Informative Advertising as Signal of Quality

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Introduction

Roles of Advertising
Empirical Evidences
Advertising Behaviours over the Product Life-Cycle

The Model

Model Description
Separating Equilibrium
Pooling Equilibrium.

Dynamic of Advertising over the Product’s Life Cycle

Separating Equilibrium
Marketing Strategy
Advertising as Quality Signalling Device


- Information contents are nonverifiable especially for experience goods.
- Can only be rationalised as an instrument that informs consumers indirectly about quality. (Advertising signals quality)
- Consumers infer quality from the volume of exposures rather than its content. (Milgrom and Roberts 1986 and Kihlstrom and Riordan 1984)
Informative View

Advertising delivers direct and explicit information.

Some information is delivered directly. (Stigler 1961; Butter 1977; and Grossman and Shapiro 1984)

- Existence
- Location
- Attribute
- Price
Empirical Evidence I

Advertising provides information...

- Studies from Marketing literature confirm that advertising does contain some information about quality. (Resnik and Stern, 1977; Abernethy and Franke, 1996)

- Advertising *both signals quality and conveys direct information* (Ackerberg 2003 on yogurt industry; Shum 2004 on breakfast-cereals; Erdem et al 2008 on ketchup industry)

- Actually, advertising may informative to some consumers and uninformative to others as they have different levels of knowledge about the advertised product, e.g. technical specification of computers, mobile phones or cars.
Product attributes such as thickness of ketchup, spiciness of food, design of cars are not all liked by all consumers.

Increased exposure to ads may reduce demand if the *match* between preference and attribute is lower than average match (Anand and Shachar, 2004)
To conclude:

1. Advertising both signals quality and conveys real information.
2. Some information contained in advertising enable consumers to learn a “match” between attributes and preference which create demand dispersion.

1st contribution of this paper: Incorporating these empirical facts into a unified model that explains how informative advertising can signal quality.
Dynamic of Firm’s Advertising Behaviours over the Product Life-Cycle

Empirical predictions of standard advertising signalling models.

Milgrom and Roberts (1986):

- Two periods model with repeat purchase
- High quality product is more costly to produce
- High price alone is not the most cost effective way to signal quality
- Multiple signals (Price & Advertising) are used in the 1st period
  - Reducing price towards monopoly level
  - Positive (dissipative) advertising
- **Empirical Prediction**: Lower (supra-monopoly) price and positive advertising in the first period to increase consumer base. Then, higher price with no advertising thereafter.
Empirical Findings

Standard signalling models cannot explain advertising dynamics.

- Advertising for a newly introduced brand is primarily to provide information on inherent product characteristics to uninformed consumers. (Ackerberg 2001, 2003)

- Dissipative advertising is relevant when the product is well established; it increases and peaks after the introductory period and then slowly declines with consumer experience. (Horstmann and MacDonald 2003)

- High prices are used initially and decline over time (Curry and Riesz, 1988 and Horstmann and MacDonald, 2003)

- 2nd contribution of this paper: Proposing a static advertising signalling model that qualitatively captures these stylised facts by allowing for both informative and dissipative advertising.
The Basic Model

- A new product with uncertain quality $q \in \{H, L\}$ privately known by the firm is introduced. The prior belief that a firm produces high-quality product is $\lambda \in (0, 1)$.

- The cost of producing one unit of the product is $c_H = c > 0$ and $c_L = 0$.

- A continuum of potential consumers with mass 1 and identical reservation price for a low quality product, $\theta \in (0, 1)$.

- Each consumer is characterised by her idiosyncratic willingness to pay for the high quality product, $\theta_i \in [\theta, 1 + \theta]$. It determines a match between the product characteristics and preference.
The Basic Model

- There are some already informed consumer. Let $X$ denote the ratio of informed to uninformed consumers. Informed consumers know both product quality and their valuations for a high-quality product. (There are initially $\frac{X}{1+X}$ informed consumers)

- Uninform consumers are ex ante identical; they do not know $q$ and $\theta_i$ unless they are reached by advertising with reasonable precision. The ex ante distribution of $\theta_i$ is $\theta_i \sim U[\theta, 1+\theta]$.

