ECO 650: Firms' Strategies and Markets
Course 1: Multiproduct firms' pricing strategies

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September 20, 2017

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MultiProduct Firms

- Retailers are intrinsically multiproduct
  - A supermarket sells on average from 30 000 (Sainsbury) to 120 000 products (Wal-Mart discount store)
- Most producers are multiproduct
  - Substitutes (Ex: Coca-Cola's product line)
  - Complementary products (Ex: Microsoft hardware + software)
- The multiproduct dimension has direct consequences on firm's pricing strategies
  - Loss-leading
  - Bundling/ Tying
- Course 1 analyzes these strategies within the following framework
  - Monopoly / Competition
  - Static
  - Perfect information.

Loss-Leading

- A practice that is common in many large stores who sell “leader products" at loss;
- Hard-Discount offer prices that are up to 60% lower than those of leading name brands, and 40% lower than large retailers’ own labels.
- In Germany, the highest court upheld in 2002 a decision of the Federal Cartel Office enjoining Wal-Mart to stop selling basic food items (such as milk and sugar) below its purchase cost, confirming that a firm" with superior market power in relation to small and medium-sized competitors" should not price below cost.
- Resale below cost laws in many countries (France, Ireland, US state laws for specific products...).

Loss-Leading & Monopoly

- A single product monopoly who faces a demand $q(p)$ sets its price "p" according to the Lerner index:

$$L = \frac{p-c}{p} = 1/\epsilon \texttt{ where } \epsilon = -\frac{\partial q}{\partial p}\frac{p}{q} \quad (1)$$

- A multiproduct monopoly who faces a demand $q_i(p_i, p_j)$ for its product i sets its prices p_i and p_j by internalizing the effect of p_j on the demand for good i...
- ...which exists as long as products' demand are "linked"
  - Products are substitutes ($\frac{\partial q_i(p_i,p_j)}{\partial p_j} > 0$ (ex: product within the same product category (Sodas, Fresh juices, Mineral water...)
  - Products are complements ($\frac{\partial q_i(p_i,p_j)}{\partial p_j} < 0$ (ex: Fries and ketchup, meat and red wine, ...)
  - Products are often "independents" (vegetables & shampoo) but become "complements" due to shopping costs!!

Loss-Leading & Monopoly

- Assume the monopoly sells goods 1 and 2,
- Marginal costs are c_1 and c_2;
- Demands are denoted q_1 and q_2 and prices p_1 and p_2;

The multiproduct monopoly maximizes: $\pi = (p_1 - c_1)q_1 + (p_2 - c_2)q_2$ =>FOC's

$$(p_1 - c_1)\frac{\partial q_1}{\partial p_1} = -q_1 - (p_2 - c_2)\frac{\partial q_2}{\partial p_1} \qquad (2)$$

which rewrites:

$$\frac{(p_1 - c_1)}{p_1} = \frac{1}{\epsilon_1} + \frac{(p_2 - c_2)}{p_1} \frac{\frac{\partial q_2}{\partial p_1} \;\lesseqgtr 0}{-\frac{\partial q_1}{\partial p_1} \;> 0} \qquad (3)$$

Multiproduct monopoly pricing

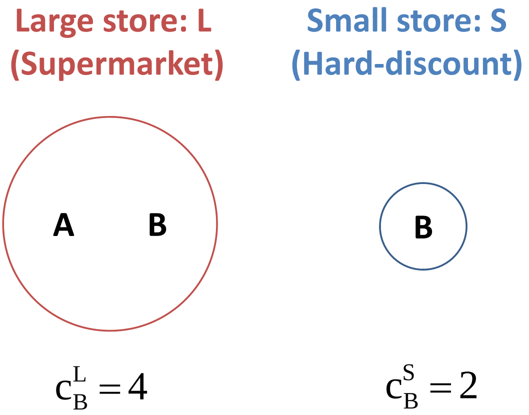
A multiproduct firm monopoly sets:

- higher prices than separate monopolies (each controlling a single output) when goods are substitutes
- lower prices than separate monopolies when goods are complements

It is possible to have $L_i < 0$=> loss-leading!!

