Firms' Strategies and Markets
Advertising

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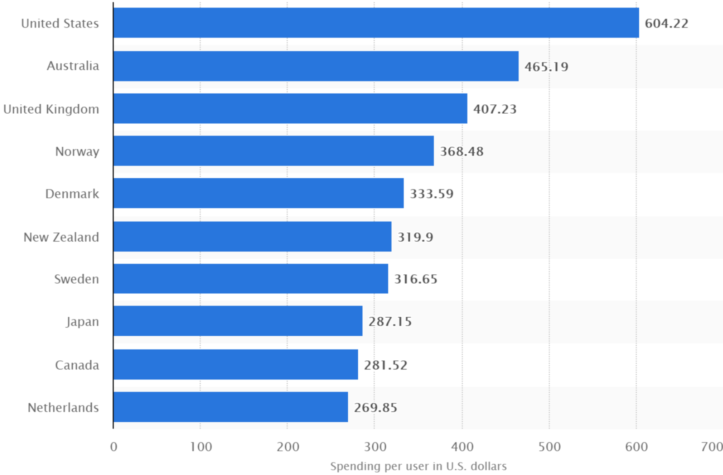
Introduction

- Worlwide amount of ad spending in 2020 is about 586 billlion \$;
- More than 60% of this amount are digital advertising and mobile phone (growing)–the rest are mainly TV and radio ($\approx$ 30%) or print medias (newspapers and magazine $<$5%);
  - Google is the largest digital ad seller in the world in 2019;
  - Google and Facebook have a 60% market share of online advertising.
  - CMA report in 2020 / role of consumer data in digital market ads.
- The largest advertisers in 2017 are Samsung and Procter & Gamble ($>$10 billions US \$ in 2017 for P&G)

Countries with highest advertising spending per person in 2016 (US $)



Advertising boosts demand

Assumptions:

- The demand $Q(p, A)$ is such that $Q_p < 0$ and $Q_A > 0$.
- The firm faces a variable cost of production $C(Q)$ with $C_Q > 0$
- The cost of advertising is $-A$.

The monopoly maximizes its profit with respect to Q and A:

$$\max_{Q,A} \Pi(Q, A) = pQ(p, A) - C(Q(p, A)) - A$$

The First Order Conditions are:

$$\Pi_p = (p - C_Q)Q_p + Q = 0 \Rightarrow \frac{p - C_Q}{p} = \frac{-1}{\epsilon_{Q/p}}$$

$$\Pi_A = (p - C_Q)Q_A - 1 = 0 \Rightarrow \frac{p - C_Q}{p} = \frac{1}{\epsilon_{Q/A}} \frac{A}{pQ}$$

Result

The advertising intensity is equal to the ratio of the advertising elasticity of demand and the price elasticity of demand: $\frac{A}{pQ} = \frac{\epsilon_{Q/A}}{-\epsilon_{Q/p}}$:
Dorfman-Steiner condition !

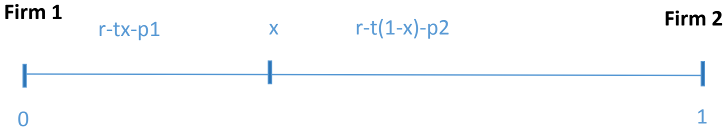
Typology of advertising

- **Persuasive Advertising** enhances consumers' tastes for a given product
  - Advertising increases consumers' willingness to pay.
  - Advertising changes the distribution of consumers' tastes.
  - Advertising increases perceived product difference.
- **Informative Advertising** provides consumers with information about the existence, prices and characteristics of products. Consumers make better informed decision.
  - Information about prices
  - Information about product's existence.
- **Signaling Quality**: the amount of ads spent or the price indirectly convey information about the quality of the products to consumers.

Persuasive Advertising

Assumptions

- Game: Stage 1- Advertising & Stage 2- price competition;
- Consumers are distributed according to $F(x)$ over $[0, 1]$
- The cost of advertising intensity λ_i is $a\lambda_i^2/2$.