- The seller can inform its true quality through informative advertising. The cost of advertising campaign that informs a fraction $\alpha$ of consumers the true quality is $C(\alpha) = \frac{1}{2} \alpha^2$ where $0 \leq \alpha \leq 1$. Advertising expenditure is observable to all consumers.
The Basic Model

- We assume for simplicity that when a consumer learns quality of the product \((q)\), she also learns the match \((\theta_i)\).
- **Perfect Bayesian Equilibrium (PBE)** is employed as an equilibrium concept.
- Equilibrium selection refinements used are **Intuitive Criterion** (Cho and Kreps, 1987) and **Undefeated Equilibrium** (Mailath et al, 1993).
Separating Equilibrium

- Consumers observing price and advertising expenditure immediately know the product quality (not necessary know their valuation for the product).
- A low-quality firm will never advertise in any separating equilibrium; so, \((p_L, \alpha_L) = (\theta, 0)\)

**Definition**

A monopoly is a *niche market* supplier if it serves only informed consumers knowing their valuations. Otherwise, a monopoly is a *mass market* supplier.
Niche Market Advertising Separating Equilibrium

- The monopolist serves only fully informed consumers. That is $p^N > \frac{1}{2} + \theta$.
- Equilibrium with profit maximisation implies
  \[
  (p^N, \alpha^N) = \arg\max_{(p,\alpha)} (p - c) \left[ \left( \frac{X + \alpha}{1 + \alpha} \right) (1 + \theta - p) \right] - C(\alpha)
  \]
- Belief system: $\lambda^e (p^N, \alpha^N) = 1$ and $0$, otherwise.
- Signalling is not an issue in a niche market equilibrium as at price $p^N$ only consumers knowing their valuations (and hence, product quality through advertising) would want to buy.
Mass Market Advertising Separating Equilibrium

- The monopolist serves both fully informed consumers (willingness to pay = $\theta_i$) and consumers who do not learn their valuations and product’s quality from informative contents of advertising (willingness to pay = $1/2 + \theta$).
- Price and advertising expenditure are used as signals of high quality by the latter group of consumers.
- The low-quality firm will not mimic a high-quality supplier’s price and advertising ($p, \alpha$) if

$$\pi(L, \lambda^e = 1, p, \alpha) \leq \pi(L, 0, \theta, 0)$$

or,

$$p \leq \frac{(\theta + 1/2\alpha^2)}{1 - \alpha} (1 + X)$$

or

$$P(\alpha)$$
Non-Imitating Condition
A lower bound of price-ads set that a L-firm has an incentive to imitate

\[ \frac{1}{2} + \theta \]

\[ \theta \]

\[ \alpha \]

\[ P(\alpha) \]

H-firm chooses \( \alpha^M \in [0, \alpha] \) and the corresponding price along \( P(\alpha) \) that maximise its profit.
Existence of Mass Market Equilibrium

This implies:

\[ \alpha^M = \arg\max_{\alpha} (P(\alpha) - c) \left[ \frac{X + \alpha}{1 + X} (1 + \theta - P(\alpha)) + \frac{1 - \alpha}{1 + X} \right] - C(\alpha) \]

and \( p^M = P(\alpha^M) \).

Let

\[ f (c, \theta, X) \equiv \pi \left( H, \lambda^e = 1, p^M, \alpha^M \right) - \sup \left\{ \pi (H, 0, \tilde{p}, \tilde{\alpha}) \mid (\tilde{p}, \tilde{\alpha}) \in \mathbb{R}^2_+ \right\} \]

be the difference between profits from mass market equilibrium and the best deviation strategy.
Existence of Mass Market Equilibrium

Proposition

A mass market advertising separating equilibrium in which the high-quality firm maximises its profit exists if either \( c < \theta \) or \( c \geq \theta \) and \( f(c, \theta, X) \geq 0 \).
Discussion

- For the firm operating in the mass market, informative advertising is demand reducing.
- While some consumers informed by advertising refuse to buy high-quality product at equilibrium price, every informed consumer will not buy from low-quality supplier.
- Asymmetry in return of advertising between two types of firm makes advertising an effective signal.
Pooling Equilibrium