Loss-Leading & Competition: Chen and Rey (2012)

- Two retailers L and S compete in a local market
- L offers a broader range of products (A and B) than S (B)
- S has a lower unit cost on B (Hard-discount): $c_B^L > c_B^S$



Loss-Leading & Competition

Demand

- Each consumer is willing to buy one unit of A and B
- Homogenous valuations: $u_A = 10$ for A, $u_B = 6$ for B
  $\rightarrow$ eliminates cross-subsidization motive based on different elasticities
- Complete information $\rightarrow$ no role for (informative) advertising
- Heterogeneous shopping costs:
  - Half shoppers have high shopping costs: $h = 4$ per store: One-stop shoppers;
  - The other half incurs no shopping cost: multi-stop shoppers.

Benchmark 1: L is a monopoly who can perfectly discriminate among consumers

L will set lower prices for consumers who have high shopping costs (personalized prices): p^h for the one-stop shoppers and p for the multi-stop shoppers.

- For one-stop shoppers consumers: L sets $U_A + U_B - p^h - h = 0$ and thus $p^h = 12$ with $(p_A^h \leq U_A$ and $p_B^h \leq U_B)$. Its profit is $\pi_L = p^h - c_B^L = 12 - 4 = 8$.
- For multi-stop shoppers: $U_A + U_B - p = 0$ and thus set $p = 16$ with $(p_A \leq U_A$ and $p_B \leq U_B)$. Its profit is $\pi_L = (p - c_B^L) = 12$.

Equilibrium

A monopolist that could discriminate earns at most $\pi_L = \frac{1}{2}8 + \frac{1}{2}12 = 10$

Benchmark 2: L is a monopoly who cannot perfectly discriminate

L can follow two strategies:

- To serve all consumers: $U_A + U_B - p^m - h = 0$ and thus set $p^m = p_A + p_B = 12$ with $p_A \leq U_A$ and $p_B \leq U_B$. Its profit is $\pi_L = p^m - c_B^L = 12 - 4 = 8$.
- To serve only multi-stop shoppers: $U_A + U_B - p = 0$ and thus set $p = 16$. Its profit is $\pi_L = \frac{1}{2}(p - c_B^L) = 6$.

Equilibrium

It is always profitable for L to set $p^m = 12$ with any $p_A \leq U_A$ and $p_B \leq U_B$. L thus also serves one-stop shoppers and gets $\pi_L = 8$

S now is a competitive fringe: $p_S = C_B^S = 2$

Can L follow the previous strategy $p^m = 12$? Assume L sets $p_A = 8$ and $p_B = 4$: What happens?

- One stop shoppers:
  - Never go to S to buy B : $U_B - h - p_S = 0$
  - Always buy A and B at L as $U_A + U_B - p_A - p_B = h$.
- Multi-stop shoppers:
  - Always buy A at L (as $U_A > p_A$).
  - As $U_B - p_B = 2 < U_B - p_S = 4$, they go to S to buy B.

$\Rightarrow$ Although L looses multi-stop shoppers on B, L gets :

$\pi_L = \frac{1}{2}(12 - 4) + \frac{1}{2}8 = 8.$

L can do even better by using loss-leading: $p_A = 10 - \epsilon$ and $p_B = 2 + \epsilon < c_B^L$

- One stop shoppers
  - Never go to S to buy B as $U_B - h - p_S = 0$
  - Always buy A and B at L as $U_A + U_B - p_A - p_B = h$.
- Multi-stop shoppers
  - Buy A at L (as $U_A > p_A$).
  - As $U_B - p_S = 4 > U_B - p_B = 4 - \epsilon$ they go to S to buy B.

$\Rightarrow$ **Although L looses multi-stop shoppers on B, L gets even more than the monopoly profit**: $\pi_L = \frac{1}{2}(12 - 4) + \frac{1}{2}10 = 9$.

Conclusion:

Loss leading appears here as an exploitative device which discriminates multi-stop shoppers from one-stop shoppers.