- Advertising increases consumers' willingness to pay: $r_i(\lambda_i)$
- Advertising changes the distribution of consumers' tastes: $F(x, \lambda_i, \lambda_j)$
- Advertising increases perceived product difference : $t(\lambda_i, \lambda_j)$

Benchmark: Without advertising

Assumptions

- We assume that there is no advertising.

The indifferent consumer address $\hat{x}$ is such that:

$$r - t\hat{x} - p_1 = r - t(1-\hat{x}) - p_2$$

$$\hat{x} = \frac{1}{2} + \frac{p_2 - p_1}{2t}$$

$$\begin{aligned} \Pi_1 &= (p_1 - c)\hat{x}(p_1, p_2) \\ \Pi_2 &= (p_2 - c)(1 - \hat{x}(p_1, p_2)) \end{aligned}$$

Firms maximize their profit with respect to p_i and the reaction functions are symmetric and increasing : Prices are strategic complement!

$$\underset{p_i}{Max}\Pi_i \Rightarrow p_i(p_j) = \frac{1}{2}(c + t + p_j)$$

Results

There is a symmetric equilibrium: $p_1^* = p_2^* = c + t$ and $\Pi_1^* = \Pi_2^* = \frac{t}{2}$.

Advertising increases consumers' willingness to pay

Assumptions

- We denote $r_i(\lambda_i) = r + \beta\lambda_i$

The indifferent consumer address $\hat{x}$ is such that:

$$r + \beta\lambda_1 - t\hat{x} - p_1 = r + \beta\lambda_2 - t(1-\hat{x}) - p_2$$

$$\hat{x} = \frac{1}{2} + \frac{p_2 - p_1}{2t} + \beta\frac{\lambda_1 - \lambda_2}{2t}$$

$$\begin{aligned} \Pi_1 &= (p_1 - c)\hat{x}(p_1, p_2, \lambda_1, \lambda_2) - a\lambda_1^2/2 \\ \Pi_2 &= (p_2 - c)(1 - \hat{x}(p_1, p_2, \lambda_1, \lambda_2)) - a\lambda_2^2/2 \end{aligned}$$

Firms maximize their profit with respect to p_i and the reaction functions are symmetric and increasing : Prices are strategic complement!

$$\underset{p_i}{Max}\Pi_i \Rightarrow p_i(p_j) = \frac{1}{2}(c + t + p_j + \beta\lambda_i - \beta\lambda_j)$$

The Nash equilibrium in prices is:

$$p_i(\lambda_i, \lambda_j) = c + t + \frac{1}{3}\beta(\lambda_i - \lambda_j)$$

$$\Pi_i(\lambda_i, \lambda_j) = \frac{1}{18t}(3t + \beta(\lambda_i - \lambda_j))^2 - a\lambda_i^2/2$$

In stage 1, each firm i maximizes its profit with respect to λ_i anticipating the stage 2 competition in prices:

$$\underset{\lambda_i}{Max}\Pi_i(\lambda_i, \lambda_j) \Rightarrow \lambda_i(\lambda_j) = \frac{\beta(3t - \beta\lambda_j)}{9at - \beta^2}$$

The best reaction functions are symmetric and decreasing: advertising investments are strategic substitutes!

Results

$\lambda_1^* = \lambda_1^* = \frac{\beta}{3a}$, $p_1^* = p_2^* = c + t$ and $\Pi_1^* = \Pi_2^* = \frac{t}{2} - \frac{\beta^2}{18a} < \frac{t}{2}$. Firms are worse-off with advertising. If they could coordinate, they would refrain from investing.

