}]N > u^{\mathrm{L}}N$. ■

The intuition is clear. If advertising is available, the only possible equilibrium is the separating equilibrium in which the high quality producer's profit is at a maximum among the separating equilibria, which means that the profit difference between the high quality producer and the low quality one is the largest in this equilibrium. A producer is more inclined to pay the sunk cost and accept the technology when it can obtain a higher profit from producing high quality products. Therefore, advertising plays a role in encouraging the producer to invest in new technology, and ultimately increases social welfare.

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