Advertising

Industrial Organization

Bernard Caillaud

Master APE - Paris School of Economics

September 22, 2016

Advertising: why do we care?

Advertising is a powerful marketing strategy to create differentiation in the consumers' perception about products

- Advertising is increasingly important business activity: almost 2% points of GDP in the US and around 1% in Europe
- Important direct and indirect allocative and production effects: affects purchase decisions, voting decisions, influences product existence and characteristics, influences media existence, content and pricing
- It is rapidly evolving: new targeting and reporting capabilities thanks to digitalization
- It is of primary interest for many actors: Google (99% of its USD 38 billions revenues in 2011 come from ads), Obama (spent USD 2.2 billions in last presidential campaign), Regulatory agencies (CSA, CNIL, ADLC)

Views on advertising

Persuasive view: Advertising alters consumers tastes and creates spurious product differentiation and brand loyalty

Informative view: Advertising generates awareness of product existence and characteristics; it is pro-competitive as it increases demand elasticity

Complement view: Advertising is complementary to the advertised product: consumers have stable preferences into which advertising enters directly in a complementary way with product consumption

Whether advertising toughens or softens competition is ambiguous: depends on the view adopted

Welfare consequences are ambiguous: idem

Reach advertising

Direct informative view: consumers not aware of products, they have to search (assumed prohitively expensive here) or be exposed to advertising by firms

Consumers learn about product existence and price through ads: they buy the best product among the ones they are informed of

- Increasing advertising means increasing the number of consumers who are informed about the product ...
- ... and therefore increasing competition (consumers informed about several products)

Firms choose their "reach", i.e. how many consumers are informed about their product, and are not able to "target"

Imperfect competition in reach advertising

Two firms with differentiated products (at extreme points of Hotelling line) competing in prices and advertising simultaneously (Grossman-Shapiro, 1984):

- Unit mass of consumers with valuation $r - p_i - td_i$ from buying from firm i at distance d_i, uniformly distributed on the Hotelling segment
- A consumer can learn about the existence and the price of a firm / product by receiving an ad from the firm
- ϕ_i share of consumers who receive an ad from firm i, at cost $a\phi_i^2/2$ (Assume $a > t/2$ to avoid full information))

Imperfect competition in reach advertising

Firm 1's demand is given by:

$$D_1(p_1, p_2, \phi_1, \phi_2) = \phi_1(1-\phi_2) + \phi_1\phi_2[\frac{1}{2} + \frac{p_2 - p_1}{2t}]$$

Evaluating the price elasticity of demand for symmetric prices: $\eta_1 = -\frac{\phi_2 p}{(2-\phi_2)t}$: More informative advertising raises price elasticity of demand: segments without competitor becomes smaller relative to competitive segment, hence more intense competition

Best reponses in prices and ad numbers

$$\begin{aligned} p_1 &= \frac{p_2 + c + t}{2} + \frac{1-\phi_2}{\phi_2}t \\ a\phi_1 &= (p_1 - c)[1 - \phi_2 + \phi_2[\frac{1}{2} + \frac{p_2 - p_1}{2t}]] \end{aligned}$$

Imperfect competition in reach advertising

Recall: $t < 2a$ to guarantee $\phi^* < 1$.

$$p^* = c + \sqrt{2at}\ ,\ \phi^* = \frac{2}{1+\sqrt{\frac{2a}{t}}} \text{ and } \pi^* = \frac{2a}{(1+\sqrt{\frac{2a}{t}})^2}$$

- $p^* > c + t$: lower elasticity than under full information (i.e. as if $phi = 1$) implies higher mark-up
- As differentiation increases (t higher), price increases (stronger effect than under full information) and more ads (as competition is relaxed, hence higher returns): profits higher
- As advertising gets cheaper (a smaller), more ads and price decreases (more intense competition as more consumers informed): profits smaller (strategic effect dominates)

Imperfect competition under persuasive advertising

Models of persuasive advertising are less popular as they carry usually a less optimistic view about advertising:

- If advertising shifts demand from one firm to the other: business stealing effects and suspicion there may be too much advertising in equilibrium
- If advertising leads to global demand expansion or global increase in market power, equilibrium advertising may be too low

We investigate two-stage Hotelling duopoly model with advertising impacting either perceived intrinsic value r or perceived differentiation t

Imperfect competition under persuasive advertising

If advertising raises willingness to pay: $r_i(\phi_i) = r + \beta\phi_i$

- Price equilibrium: $p_1(\phi_1, \phi_2) = c + t + \frac{\beta}{3}(\phi_1 - \phi_2)$
- Advertising induces rival to charge a lower price
- First stage: advertising expenditures are strategic substitutes
- Global equilibrium: $\phi^* = \frac{\beta}{3a}$ and $p^* = c + t$; firms neutralize themselves and are made worse off: $\pi^* = \frac{t}{2} - \frac{\beta^2}{18a}$
- Firms welcome an increase in ad cost (a larger) or reduction in persuasive power (β smaller)

Advertising is a form of wasteful competition, firms would agree not to advertise if they could cooperate.