Advertising changes the distribution of consumers' tastes

Assumptions

- We denote $F(x, \lambda_1, \lambda_2) = (1 + \lambda_1 - \lambda_2)x - (\lambda_1 - \lambda_2)x^2$ with a continuous density $f(x, \lambda_1, \lambda_2) = (1 + \lambda_1 - \lambda_2) - 2x(\lambda_1 - \lambda_2)$.
- If $\lambda_1 = \lambda_2$ we find a uniform distribution, $\lambda_1 = 1$ and $\lambda_2 = 0$ a distribution that favors firm 1. Distribution Function

The address of the indifferent consumer $\hat{x}$ is such that:

$$r - t\hat{x} - p_1 = r - t(1 - \hat{x}) - p_2 \Rightarrow \hat{x} = \frac{1}{2} + \frac{p_2 - p_1}{2t}$$

$$Q_1 = F(\hat{x}, \lambda_1, \lambda_2), Q_2 = 1 - F(\hat{x}, \lambda_1, \lambda_2)$$

$$\Pi_1 = (p_1 - c)Q_1 - a\lambda_1^2/2 \text{ and } \Pi_2 = (p_2 - c)Q_2 - a\lambda_2^2/2$$

Maximizing their profit **simultaneously** with respect to p_i and λ_i, and focusing on the symmetric equilibrium:

Results

$p_1^* = p_2^* = c + t$ and $\lambda_1^* = \lambda_2^* = \frac{t}{4a}$. $\Pi_1^* = \Pi_2^* = \frac{t}{2} - \frac{t^2}{32a} < \frac{t}{2}$. Firms are worse-off with advertising. If they could coordinate, they would refrain from investing.

Advertising increases perceived product differences

Assumptions Differentiation

- We denote $t(\lambda_1, \lambda_2) = t + \beta\lambda_1 + \beta\lambda_2$.

It is immediate that in stage 2:

$$p_1(\lambda_1, \lambda_2) = p_2(\lambda_1, \lambda_2) = c + t + \beta\lambda_1 + \beta\lambda_2$$

$$\Pi_1 = (p_1 - c)\hat{x} - a\lambda_1^2/2 \text{ and } \Pi_2 = (p_2 - c)(1 - \hat{x}) - a\lambda_2^2/2$$

In stage 1, maximizing their profit with respect to λ_i, and focusing on the symmetric equilibrium:

$$\lambda_1^* = \lambda_2^* = \frac{\beta}{2a} \text{ and } p_1^* = p_2^* = c + t + \frac{\beta^2}{a}$$

$$\Pi_1^* = \Pi_2^* = \frac{t}{2} + \frac{3\beta^2}{8a} > \frac{t}{2}$$

Result

Advertising that increases perceived product difference relaxes competition and therefore firms' investment is profitable.
Public good: coordination raises investment.

Remember

- Advertising creates or boosts the demand for a product.
- In a competition framework: different types of persuasive advertising lead to different outcomes
  - Increasing the consumers' willingness to pay, or changing consumers' taste for a good at the expense of rivals may lead to a business stealing effect and result in an efficient advertising race.
  - Advertising characteristics of the products may increase the perceived differentiation among products and soften competition !
- Heavy regulation of ads – in France:
  - Comparative ads are regulated (not authorized to depreciate/lie the product of a rival)!!
  - Law "Evin" (1991) forbids any ads on tobacco or alcool.
  - Law project under debate to forbid ads on some products that are bad for environment (high GHG emissions- SUV) or for health (food products listed by PNNS).

Informative advertising on prices

Assumptions

- Consider a duopoly of homogenous products with marginal cost c.
- Consumers do not know the price charged by each firm.
- Consumers have a valuation $v > c$ for the good.
- Consumers have search cost: they can only discover one price (0 for one firm , $+\infty$ for two).

Without advertising on prices : consumers choose between the two firms randomly, check the price and buy if $p < v$. The two firms set $p = v$. With advertising : Competition is Bertrand like, because the product is

homogenous: $p = c$.

Result

Informative advertising on prices may intensify competition by reducing consumers' search costs.

- Argument often put forward in favor of “online" sales.