- Both high- and low-quality suppliers set the same price and advertising intensity \((p^*, \alpha^*)\).
- Uninformed consumers’ max willingness to pay is \(\frac{\lambda}{2} + \theta\) (expected utility from consumption given belief about firm’s type).
- Both types of firms must be willing to pool.
Pooling Equilibrium

\[ P(\alpha) \]

\[ \frac{1}{2} + \theta \]

\[ \frac{3}{2} + \theta \]

\[ L\text{-mimic} \]

\[ L\text{-pool} \]

\[ \theta \]
Existence of Pooling Equilibrium

**Proposition**

\((p^*, \alpha^*)\) and a belief system \(\lambda^e(p^*, \alpha^*) = 1\) and \(\lambda^e(p', \alpha') = 0\) for all \((p', \alpha') \neq (p^*, \alpha^*)\) constitute a pooling equilibrium if

1. \(\max\{c, \bar{P}(\alpha^*)\} \leq p^* \leq \frac{\lambda}{2} + \theta\)
2. \(\pi(H, \lambda, p^*, \alpha^*) \geq \pi(H, 0, \tilde{p}, \tilde{\alpha})\) for all \((\tilde{p}, \tilde{\alpha}) \in \mathbb{R}_+ \times [0, 1)\).

- There are multiple pooling equilibria. We apply the refinement concept of Undefeated Equilibrium (Mailath et al 1993) to select away equilibrium prices that give unreasonable surplus to consumers.
Pooling Equilibrium

Niche market advertising separating equilibrium

Mass market advertising separating equilibrium

Pooling equilibrium at $(p^*, \alpha^*) = (\sqrt[4]{2} + \theta, 0)$
To make prediction on a firm’s advertising behaviours over the product life-cycle, we need to extend the model to represent market environment in each stage of product’s life.

Suppose firms can spend on both informative and uninformative advert campaign but only total expenditure is observable.

Let $Z_q$ demote uninformative advertising expenditure of type q firm. Consumers can observe only $A_q = C(\alpha_q) + Z_q$ but not its composition.

Stages of product life cycle are characterised by the size of exogenously informed consumers. Overtime, as information about the product diffuses, the size of these 'already informed' consumers increases. ($X$ grows over product life cycle).
In niche market, the firm supplies to informed consumers only. This means $Z_N^H = 0$ and conditions for existence are identical to the one discussed before.

- \[(p^N, \alpha_N^H) = \left( \frac{1+\theta+c}{2}, \frac{1}{1+X} \left( \frac{1+\theta+c}{2} \right)^2 \right)\]

- $\pi^* (H, 1, p^N, \alpha_N^H, Z_H^N = 0) = \pi^* (H, 0, p^N, \alpha_N^H, Z_H^N = 0)$

- Only informative advertising is used.
When uninformative advertising is available and consumers can observe only total expenditures on advertising, any expenditure on informative advertising which is demand reducing in a mass market will be matched by low-quality firm spending on dissipative advertising without losing any demand.

Sending higher signals (high price and informative advertising) is no longer relatively more profitable for the high-quality.

In any mass market equilibrium, $\alpha = 0$.

Only uninformative advertising is used.
Mass Market
Dissipative Advertising can be used to signal quality when product is not too mature

- Let \((p^M, Z_H)\) denote equilibrium price and uninformative advertising expenditure of high-quality firm, a low-quality firm will not imitate if \(\pi(L, 0, \theta, 0, 0) \geq \pi(L, 1, p^M, 0, Z_H)\) or \(\theta \geq \frac{p^M}{1+X} - Z_H\).

- \(\bar{X} = \frac{p^M}{\theta} - 1\) is the proportion of informed consumer such that when \(X > \bar{X}\), only price is enough for separation and the H-firm stops advertising in the mass market \((Z_H = 0)\).

