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

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September 22, 2021

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.

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Loss-Leading

- A practice that is common in many large stores who sell “leader products" at loss;
  - Loss leaders are mainly “staples such as milk and dairy, alcohol, bread and bakery products that consumers purchase repeatedly and regularly;"
  - Loss leaders can also be highly attractive products (Champagne)
- A practice that is often regulated:
  - 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.
  - Resale below cost laws in many countries (France, Ireland, US state laws for specific products...).

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Loss-Leading & Monopoly

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

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

- 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' demands 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!!

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Loss-Leading & Monopoly

- Formally, assume the marginal costs are c_i and c_j;

The multiproduct monopoly maximizes: $\pi = (p_i - c_i)q_i + (p_j - c_j)q_j$
=>FOC's (for $i = 1, 2$)

$$(p_i - c_i)\frac{\partial q_i}{\partial p_i} = -q_i - (p_j - c_j)\frac{\partial q_j}{\partial p_i}$$

which rewrites:

$$\frac{(p_i - c_i)}{p_i} = L_i = \frac{1}{\epsilon_i} + \frac{(p_j - c_j)}{p_i}\frac{\frac{\partial q_j}{\partial p_i} \lesseqgtr 0}{-\frac{\partial q_i}{\partial p_i} > 0}$$

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!!

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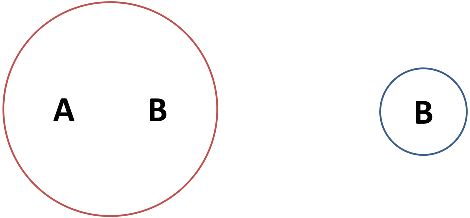
Loss-Leading & Competition

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): $c_B^L > c_B^S$

Large store: L (Supermarket)

Small store: S (Hard-discount)



$c_B^L = 4$ $c_B^S = 2$

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 $\pi_L = \frac{1}{2}8 + \frac{1}{2}12 = 10$

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Benchmark 2: L is a monopoly

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: $U_A + U_B - p^m = 0$ and thus set $p^m = 16$. Its profit is $\pi_L = \frac{1}{2}(p - c_B^L) = 6$.

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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 $\pi_L = 8$

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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?

To break indifference (hyp) consumers always prefers to buy the two goods rather than one!

- One stop shoppers:
  - Going to S to buy B : $U_B - h - p_S = 0$
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  - Go to L to buy A (as $U_A > p_A$).
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$\Rightarrow$ Although L looses multi-stop shoppers on B, L gets :

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

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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

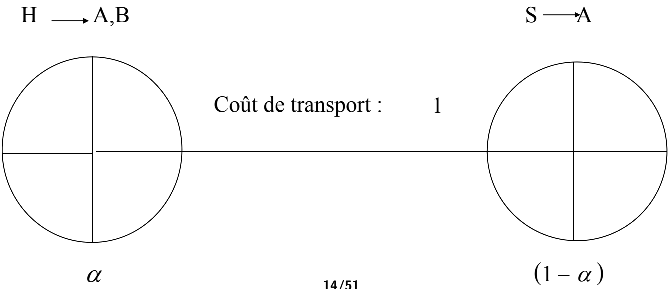
When the small store also sets its price strategically, the results holds.

Remember

- Complementarity among products naturally explains loss leading, absent any competition motive: Ramsey rule!
- A retailer sell products with the highest demand elasticity below cost and then sell other products in the store with higher margins!!
- Loss-leading practices might be used to better discriminate consumers.
- One-stop shopping behavior creates complementarity between independent goods (See exo 1)
- Bliss (1988) extends the Ramsey rule to a framework of imperfect competition when consumers are one-stop shoppers.

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.



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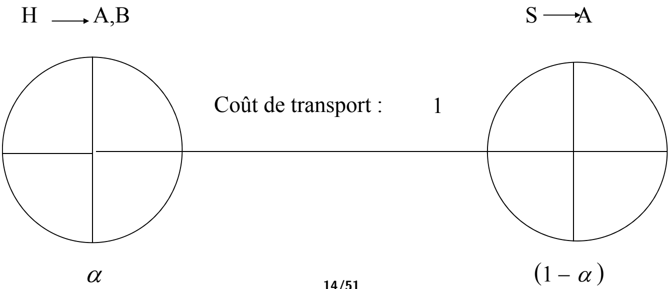

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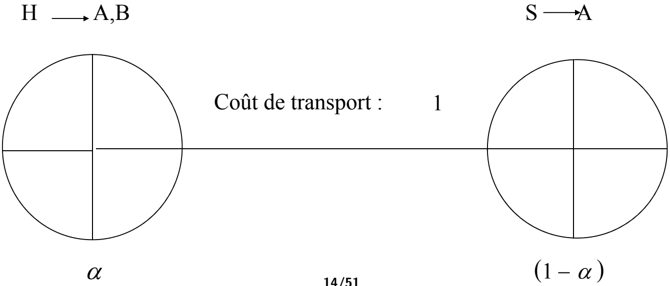