Informative advertising on product's existence

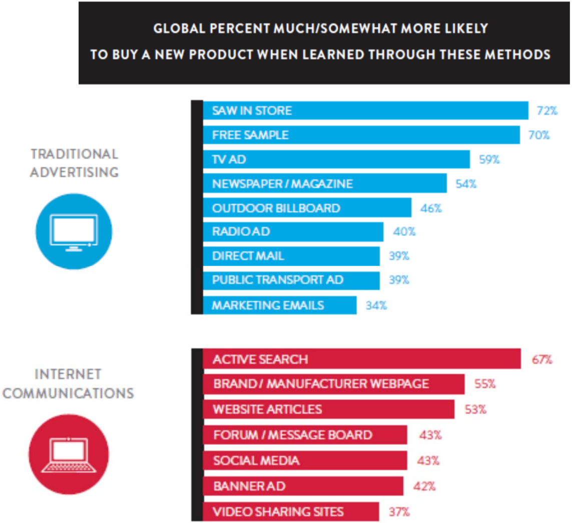
Grossman & Shapiro (1984)

- Consumers unaware of a new product's existence: no utility and no demand.
- Consumers aware of a new product's existence
  - $u(q) > 0$ with $u'(q) > 0$ and $u''(q) < 0$.
  - Maximising $u(q) - pq$ where p is the price, we derive a demand $q(p) > 0$, with $q'(p) < 0$.

Information about the existence of a product

Advertising can inform consumers about the very existence of a product!

Advertising is key to launch a new product



Source: Nielsen Global Survey of New Product Purchase Sentiment, Q3 2012

Remember

- In a competition framework: different types of informative advertising lead to different outcomes
  - It might increase competition when it vehicles information on prices.
  - Informative advertising is profitable when it reveals the product's existence (See Exercice 1).

Exercise 1

Assumptions

- Consumers are uniformly distributed along a segment $[0, 1]$. A firm is localized in 0 and another firm in 1.
- A consumer who travels a distance x to buy one unit at price p has a utility $U = v - p - tx$ if he buys and 0 if he does not buy. There is no utility for a second unit.
- A consumer buys only if he receives an ad. Let Φ_i denote the share of consumers who have received an ad from i. The cost to reach this fraction of demand is $A(\phi) = \frac{a\phi^2}{2}$ with $a \geq \frac{t}{2}$.

Questions

1. What is the demand of consumers who receive only an ad from i?

1. What is the demand of consumers who receive only an ad from i?

- The probability to receive an ad only from firm i is: $\phi_i(1-\phi_j)$.
- Consumers who buy are such that $v - p_i - tx \geq 0$
- $D_i = 1$ if $x_0 = \frac{v-p}{t} > 1$ (covered market)! $\Rightarrow$ We focus on this case for simplicity
- $D_i = \frac{v-p_i}{t}$ otherwise (uncovered market).

2. What is the demand of consumers who receive an ad from i and j?

- The probability to receive an ad from both firms is: $\phi_i \phi_j$.
- Among them the address of the indifferent consumer $\tilde{x}$ is such that $v - p_i - tx = v - p_j - t(1-x)$ or $\tilde{x} = \frac{1}{2} + \frac{(p_j - p_i)}{2t}$.
- $\tilde{x}$ (resp. 1-$\tilde{x}$) is the demand for i (resp. j) when the gap in price is not too high.

3. What is the total demand for firm i? How the price elasticity of demand varies in ϕ in $p_i = p_j = p$ and $\phi_i = \phi_j = \phi$?

- $D_i = \phi_i[(1-\phi_j) + \phi_j \tilde{x}]$
- At point $p_i = p_j = p$ and $\phi_i = \phi_j = \phi$, the elasticity $\epsilon = \frac{-p_i \partial D_i / \partial p_i}{D_i} = \frac{p\phi}{t(2-\phi)}$ which increases in ϕ.
- A larger ϕ implies a larger the probability that consumers are informed of the existence of both goods: They are thus more sensitive to price.