Imperfect competition under persuasive advertising

If advertising raises perceived product differences:

$$t(\phi_1, \phi_2) = t + \beta\phi_1 + \beta\phi_2$$

- Price equilibrium: $p_1(\phi_1, \phi_2) = c + t + \beta\phi_1 + \beta\phi_2$
- Global equilibrium: $\phi^* = \frac{\beta}{2a}$ and $p^* = c + t + \frac{\beta^2}{a}$
- Advertising increases differentiation, relaxes price competition and leads to higher profits: $\pi^* = \frac{t}{2} + \frac{3\beta^2}{8a}$

Advertising has a public good nature, leading to free-riding by firms: if firms were able to cooperate, they would choose higher levels of advertising and reach high profits.

Advertising and demand dispersion

If product promotion unambiguously persuasive or informative: demand shifts outward

If, however, advertising provides information that enables consumers to ascertain better true idiosyncratic preferences: may discourage some and encourage others... hence change in dispersion of valuations → demand rotation

Johnson-Myatt (2006) proposes a model to analyze advertising as inducing a dispersion of consumers' valuation. Their findings:

- Firms have preferences for extremes: high or low levels of dispersion
- Maximize or minimize dispersion: pursuit of a niche or mass-market position

Demand rotation

Valuation θ of unit mass of consumers, drawn from $F_s(.)$ on $(\underline{\theta}_s, \bar{\theta}_s)$, $s \in S$ indexes the family. Alternatively, inverse demand: $P_s(z) = F_s^{-1}(1-z)$

Demand rotation

Local change in s leads to a "rotation" of $F_s(.)$ if, for some θ_s^+,

$$\theta \lessgtr \theta_s^+ \Leftrightarrow \frac{\partial F_s(\theta)}{\partial s} \gtrless 0.$$

Or, with $z_s^+ \equiv 1 - F_s(\theta_s^+)$, $\quad z \lessgtr z_s^+ \Leftrightarrow \frac{\partial P_s(z)}{\partial s} \gtrless 0.$

- Slope of inverse demand increases at z_s^+, but no restriction away from this point
- The rotation point may change in s

Demand rotation

Increasing variance ordered family

With $F(.)$ zero mean, unit variance, positive density, and $\mu(.)$ smooth

$$F_s(\theta) = F(\frac{\theta - \mu(s)}{s}) \Leftrightarrow P_s(z) = \mu(s) + sP(z)$$

Increasing s is a rotation with $z_s^+ = 1 - F(-\mu'(s))$

Decreasing elasticity ordered family

With $\mu(.)$ smooth decreasing and s always smaller than 1

$$\log P_s(z) = \mu(s) - s \log z$$

Increasing s is a rotation with $z_s^+ = \exp(\mu'(s))$

Monopolist's preferences for extremes

Focus on the case of a monopolist with cost $C(z)$

For a given s, let z_s^* denote the optimal monopoly quantity

If $z_s^* > z_s^+$, "mass market supplier": The monopolist produces at large scale and dislikes locally an increase in dispersion (clockwise rotation), as the willingness to pay of marginal consumer decreases, hence lower profits

If $z_s^* < z_s^+$, "niche supplier": low production for a few high valuation buyers whose willingness to pay increases with more information about the product, hence higher profits

But when s varies, both situations may alternate ...

