Product differentiation

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Topic 7. Product differentiation: patterns of price setting

1. Introduction

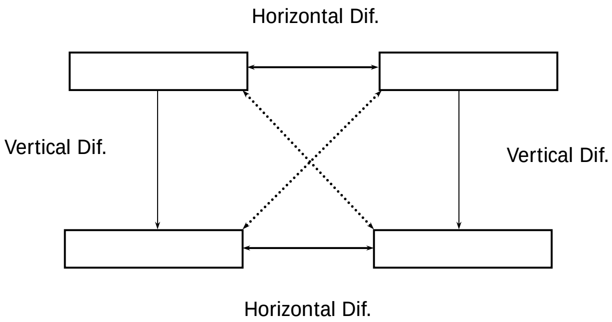
- **Aim**: To study an oligopoly model relaxing the homogeneous product assumption, to analyse the effect of product differentiation on price competition intensity and product choice.

- Main implication of the homogeneous product assumption in an oligopoly model of price competition (*à la Bertrand*)
  - Bertrand paradox → Price competition between two firms is a sufficient condition to restores the competitive situation
    $p = c$

2. Horizontal and vertical product differentiation

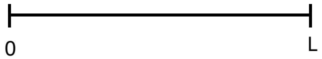
- **Horizontal product differentiation**: two products are differentiated horizontally if, when they are offered at the same price consumers **do not agree** on which is the preferred product.
  Example:
- **Vertical product differentiation**: two products are differentiated vertically if, when they are offered at the same price consumers **agree** on which is the preferred product.
  - Example:

Example



3 Linear city model with linear transport costs : assumptions

- Consumers are uniformly distributed with unit density along a segment of L length



- Two firms (firms 1 and 2) are located along the segment
- The two firms sell a product that is identical except for the location of the firm.
- The two firms have constant and identical marginal cost $c \rightarrow c_1 = c_2 = c$
- Each consumer buys a single unit of the product.

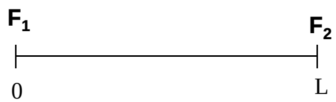
$\rightarrow$ Alternative interpretation of the segment as a product characteristic

3Linear city model with linear transport costs : two-stage game

Stage 1: the two firms choose simultaneously their location (long-run decision)

Stage 2: the two firms choose simultaneously their prices (short-run decision)

We impose maximum product differentiation and so we focus on the determination of the *Nash equilibrium in prices* (Stage 2).



3. Linear city model with linear transport costs : consumers' utility function

- The utility that a consumer *i* located in X obtains from the purchase of of the good of firm *j* is given by:

r: reservation price

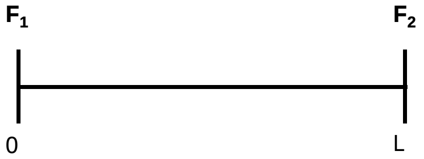
p_j: price of the product of firm *j*

x_{ij}: distance (along the segment) between the location of consumer *i* and the location of firm *j*

t: transport cost per unit of distance (or alternatively intensity of the preference for a given product)

3 Linear city model with linear transport costs : transport costs

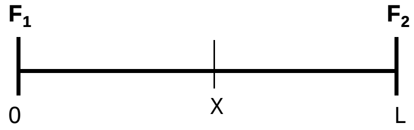
- With linear transport costs per unit of distance :



  - Transport cost if the product is bought at firm 1 =
  - Transport cost if the product is bought at firm 2 =

- Total cost of the product = price + transport costs
  - Total cost if the product is bought at firm 1 =
  - Total cost if the product is bought at firm 2=

3 Linear city model with linear transport costs : demands determination



3 Linear city model with linear transport costs : demand properties

- Price elasticity of demand

$$\eta = \frac{\partial d_1}{\partial p_1}\frac{p_1}{d_1} = -\frac{p_1}{p_2 - p_1 + Lt} < 0$$