4. Firms choose simultaneously their price and their ad level. Determine the symmetric Nash equilibrium of this game.

- The profit of firm i is:

$$\Pi_i = (p_i - c)D_i - A(\phi_i)$$

- with $D_i = \phi_i[(1-\phi_j) + \phi_j \frac{p_i - p_j + t}{2t}] = \frac{\phi_i}{2t}[(1-\phi_j)2t + \phi_j(p_i - p_j + t)]$
- The first order conditions are :

$$2p_i = c + t + p_j + \frac{2(1-\phi_j)t}{\phi_j}$$

$$\phi_i = (p_i - c)\frac{(1 - \phi_j + \phi_j \tilde{x})}{a}$$

- At the symmetric equilibrium $p_i = p_j = p^* = c + \sqrt{2at}$ and $\tilde{x} = \frac{1}{2}$ and $\phi_i = \phi_j = \phi^* = \frac{2}{(1+\sqrt{2a/t})}$.

Advertising Signals

Assumptions

- One consumer with a valuation for a high quality good v_H and for the low quality $v_L < v_H$.
- Production cost is the same, $c < v_L$, for a high or a low quality good.
- Two period game. The consumer wants one unit in each period. Experience good!
- Firms can choose to spend an advertising amount A which is observed by the consumer before he chooses to purchase in period 1.

Full Information

Consumers know the quality and thus firms do not advertise.
A high quality firm sets $p_H = v_H$ and gets $\Pi_H = 2(v_H - c)$);
A low quality firm sets $p_L = v_L$ and gets $\Pi_L = 2(v_L - c)$.

Asymmetric Information

We look for a separating equilibrium BOUTON. We assume that only advertising amounts (not price) can convey a signal about quality.

Advertising Signals

Assume that there exists a separating equilibrium such that if a firm spends A in advertising, consumers believe that it is a high quality firm with probability 1.

In such separating equilibrium: $\Pi_H = 2(v_H - c) - A$, and $\Pi_L = 2(v_L - c)$.

Participation constraint

- Check that a high quality firm makes a positive profit i.e. $\Pi_H > 0$, that is $A < 2(v_H - c)$.

Incentive constraints

- Check that a high quality firm is better off advertising! Its deviation profit is $\Pi'_H = v_L + v_H - 2c < \Pi_H \Rightarrow A \leq v_H - v_L$
- Check that a low quality firm is better off not advertising! Its deviation profit is $\Pi'_L = v_H + v_L - 2c - A < \Pi_L \Rightarrow A \geq v_H - v_L$

Advertising Signals

Assume now that if a consumer was cheated in the first period, the firm is boycotted in the next period. The incentive constraint for the low quality firm becomes:

- A low quality firm is better off not advertising! Its deviation profit is $\Pi'_L = v_H - c - A < \Pi_L \Rightarrow A \geq v_H - v_L - (v_L - c)$
- A separating equilibrium exists for $A \in [v_H - v_L - (v_L - c), v_H - v_L]$.
- In equilibrium the high quality firm chooses the minimum advertising amount $A^* = v_H - v_L - (v_L - c)$ and obtains a profit $\Pi^*_H = v_H - c + 2(v_L - c) > \Pi'_H$

Result

Burning money through advertising can be a credible means for a firm to signal a high quality in particular in the case of experience good with repeated purchases.

Price and Advertising signals

Milgrom and Roberts (1986)

Assumptions

- A firm has a new product of quality H or L and knows its quality.
- Consumers do not know the quality.
- Repeated purchase game. Consumers discover the quality after one purchase.
- $\pi(P, q, Q) - A$, expected present value of the profit of a firm where :
  - q true quality;
  - the introductory price is P;
  - the introductory advertising spending A
  - consumers believe the product is of quality Q.
- $\pi(P, q, Q)$ increases in Q (initial sales)

- We define $P_Q^q = \arg\max_P \pi(P, q, Q)$. P_L^L and P_H^H are full information optimal prices.
- We are looking for a SE such that there exists a couple (P, A) that makes consumers believe the quality is H (with proba 1) and L otherwise.