Monopolist's preferences for extremes

Yet, if z_s^+ increases, say from s to s', then if $\frac{\partial P_s(z)}{\partial s} > 0$ (i.e. $z < z_s^+$), then $\frac{\partial P_s(z)}{\partial s} > 0$ for s': i.e. quasi-convexity of $P_s(z)$ in s

So, if z_s^+ increases in s, the monopoly profit

$$\max_z \{P_s(z)z - C(z)\}$$

is a max of quasi-convex functions, hence also quasi-convex in s. It is then maximized at an extreme $s \in \{s_L, s_H\}$

Profits are high when consumers are either homogenous or highly indiosyncratic

Monopolist's preferences for extremes

- In variance ordered family, z_s^+ increases in s iff $\mu'(s)$ weakly increasing
- In elasticity ordered family, z_s^+ increases in s iff $\mu'(s)$ weakly increasing
- z_s^+ increases in s iff $F_s(\theta)$ quasi-concave in s for all θ
- Suppose local increase in s raises and lowers $P_s(z)$ in multiple regions, seperated by multiple rotation quantities: sufficient condition for quasi-convexity of profit function is each clockwise rotation quantity is increasing and each counter-clockwise rotation quantity is decreasing

Monopolist's preferences for extremes

s rotates MR if, for some z_s^{++}, $z \lessgtr z_s^{++} \Leftrightarrow \frac{\partial MR_s(z)}{\partial s} \gtrless 0$.

- Note that necessarily, $z_s^{++} < z_s^{+}$: at z_s^{+}, demand steepens and so marginal revenue must fall.
- It holds for variance ordered and elasticity ordered families

Property of the monopoly's optimal supply: Assume $MR_s(z) = P_s(z) + zP_s'(z)$ is decreasing in z, $C(z)$ convex; if MR curves are rotation-ordered and z_s^{++} is increasing, the monopoly quantity z_s^* is quasi-convex in s (U-shaped)

- Small s, $z_s^{++} < z_s^{+} < z_s^*$, output and profit fall with s: contracting mass market
- Intermediate s, $z_s^{++} < z_s^* < z_s^{+}$, output falls and profit rises with s: contracting niche market
- Large s, $z_s^* < z_s^{++} < z_s^{+}$, output and profit rise with s: expanding niche market

Hype vs real information

From positive point of view, not much difference between persuasive advertising and informative advertising for a monopolist: both shift demand outward and increase sales.

View an ad as containing both hype and real information

- Hype tells consumers about the existence of a product, it always increases demand
- Real information allows consumers to evaluate their subjective preferences and hence increases dispersion (demand rotation)
- Advertising campaign design: size, i.e. hype of campaign (costly) and real information content (costless)
- Related to: hype about vertical differentiation, real information about horizontal differentiation

A model of real information advertising

- Consumer's true taste: unknown ω, drawn from $G(.)$
- Consumer observes an ad x, not ω; $x = \omega$ with proba. $s \in [s_L, s_H]$, x is independent draw of $G(.)$ with proba. $1 - s$
- Bayesian updating: $\theta(x) = sx + (1 - s)\mathbb{E}[\omega]$
- Only consumers receiving a signal x such that $\theta(x) \geq p$ will buy at price p. So:

$$P_s(z) = sG^{-1}(1 - z) + (1 - s)\mathbb{E}[\omega]$$

- Demand rotation holds; inverse demand is even linear in s

Then, profits are convex in s, maximized at boundary

A model of real information advertising

If $[s_L, s_H] = [0, 1]$, the monopolist prefers either full information or complete ignorance for consumers

If s_L increases (by word-of-mouth communication, or independent product reviews), the monopolist may be prompted to switch from low accuracy of advertising (at $s = s_L$) to high accuracy of advertising ($s = s_H$) (by convexity)

The monopolist may have incentives to lower $s = s_L$, by destroying any available real information

Limits: $z_s^+ = 1 - G(\mathbb{E}[\omega])$ is constant and increases in s do not affect mean of valuation distribution (this is due to risk neutrality)

Advertising and risk aversion

Preferences CARA with coefficient λ. $G(.)$ is Normal $\mathcal{N}(\mu, \kappa^2)$

- κ measures dispersion of consumers' true payoffs; idiosyncrasy in product design, all value product in similar way when κ small, a "plain-vanilla" design, valuations more variable when κ large, a "love-it-or-hate-it" design