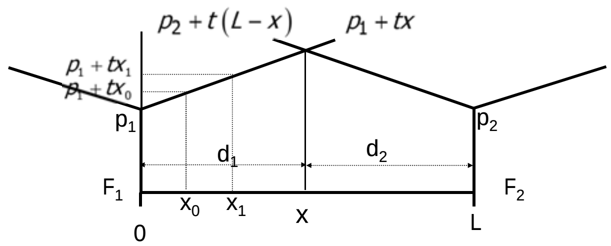
- Price elasticity of demand and transport costs

$$\frac{\partial |\eta|}{\partial t} = -\frac{Lp_1}{(p_2 - p_1 + Lt)^2} < 0$$

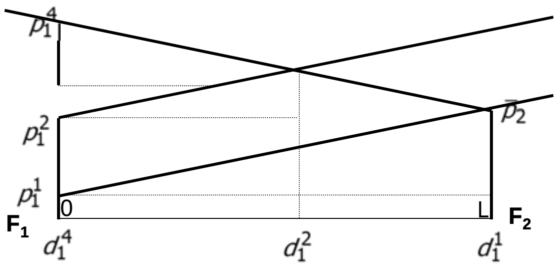
3 Linear city model with linear transport costs : demands determination

- Total cost of buying at 1 = Total cost of buying at 2

$$p_1 + tx = p_2 + t(L - x)$$



3 Linear city model with linear transport costs : firm 1 demand



3 Linear city model with linear transport costs : Obtaining the Nash equilibrium in prices (I)

- Maximization problem of firm 1

- Maximization problem of firm 2

3 Linear city model with linear transport costs : Obtaining the Nash equilibrium in prices (II)

- Solving the system of equations given by the two reaction functions we obtain the price equilibrium: (given locations)

- Profits for both firms are:

3 Linear city model with linear transport costs : Obtaining the Nash equilibrium in prices (I)

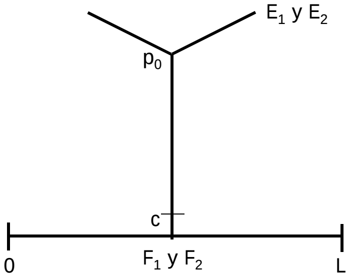
- Although both products are physically identical, as long as t>0 the price is greater than the marginal cost

- Why?:
  - The larger is t the more differentiated are the products for the consumers → the higher is the costs of buying in a further shop.
  - The larger is t the lower in the intensity of competition between firms 1 and 2 (for the consumers located between the two firms).
  - When t=0 the products are not differentiated any more → price is equal to marginal cost as in the Bertrand model with homogeneous.

3 Linear city model with linear transport costs : Analysis of the location decisions (I)

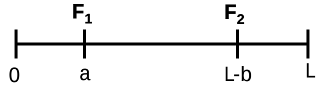
- Two extreme cases:
  - Maximum product differentiation: if $t>0 \rightarrow p>c$ y $\Pi>0$
  - Minimum product differentiation: both firms choose the same location → no differentiation → Bertrand model with homogeneous products

$$p_1^C = p_2^C = c \text{ y } \Pi_1 = \Pi_2 = 0$$



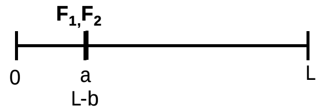
3 Linear city model with linear transport costs : Analysis of the location decisions (II)

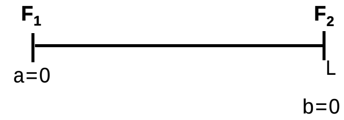
- With a gain of generality we can assume:



where $a \geq 0$, $b \geq 0$ y $L-a-b \geq 0$ → It allows the consideration of captive demands

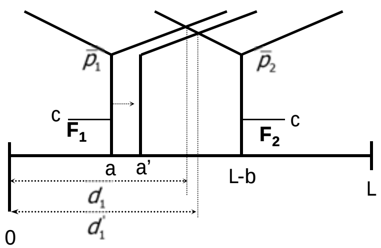
- If a+b=L → minimum differentiation
- If a=b=0 → maximum differentiation





3 Linear city model with linear transport costs : Analysis of the location decisions (III)

- Nash equilibrium in locations is the one in which firm i (i=1,2) takes its optimal decision of location and price given its rival's locations an price decisions
- The original result in the Hottelling model (1929): minimum differentiation. Once prices have been chosen, both firms locate in the centre of the segment → L/2



4. Application: Coca-Cola vs. Pepsi-Cola

- **Coca-Cola** and **Pepsi-Cola,** the world leaders on the carbonated colas market, sell horizintally differentiated products.
- **Simplifying assumption:** the relevant competition dimension is price (→ advertising)

- **Laffont, Gasmi y Vuong** (1992) analyse price competition between Coca-Cola and Pepsi-Cola. They estimated using econometric methods the following demand and marginal costs functions.