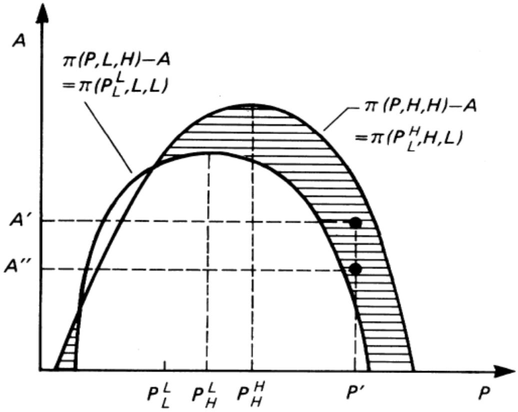
Result 1

There exists a separating sequential equilibrium if and only if for some (P, A):

$$\pi(P, H, H) - \pi(P_L^H, H, L) \geq A \geq \pi(P, L, H) - \pi(P_L^L, L, L) \qquad (1)$$

- $\pi(P, H, H) - A \geq \pi(P_L^H, H, L)$: a firm of quality H earns a larger profit in selecting (P, A) which conveys the signal H to consumers than her best profit when consumers believe it is of quality L.
- $\pi(P, L, H) - A \leq \pi(P_L^L, L, L)$: a firm of quality L earns a smaller profit in selecting (P, A) rather than its best profit when consumers believe its quality is L.

- Isoprofit curves:
    - $A(P) = \pi(P, H, H) - \pi(P_L^H, H, L)$ (Above)
    - $A(P) = \pi(P, L, H) - \pi(P_L^L, L, L)$ (Below)



- Elimination of equilibria with dominated strategies.

Result 2

There exists a separating equilibrium if and only if there is some (P, A) such that eq(1) holds. At any separating equilibrium, the choice (P, A) of the high-quality firm must be a solution to the following programme (2):

$$\max_{P,A} \pi(P, H, H) - A$$

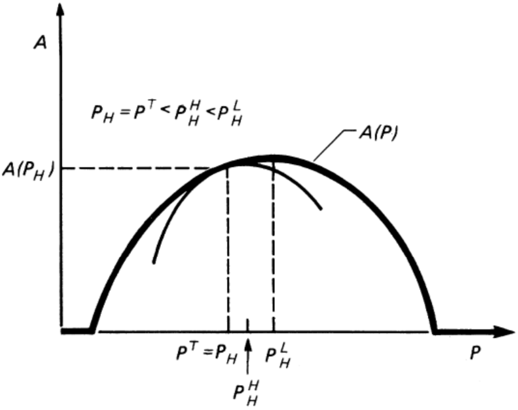
$$\texttt{subject to} \pi(P, L, H) - A \leq \pi(p_L^L, L, L)$$

. If the solution (P^*, A^*) to (2) is such that $A^* > 0$, then P^* solves

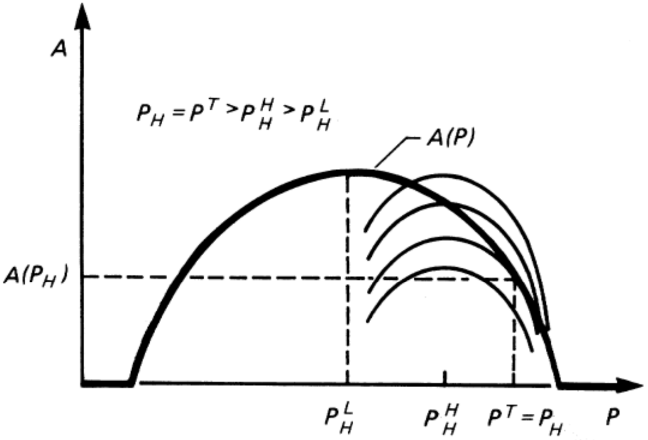
$$\max_{P} \pi(P, H, H) - \pi(P, L, H)$$

$$\Rightarrow \frac{\partial \pi(P, H, H)}{\partial P} = \frac{\partial \pi(P, L, H)}{\partial P}$$

- Assume $\pi(P,H,H) - \pi(P,L,H)$ has a maximum in P.
- $A(P) = \pi(P,L,H) - \pi(P_L^L,L,L)$
- The other curve is $\pi(P,H,H) - A$
- The separating equilibrium is at the tangency point (P^T, A^T).