The signal x drawn from Normal: $\mathcal{N}(\omega, \gamma^2)$

- $\psi = 1/\gamma^2$ is the precision of real information provided

Then, $\theta(x)$ is $N(\mu - \frac{\lambda\kappa^2}{2(1+\psi\kappa^2)}, \frac{\psi\kappa^4}{1+\psi\kappa^2})$ and changes in ψ or κ^2 yield variance ordered family:

$$P_{\kappa^2,\psi}(z) = \mu - \frac{\lambda\kappa^2}{2(1+\psi\kappa^2)} + P(z)\sqrt{\frac{\psi\kappa^4}{1+\psi\kappa^2}}$$

with $P(z) = \Phi^{-1}(1-z)$

Advertising and risk aversion

- Valuation distribution is riskier (std dev: $\sqrt{\psi\kappa^4/1+\psi\kappa^2}$) when more idiosyncratic product design (increase in κ^2) or more informative advertising (increase in ψ)
- κ larger means a more idiosyncratic product: a purchase is more of a gamble, hence higher risk premium and lower $\mathbb{E}\theta$. Increase in variance AND inward shift of inverse demand curve
- ψ larger means more informative advertising: more real information reduces the risk premium and increases $\mathbb{E}\theta$. Increase in variance AND outward shift of inverse demand curve
- So κ and ψ both induce demand rotation clockwise but opposite shifts of the mean

Advertising and risk aversion

Preferences for extremes and consistency

Profits are quasi-convex in κ and in ψ.

- If $\frac{\partial \pi}{\partial \kappa^2} > 0$, then $\frac{\partial \pi}{\partial \psi} > 0$
- If $\frac{\partial \pi}{\partial \psi} < 0$, then $\frac{\partial \pi}{\partial \kappa^2} < 0$
- If $\lambda = 0$, reverse inequalities also hold

- Never κ_H and ψ_L: more idiosyncratic products complemented by detailed advertising
- If risk neutrality, a plain vanilla product cannot be advertised with a lot of real information
- Under risk aversion, it can, and even more likely when risk aversion increases

Content matters

Marketing literature on content analysis insists on: what is advertized?

Information cues: price, quality, performance, availability, nutrition, warranties...

Mean number of cues (US TV, magazine, newspapers): 1 - 1.5, less than 25% have 3 of more cues, more than 15% no cues, price information not given in at least 35%

So, not only about prices and advertising does not provide all information that could be provided

Content matters

Anderson-Renault (2006) belongs to literature on directly informative advertising

Distinguish between information about price and information about attributes of the product: analyze advertising content

Product is an inspection good: costly to check whether it meets consumer's needs, requires search or provision of information (otherwise, no issue about advertising attributes)

Information is hard: legal sanctions prevent false ads / lies

Model of advertising for an inspection good

Demand side for single search / inspection good

- Consumer's valuation r (match value), for one unit, unknown to her and to the firm: $F(.)$ on $[a, b]$
- Price p a priori unknown to consumer, but consumer forms rational expectations about it
- Search cost c to discover r and price p by going at store

Monopolist, with zero cost, can advertise beforehand on price and/or on attributes (update consumer's beliefs about r)

Timing: Firm chooses p and advertising (no false ads), then consumer decides whether to search or not and if yes, whether to buy or not

Model of advertising for an inspection good

Given search, demand is equal to: $1 - F(p)$. Let

$$p^m = \arg\max p(1 - F(p)$$

denote the monopoly price, may be interior or equal to a

Active market with monopoly price and without advertising, provided $c \leq c_1$ with:

$$c_1 \equiv \int_{p^m}^{b} (r - p^m) dF(r)$$

If, however $c > c_1$, firm needs to reassure consumers that it is worth searching through advertising

Model of advertising for an inspection good

Perfect advertising only on price:

- if advertising on price p only, expected utility of searching is: $\int_p^b (r-p)dF(r) - c$
- Setting this to 0 yields the maximum price that can be charged and advertised with an active market.
- With $c > c_1$, the monopoly price is not tenable anymore, the sustainable price has to be lower than p^m

Perfect attributes-only-advertising:

- Information enables consumer to learn r exactly
- Hold up problem: if $p < b$, a consumer who searches must have learned $r \geq p+c$ so that firm could charge $p+c$ without losing consumers
- So, inactive market !

Model of advertising for an inspection good

What about partial information disclosure about attributes only, to change consumer's posterior ?

- Suppose consumer is told whether r is below/above some threshold $\tilde{r} \leq p^m$; if below, she does not search
- If above, valuation is given by the prior truncated on $[\tilde{r}, b]$, so the monopolist should still charge p^m
- Ex ante, the expected benefit from searching is now:

$$\int_{p^m}^{b} (r - p^m) \frac{f(r)}{(1 - F(\tilde{r}))} dr - c = \frac{c_1}{1 - F(\tilde{r})} - c > c_1 - c$$

So, the firm strictly benefits from advertising partial information about the match even if $c > c_1$. Note that the price may be advertised wlog (correctly anticipated at p^m)

Model of advertising for an inspection good

What is the general optimal content of advertising? (Preliminary: price always advertised wlog, as correctly anticipated)

General mechanism induces a joint probability measure over valuations and signals sent, which enables the consumer to update based on observing the signal.