- Loss-leading allows large retailers to extract additional surplus from consumers
- and hurts smaller rivals as a by-product

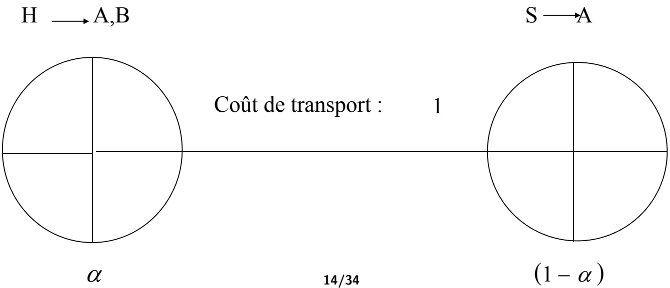
When the small store also sets its price strategically, the results holds.

Remember

- One-stop shopping behavior creates complementarity between independent goods
- A retailer sell products with the highest demand elasticity below cost and then sell other products in the store with higher margins!!!
- Such practice naturally arises absent any competition motive!!! It is inherent to the “multi-product" nature of the seller.
- Bliss (1988) extends the Ramsey rule to a framework of imperfect competition when consumers are one-stop shoppers.
- Loss leading may also enable a large firm to discriminate its costumers. In such case loss leading is an exploitative device that may hurt smaller rivals only as a "by product".

Exercice 1

- Two stores H (Hypermarket) and S (Supermarket)
- H sells A and B – S sells A
- $\alpha \in [0, \frac{1}{2}]$ consumers are located at H and $1 - \alpha$ in S.
- Transportation cost among the stores is normalized to 1.
- $u_A = 1$; u_B uniformly distributed over $[0, 1]$ around each store.
- $b \in [0, 1]$ is the unit cost for B. No cost for A.



1. Which consumers may travel from one store to the other?
2. We note $p^H = p_A^H + p_B^H$ the sum of prices for the two goods at store H; p^S the price of B at store S.
   Determine the demand at each store.
3. Determine the two candidates Nash equilibria in pure strategy.
4. Assume that $\alpha = \frac{1}{9}$ and show that the loss-leading equilibrium is the unique Nash equilibrium in pure strategy.
5. How do you explain the emergence of this loss-leading equilibrium?

Bundling strategies

Bundling: consists in selling two or more products in a single package.

The example of gasoline sales

- Supermarkets accounted for 56% of the gasoline sales in France, 28% in the U.K. in 2004. U.S. supermarkets started in the late 1990s and had 5.9% of the gasoline sales nationwide in 2002.
- Many major supermarkets in the U.S. and in UE offer grocery-gasoline bundled discounts!
  Ex: For 50 euros of gasoline you get a discount of 3 euros at the store!!

Bundling strategies are:

- A form of second-degree price discrimination
- Instead of setting a menu of prices to better cater for consumers' heterogeneity, bundling rather tends to reduce consumers' heterogeneity.

Monopoly Bundling: Adams and Yellen (1976)

A simple model: Assumptions

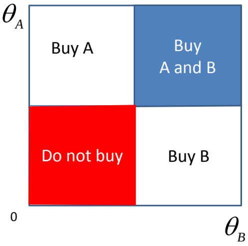
- Consider a monopoly firm producing two goods A and B at zero cost.
- A unit mass of consumers have preferences over the two goods: each consumer is identified by a couple (θ_A, θ_B) uniformly distributed over $[0, 1]^2$.
- The two goods valuations are independent and thus a consumer valuation for the bundle is $\theta_A + \theta_B$.
- We compare 3 strategies:
  1. Separate selling,
  2. Pure bundling,
  3. Mixed bundling.

1. Separate selling

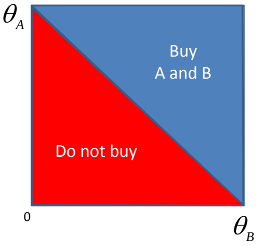
- Demand for A is: $D_A = \int_{p_A}^{1} d\theta_A$ and thus p_A is chosen to maximize $p_A(1 - p_A)$
- Similar for good B and thus $p_B = p_A = \frac{1}{2}$
- Profit with separate selling: $\pi_s = \frac{1}{2}$

2. Pure Bundling

- The retailer can replicate the same profit by setting $p = p_A + p_B = 1$ for the bundle!
- Profit is the same but consumers who buy are not the same!