- The separating equilibrium is at the tangency point (P^T, A^T).
- In the case below there is an upward distortion in price $P^T > P_H^H$



Assume that $\pi(P, L, H)$ is strictly concave in P and that $A(P)$ is positive on an interval $(\underline{P}, \overline{P})$ with $P > 0$.

- A necessary condition for advertising to occur at equilibrium is $P_H^H \in (\underline{P}, \overline{P})$ or, equivalently,

$$\pi(P_H^H, L, H) > \pi(P_L^L, L, L)$$

  - **Case in which** $P_H^H > \overline{P}$: If a new high-quality product is very expensive to produce and is aimed at a limited market.
  - **Case in which** $P_H^H < \underline{P}$: If the new high-quality product is very cheap to produce the introducing firm may set a low initial price or give away free samples in launching the product.

Remember

- Burning money, i.e. a high level of advertising may signal a high quality
- Together with advertising, a high price (ie. higher than the high quality monopoly) may signal a high quality: it claims that the producer is confident enough in its product quality
- Together with advertising, a low price may signal a high quality (i.e lower than the high quality monopoly price): it claims that consumers that will taste it won't be disappointed.

Exercise 2

Advertising as a commitment device (Lal and Matutes, 1994)

Assumption

- Firms A and B are located at the extreme of a segment of lenght 1.
- Consumers are uniformly distributed along the segment and incur linear transport cost tx.
- A and B sell two products 1 and 2.
- Consumers have the same willingness to pay for each good, denoted H.
- Unless they receive an ad (catalog, leaflet,...), consumers are uninformed about prices but make rational expectations about prices.
- Each firm can choose to advertise one or two goods. Advertising costs F and vehicles the information about a product's price to all consumers.
- **We exclude that a consumer visit both stores.**

Exercise 2

1. What happens if no firm advertise any product?

Exercise 2

1. What happens if no firm advertise any product?

- If there are no advertising, consumers rationally expect that all prices are equal to H.
  - Once at the store the firm knows that the transportation cost is sunk for the consumer and has an incentive to set a price H.
- Anticipating this, no consumer buy anything and therefore no profit for both firms.

2 What happens if the two firms advertise both products? Is this an equilibrium?

- Assume that the two firms advertise both products at prices (p_{A1}, p_{A2}) and (p_{B1}, p_{B2}) which costs $2F$ to each firm!
- The indifferent consumer is such that the surplus it obtains in visiting A, i.e. $2H - p_{A1} - p_{A2} - t\hat{x}$ is the same as the surplus it obtains in visiting B, i.e. $2H - p_{B1} - p_{B2} - t(1 - \hat{x})$

$$\hat{x} = \frac{p_{B1} + p_{B2} - p_{A1} - p_{A2} + t}{2t}$$

- A maximizes its profit $(p_{A1} + p_{A2})\hat{x}$, and B maximizes $(p_{B1} + p_{B2})(1 - \hat{x})$!
- This leads to $p_A^* = p_{A1} + p_{A2} = t$ and $p_B = p_{B1} + p_{B2} = t$.

2 What happens if the two firms advertise both products? **Is this an equilibrium?**

- The first important condition to check is that $t < 2H$. Then, the profit each firm realizes is $\pi_j = \frac{t}{2} - 2F > 0 \rightarrow F < \frac{t}{4}$.
- Another condition to check is that the marginal consumer has a positive surplus, i.e. that $2H - t - \frac{t}{2} > 0 \rightarrow t < \frac{4H}{3}$ (covered market).
- To check whether this is an equilibrium, we check that a firm, say B, has no incentive to deviate unilaterally by only advertising one of its products, say 1.
  - Consumers rationally expect that a product that is not advertised will be sold at H.

$$\hat{x} = \frac{p_{B1} + H - p_A^* + t}{2t}$$

  - Maximizing its profit $(p_{B1} + H)\hat{x}$ with respect to p_{B1}, we obtain $p_{B1} = t - H$.
  - The profit obtained by firm B is therefore $\pi_B = \frac{t}{2} - F > \frac{t}{2} - 2F$: NO.