Formal lemma

For any price p, firm cannot do better that informing the consumer whether r is above or below some $\tilde{r} \in [p, b]$

INtuition: think of $\tilde{r}$ as lowest valuation for which the signal is good enough to induce search (good news set); cannot be smaller than p; if more information is given, those who do not get it will not search, hence a loss !

Model of advertising for an inspection good

Firm's problem:

$$\begin{aligned} \max_{(p,\tilde{r})} \quad & p(1-F(\tilde{r})) \\ \text{s.t.} \quad & \tilde{r} \geq p \\ & \int_{\tilde{r}}^{b} \frac{(r-p)}{(1-F(\tilde{r}))} dF(r) = \int_{\tilde{r}}^{b} \frac{r}{(1-F(\tilde{r}))} dF(r) - p \geq c \end{aligned}$$

- When $c \leq c_2 \equiv \frac{c_1}{1-F(p^m)}$, $p = \tilde{r} = p^m$: the firm enjoys monopoly profits (even through match only advertising)
- When, however, $c > c_2$, monopoly profits cannot be attained with match only advertising.

Assume from now on: $c > c_2$. Second constraint must bind: i.e. firm gets all social expected surplus: $p(1-F(\tilde{r})) = \int_{\tilde{r}}^{b}(r-c)dF(r)$

Model of advertising for an inspection good

If at optimum $\tilde{r} > p$, then decreasing $\tilde{r}$ down to c maximizes the expected surplus: $\int_{\tilde{r}}^{b}(r-c)dF(r)$, hence also profits. So,

$$p = \phi(c) \equiv \int_{c}^{b} \frac{(r-c)}{(1-F(c))} dF(r)$$

if $\phi(c) > c$.

Otherwise, $\tilde{r} = p$ and p solves: $\phi(p) = c$

There exists a unique c_3 such that $\phi(c_3) = c_3$ and

- if $c_2 < c \leq c_3$, $\tilde{r} = p = \phi^{-1}(c) > c$
- if $c_3 < c \leq b$, $\tilde{r} = c > p = \phi(c)$

Picture in class

Model of advertising for an inspection good

Above c_2, the monopolist needs to propose a better deal to consumers: decrease price or improve anticipation of match ?

Price declines monotonically in c, but threshold $\tilde{r}$ decreases within (c_2, c_3) (equal to the price) and then increases

Social optimum: all $r \geq c$ should (search and) consume: attained when a lot of search friction, i.e. $c > c_3$!

To achieve social optimum: attract the right people with $\tilde{r} = c$ and have them all buy with a price $p \leq c$. If c large enough, firm can extract all surplus that way; if $c < c_3$, it cannot and so prefers to extracts surplus by charging a price above c

Model of advertising for an inspection good

Suppose here that match advertising necessarily reveals r exactly (full disclosure) and advertising also bears on price

- Demand is: $1 - F(p + c)$; p^f and maximized profits (and price p^f) strictly smaller than monopoly profits (than p^m)
- At $c = c_1$, price-only advertising yields monopoly profits, while price-and-match advertising yields strictly smaller profits: true also on right neighborhood of c_1
- Left neighborhood of b: even at zero price, price-only advertising yields zero demand, while positive profits possible with small positive price and match advertising for high value consumers
- Optimum: within $(c_1, \hat{c})$, price-only advertising; within $(\hat{c}, b)$, price-and-match advertising

Effect of regulation policies on advertising

- Forcing full match information: the full price paid by consumers is $p^f + c > p^m$, hence sub-optimal trade
- Forcing price information: never optimal since rational expectations anyway
- Forbidding price information: never optimal since when the firm does advertise on price, it is to commit on a lower price than p^m
- Forbidding match information: whether threshold-match advertising or price-only advertising, consumers down to their visit constraint, hence zero consumer's surplus, so welfare decreasing (limits profits); if price-and-match advertising dominates price-only advertising, profits and consumer's surplus larger, again welfare decreasing

References

- * Belleflamme - Peitz, Ch.6
- * Bagwell, K. (2007), Handbook of IO, Vol.3
- Grossman, G. and C. Shapiro (1984), REStud, 51(1), 63-81
- Anderson, S. and R. Renault (2006), AER, 96(1), 93-112
- Johnson, J. and D. Myatt (2006), AER, 96(3), 756-784.