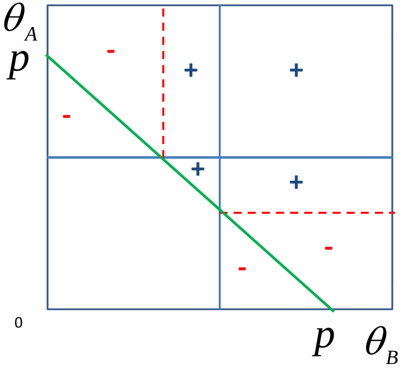


Separate selling



Pure bundling: p=1

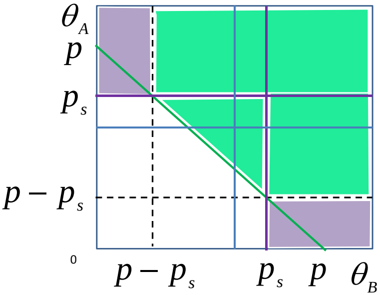
- The monopolist can reach higher profits by setting $p < 1$
- Consumers buy when $\theta_A > p - \theta_B$, thus $D = 1 - \frac{p^2}{2}$
- Thus p is chosen to maximize $p(1 - \frac{p^2}{2}) => p = \sqrt{\frac{2}{3}} \approx 0.82$
- The profit of the optimal bundling is $\pi_b = \frac{2}{3}\sqrt{\frac{2}{3}} \approx 0.544 > \pi_s$
- Total consumers surplus increases



Optimal pure budling

3. Mixed Bundling

- The analysis is restricted to the case $p_A = p_B = p_s$
- Consumers who prefer buying one good k than nothing are such that $\theta_k > p_k$
- Consumers who prefer buying the bundle rather than A alone are such that $\theta_A + \theta_B - p > \theta_A - p_s => \theta_B > p - p_s$
- Consumers who prefer buying the bundle rather than B alone are such that $\theta_A > p - p_s$
- Consumers who prefer buying the bundle than nothing are such that $\theta_A + \theta_B - p > 0$



Optimal mixed bundling

- Demands are:

$$
\begin{aligned}
D_A &= D_B = (1-p_s)(p-p_s) \\
Db &= (1-p_s)^2 + 2(2p_s - p)(1-ps) + \frac{(2p_s-p)^2}{2}
\end{aligned}
$$

- The monopolist chooses (p_s, p) which maximizes $\pi = p_s(D_A + D_B) + pD_b$:
- $p_s = \frac{2}{3}$ and $p = \frac{4-\sqrt{2}}{3} \approx 0.86$;
- The profit $\pi_{mb} = 0.549 > \pi_b > \pi - s$
- Consumers are worse off in the mixed bundling case compared to the pure bundling case.

Bundling

Mixed bundling allows the monopolist to increase its profit even further than pure bundling.
Consumers may be worse off under mixed bundling than under pure bundling.

Remember

- Bundling strategies arise in a monopoly situation for a discrimination purpose (absent any competition motive!!).
- The discrimination motive only requires consumers' heterogeneity in their valuations for the goods.
- Bundling is even better when valuations for the two goods are perfectly negatively correlated. In that case, every consumer as a total valuation for the two goods of 1 and bundling its product at a price $p = 1$, the monopolist obtains the maximal profit of 1. Bundling makes consumers perfectly homogenous.
- It is less profitable as valuations become positively correlated.

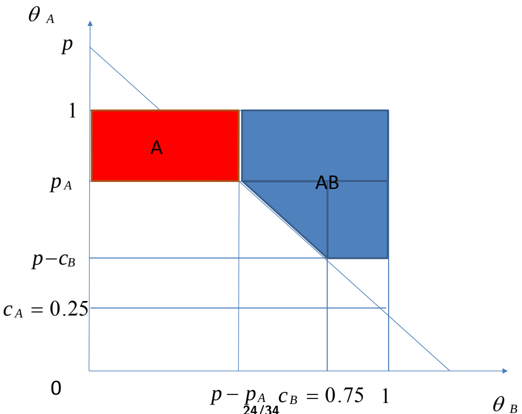
Bundling & Competition: Chen (1997)