3. Determine the two types of equilibria of this game. For which conditions on H and F do these equilibria exist?

- There are two symmetric equilibria: (i) one firm advertises 1 and the other 2 or (ii) the two firms advertise the same good.
  - A and B advertise product 1. Consumers expect product 2 to be sold at price H at both stores.
  - The indifferent consumer is:

$$\hat{x} = \frac{p_{B1} + H - p_{A1} - H + t}{2t}.$$

  - A maximizes its profit $(p_{A1} + H)\hat{x}$ whereas B maximizes $(p_{B1} + H)(1 - \hat{x})$.
  - We obtain $p_{A1} = p_{B1} = t - H$ and therefore the profit is $\frac{t}{2} - F > 0$.

3. Determine the two types of equilibria of this game. **For which conditions on H and F do these equilibria exist?**

- There is no incentive for a firm to deviate towards no advertising as it brings no profit.
- There is no incentive to deviate towards advertising both products as it brings a lower profit $\frac{t}{2} - 2F$.
- A firm could deviate by advertising instead the other product. But as everything is symmetric here, it brings the same profit.
- From above it is immediate that there is another symmetric equilibrium in which A advertises 1 and B advertises 2 and conversely.

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Signaling Game

- Player 1 has a private information about his type $\theta \in \Theta$ and chooses a signal $s \in S$.
- Player 2 observes s and chooses an action $b \in B$.
- Player 2 has prior belief about Player 1's type p(.). After observing s, Player 2 revises its beliefs according to the Baye's rule and has a posterior belief $\mu(./s)$ over Θ.
- Player 1 determines $\sigma_1(s/\theta)$, the probability to send a signal s when being of type θ.
- Player 2 determines $\sigma_2(b/s)$, the probability to choose the action b given the signal s and posterior belief $\mu(./s)$.

Definition . A perfect Bayesian equilibrium of a signaling game is a strategy profile (σ_1^*, σ_2^*) in which each player's strategy is the best reaction to the other's strategy according to the posterior beliefs $\mu(./s)$.

back

Types of equilibria

A **separating equilibrium** is an equilibrium where Players 1 of different types always choose different messages and therefore fully reveal their type to Player 2.

A **pooling equilibrium** is an equilibrium where Players 1 of different types always choose the same message and no information is revealed to Player 2.

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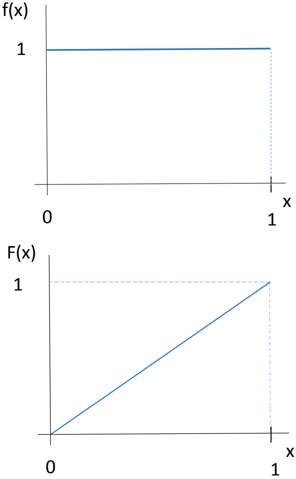
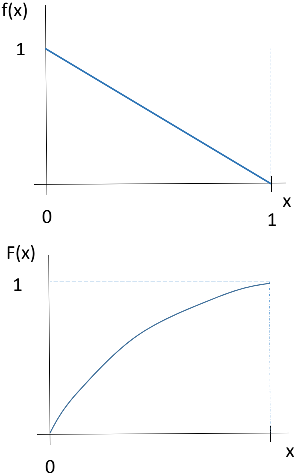
Uniform distribution: $\lambda_1 = \lambda_2$



Distribution in favor of 1: $\lambda_1 = \lambda_2$



	Colgate	**P&G CREST**
Help reduce Cavities	★★★	★★★
Help brush away Plaque	★★	★
Prevent Gingivitis	★	★★
White teeth	★★	★
Fresh feeling breath	★	★★