- Our attention will be focused on the case \(X \leq \bar{X}\). (The product is not too mature to be advertised)
H-firm problem:

$$\max_{p,Z} (p - c) \left[ \left( \frac{X}{1+X} \right) (1 + \theta - p) + \frac{1}{1+X} \right] - Z \text{ st. } Z \geq \frac{p}{1+X} - \theta$$

The corresponding solutions are

$$p^M = \begin{cases} \frac{1+\theta+c}{2} & \text{if } \ c < \theta \\ \frac{1}{2+\theta} & \text{if } \ c \geq \theta \end{cases}$$

$$Z^M_H = \frac{p^M}{1+X} - \theta$$
Marketing Strategy

When to operate in Niche vs. Mass market

- H-firm compares profits between Niche and Mass market strategies and decides which market to operate. Define

\[ \Delta (X, c, \theta) \equiv \pi^* \left( H, 1, p^N, \alpha^N_H, 0 \right) - \pi^* \left( H, 1, p^M, 0, Z^M_H \right) \]

- When \( c < \theta \), \( \Delta (X, c, \theta) < 0 \) for all \( (X, c, \theta) \). The firm has no incentive to supply information. Mass market strategy (dissipative advertising) is used over the life cycle of the product.
Marketing Strategy
Niche market is more profitable for the new product

When $c \geq \theta$,

$$\Delta (X, c, \theta) = \frac{1}{2} \left( \frac{1}{1+X} \right)^2 \left( \frac{1+\theta-c}{2} \right)^4 - \frac{4\theta X - 4(c-\theta) - (c-\theta)^2 X}{4(1+X)}$$

- When

$$\Delta (X = 0, c, \theta) = \frac{1}{2} \left( \frac{1+\theta-c}{2} \right)^4 - (c - \theta) > 0$$

- A new high-quality product will be introduced to a niche market when high price and informative advertising are used.
Product Life
Mass market becomes more profitable as product is more mature

\[ \Delta X = \frac{\partial}{\partial X} \Delta = - \left( \frac{1}{1+X} \right)^3 \left( \frac{1+\theta-c}{2} \right)^4 - \frac{4c-(c-\theta)^2}{4(1+X)^2} \]

\[ \Delta X < 0 \]

- Mass market becomes more profitable when the market is better informed
- Intuitively, imitation is less profitable for L-firm; small advertising budget is needed to separate. Mass market profit increases.
Strategy Switching

- Since $\Delta (X = 0, c, \theta) > 0$ and decreasing in $X$ ($\Delta_X < 0$), if at $X = \bar{X}$, $\Delta (X = \bar{X}, c, \theta) < 0$ then there exists a unique $X \in (0, \bar{X})$ that the firm switches from niche market to mass market strategy.

- The switching point from informative advertising to uninformative advertising, $\underline{X}$, marks the end of introduction period of the new market. The market is sufficiently informed and the firm operate in the mass market: Stopping information provision and using uninformative ads to signal high quality.
Advertising Strategies in a Separating Equilibrium

\[
\Delta (X = \overline{X}, c, \theta) = \frac{1}{2} \left( \frac{2\theta}{1+2\theta} \right)^2 \left( \frac{1+\theta-c}{2} \right)^4 - \frac{4\theta(1-2(c-\theta)-(c-\theta)^2}{8\theta(1+2\theta)}
\]

Informative Advertising only

Informative Ads initially and then switch to Dissipative Ads

Dissipative Advertising only
Advertising

Informative Ads

Dissipative Ads

No Advertising

\[ p^N = \frac{1+\theta+c}{2} \]

\[ p^M = \frac{1}{2} + \theta \]
Introduction

The Model

Dynamic of Advertising over the Product’s Life Cycle

Separating Equilibrium

Marketing Strategy

Length of Introductory Phase

- Introductory Phase is determined by $X$ which, in turn, depends on $c$ and $\theta$.
- Since, by definition, $\Delta (X, c, \theta) = 0$, applying the Implicit Function Theorem, we summarise comparative static analyses on the length of product introduction period.
Proposition

A high-quality monopolist switches from a niche market to a mass market advertising strategy relatively later if $c$ is larger or $\theta$ is smaller.

- When $c$ is large, mass market is less attractive. The firm is willing to wait longer until the market is sufficiently informed and the cost of uninformative ads required for separation reduces.
- When $\theta$ is small, the whole market has lower valuation on average. Operating in a mass market becomes a less lucrative strategy.
Thank You!!!