- Assumptions
  - Good A is offered by two firms denoted 1 and 2 at marginal cost $c_A < 1$.
  - Good B is produced by a perfectly competitive industry at marginal cost c_B. Firms 1 and 2 may also offer it at marginal cost c_B.
- The game
  1. Firms 1 and 2 simultaneously choose their marketing strategy (A only, A and B in bundle, sell A and the bundle)
  2. Price competition.
- In 5/9 subgames, no profit!!
  1. If 1 and 2 only sell A, $p_A = c_A$;
  2. If 1 and 2 only sell the bundle AB, $p = c_A + c_B$;
  3. If 1 and 2 sell A and the bundle AB, $p_A = c_A$, $p = c_A + c_B$
  4. If 1 or 2 specializes while the other adopts mixed bundling: $p_A = c_A$, $p = c_A + c_B$

Bundling & Competition

If 1 specializes on A and 2 sells the bundle only:

- Bundle/A: $\theta_A + \theta_B - p > \theta_A - p_A \Rightarrow \theta_B > p - p_A$;
- Bundle/B: $\theta_A + \theta_B - p > \theta_B - c_B \Rightarrow \theta_A > p - c_B$;
- Bundle/A and B: $\theta_A + \theta_B - p > \theta_A + \theta_B - p_A - c_B \Rightarrow p \leq c_B + p_A$;
- Bundle/nothing: $\theta_A + \theta_B - p \geq 0$.



Bundling & Competition

- There is not always a Nash equilibrium!
- Demands are:

$$\begin{aligned} D_A &= (1-p_A)(p-p_A) \\ D_{AB} &= (1-p_A)(1-p+p_A)+\frac{1}{2}(2+p_A-p-c_B)(c_B-p+p_A) \end{aligned}$$

- Each firm maximize its profit respectively $\pi_1 = (p_A - c_A)D_A$ and $\pi_2 = (p - c_A - c_B)D_{AB}$:
- For $(c_A, c_B) = (\frac{1}{4}, \frac{3}{4})$, $p_A^* = 0.529$ and $p^* = 1.213$; $(p_A^* + c_B = 1.279 > p^*)$
- The profit $\pi_1^* = 0.09 > \pi_2^* = 0.035$
- Two sources of deadweight loss:
  1. $p_A^* > c_A$
  2. Some consumers with $\theta_B < c_B$ buy B through the bundle.

Conclusion:

Bundling strategies may enable to soften retail competition!

Bundling as a barrier to entry: Nalebuff (2004)

- Bundling is an effective deterrence strategy
  - Motivating example: Microsoft Office (Word, Excel,Powerpoint and Exchange are bundled and compete with Corel's word perfect, IBM's lotus 123 and Qualcomm's Eudora

Assumptions:

- Same framework as in Adams and Yellen, two products with independent valuations uniformly distributed over$[0, 1]$ but TWO firms I and E. No production cost for I or E.
- Two-stage Game
  1. The incumbent (I) offers A and B and sets its prices;
  2. An entrant (E) can enter at a fixed cost F and sell a single product (either A or B) and set its price.

Bundling as a barrier to entry

Benchmark: Products are only sold separately

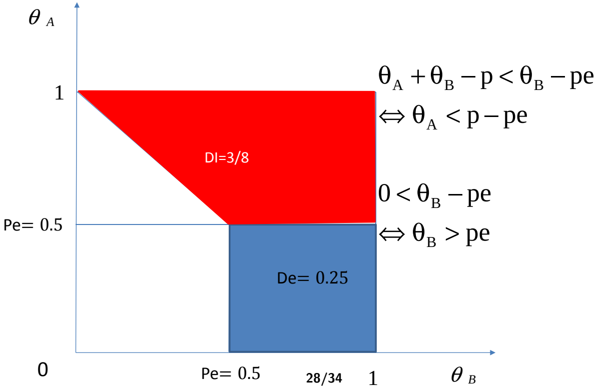
- Without entry threat: the monopolist sets $p_A = p_B = \frac{1}{2}$ and obtains a profit $\pi_I^M = \frac{1}{2}$ (see slide 21).
- If E enters and I did not change its behavior: E sets $p_E = \frac{1}{2} - \epsilon$ on product A or B and gets $\pi_E = \frac{1}{4}$ and I gets $\pi_I = \frac{1}{4}$. Entry would occur for $F < \frac{1}{4}$.
- If I changes its behavior to prevent entry: I sets $p_A = p_B = p$ to get a profit $2p(1-p) = 2F$.