4. Application: Coca-Cola vs. Pepsi-Cola: demand and costs functions

- Demand functions for Coca-Cola (product 1) and Pepsi-Cola (product 2).

  $Q_1 = 63.42 - 3.98\ p_1 + 2.25\ p_2$

  $Q_2 = 49.52 - 5.48\ p_2 + 1.40\ p_1$

- Marginal costs for Coca-Cola and Pepsi-Cola

  $c_1=4.96$

  $c_2=3.96$

- Which is the optimal price for Coca-Cola and Pepsi-Cola?

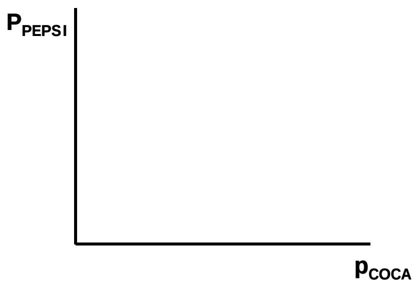
4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination

- Step 1: solve the maximization problems of Coca-Cola and Pepsi-Cola.
  - Coca-Cola's maximization problem:
  - Pepsi-cola's maximization problem:

4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (II)

- Step 2: solve the system of reaction functions.

Coca-Cola sets a price higher than the Pepsi-Cola one.



4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (III)

- Why Coca-Cola's price is higher that Pepsi-Cola's one?
  - Cost asymmetries
  - Demand asymmetries

4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (IV)

- Costs asymmetries:
  - Coca-Cola marginal cost (4.96) > Pepsis-Cola marginal cost (3.96)

  → Coca-Cola's price > Pepsi-Cola's price

4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (V)

- Demand asymmetries

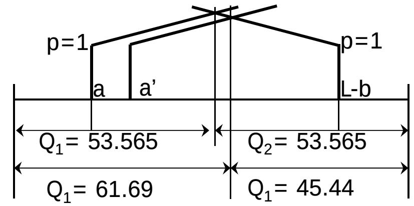
$$Q_1=63.42 - 3.98\ p_1 + 2.25\ p_2 \qquad \xrightarrow{p_1 = p_2 = p} \qquad Q_1=63.42 - 1.73p$$

$$Q_2=49.52 - 5.48\ p_2 + 1.40\ p_1 \qquad\qquad\qquad Q_2=49.52 - 4.08p$$

- Graphic analysis → normalize p=1
  - Q_1= 61.69 y Q_2=45.44
  - $Q=Q_1+Q_2$=107.13

1. Symmetric Eq.
   a=b → $Q_1=Q_2$

2. Aymmetric Eq.
   a'>b → $Q_1>Q_2$



4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (VI)

- The higher Coca-Cola's price is due to:
  - Higher marginal cost (cost asymmetries)
  - Demand asymmetries that favour Coca-Cola

4. Application: Coca-Cola vs. Pepsi-Cola: optimal prices determination (VII)

- Do these asymmetries have any additional impact? → price-cost margin

- The price-cost margin of Coca-Cola is higher than the Pepsi-Cola's one

  → Demand asymmetry in favour of Coca-Cola

  → Higher market power for Coca-Cola

5. Concluding Remarks

- Product differentiation solves the Bertrand paradox:
  - It allows firms to set price above marginal cost
  - It allows firms to obtain positive profits

- Firm will intend to differentiate their products (from those of its competitors) as much as possible, the aim is to reduce the intensity of price competition:
  - Actual product differentiation
  - Perceived product differentiation: increase consumers' preference for the products of the firm