Bundling & Competition

Bundling effects

1. Pure bundling effect
2. Bundling discount effect

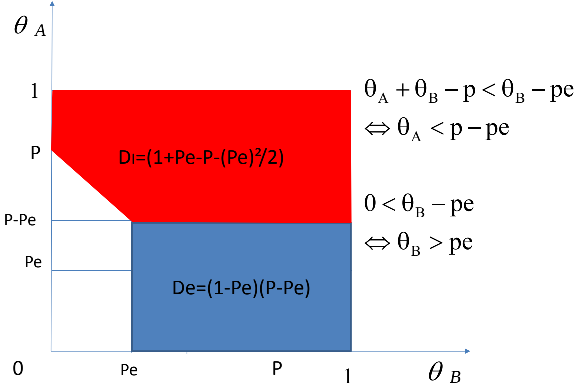
1-Pure bundling effect Assume I offers only the bundle at a price $p_A + p_B = p = 1$ and E still offers B at price $p_e = \frac{1}{2} - \epsilon$. E gets a profit $\frac{1}{8}$ and entry is deterred for $\frac{1}{8} < F < \frac{1}{4}$.



Bundling & Competition

2-Bundling discount effect Assume I now offers only the bundle at a price $p_A + p_B = p = \sqrt{\frac{2}{3}} \approx 0.82$ which brings the highest profit if entry is deterred $\pi_b = \frac{2}{3}\sqrt{\frac{2}{3}} \approx 0.544$ (Slide 22)

What is the entrant's best response? $p_e \approx 0.3$ and $\pi_e = 0.105 < \frac{1}{8}$



Bundling & Competition

Bundling discount effect The entrant E maximizes its profit

$\pi_e = p_e(1-p-p_e)(p-p_e)$ according to the level of p.

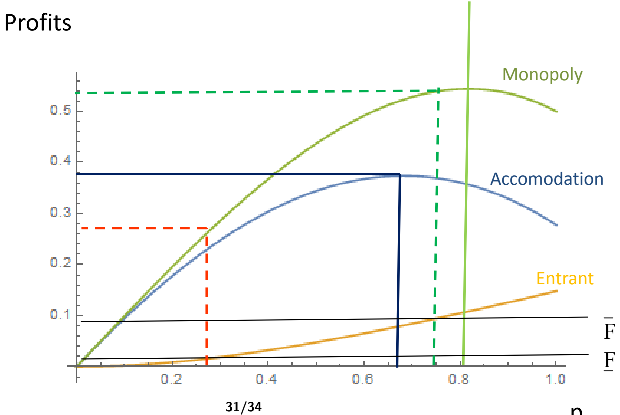
$$p_e = \frac{1+p}{3} - \frac{1}{3}\sqrt{1+p^2-p}$$

The incumbent obtains:

$$\pi_I = p(1-p+p_e-\frac{p_e^2}{2})$$

p	p_e	I's profit|No entry	I's profits|entry	E's profit
1.	0.33	0.5	0.277	0.148
0.8	0.295	0.544	0.361	0.105
0.68	0.265	0.523	0.374	0.080
0.5	0.211	0.437	0.34	0.048
0.41	0.17977	0.375	0.30	0.034

- If $F = \overline{F}$, I sets a constrained bundling price below 0.8 to prevent entry.
- If $F = \underline{F}$, I sets $p = 0.681$ the optimal accomodation price, and E enters.



Remember

Bundling strategies in a competition framework

- Bundling still enables firms to discriminate consumers.
- Bundling may enable competing firms to differentiate themselves and therefore relax competition!
- Bundling may be a way to intensify competition and therefore discourage entry!

Exercice 2

Food for life makes health food for active, outdoor people. They sell 3 basics products (Whey powder, high protein Strenght bar, a meal additive(Sawdust))

Consumers fall into two types:

Consumers	Whey	Strenght	Sawdust
Type A	10	16	2
Type B	3	10	13

Question: Each product costs 3 to produce and the bundle of 3 products costs 9. What is the best pricing strategy for the firm? Separate selling, Pure bundling (only bundles of 3 products must be considered)? or mixed bundling?

The firm cannot discriminate among consumers. We assume there is 1 consumer of each type (A and B) and he wants one unit of each product.

Main References

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