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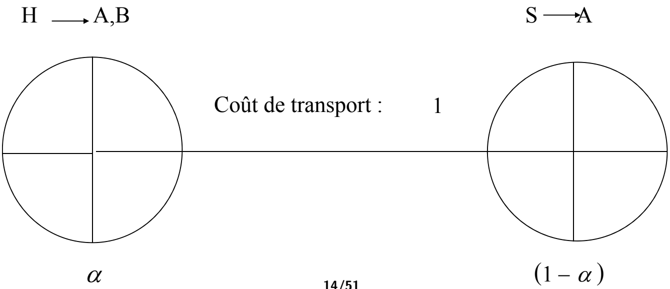

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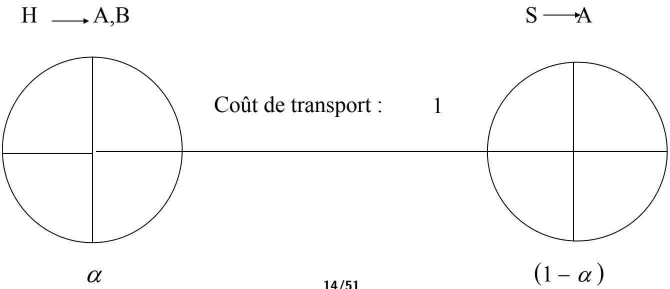

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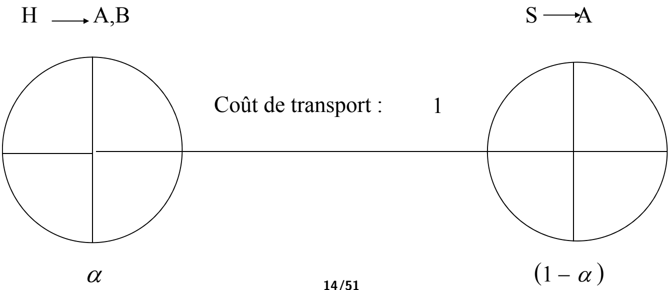

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Assume $b \to 0$, when $\alpha = \frac{1}{9}$:

- In the loss-leading candidate, H obtains $\Pi^{H*} = \frac{1}{2}.(\frac{5}{9})^2$ and S gets $\Pi^{S*} = \frac{(17)^2}{(9)^2.8} \approx 0.44$.
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- A complementarity between the two independent products arises through the transportation cost.
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Bundling strategies

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

Various example

- Supermarkets account for a large share of gazoline sales (61% in France, >50% in the U.S): grocery-gasoline bundled discounts!
- Membership card for movie theater, sports club etc...
- Coca-Cola who sells its entire product line (or nothing!) to retailers (The TCCC case in 2005).
- Recent Google Cases!

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.

Bundling strategies are a way to distort competition!

- To exclude a competitor or deter entry (leverage theory!)
- To soften competition.

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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 valuations for the two goods are independent; a consumer valuation for the bundle is $\theta_A + \theta_B$.
- We compare 3 strategies:
  1. Separate selling,
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  3. Mixed bundling.

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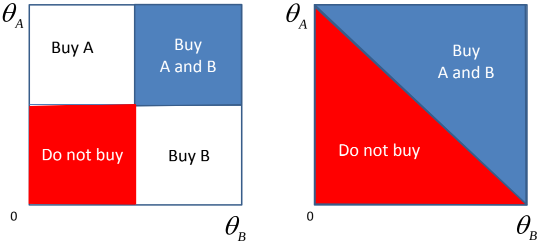
1. Separate selling

- 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

29/51

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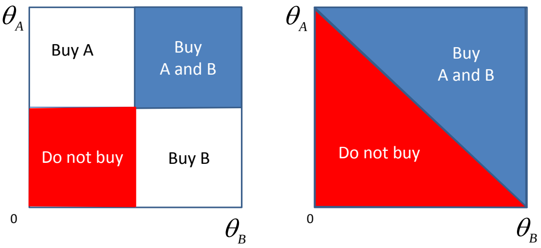
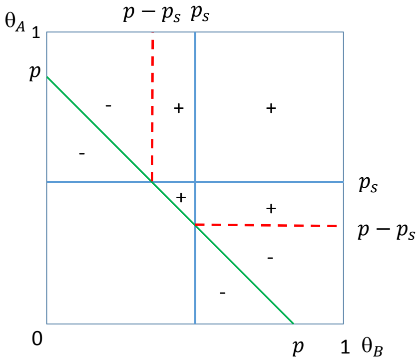


Separate selling

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



3. Mixed Bundling

- The analysis is restricted to the case $p_A = p_B = p_s$
- Consumers who prefer buying good k than nothing are: $\theta_k > p_k$
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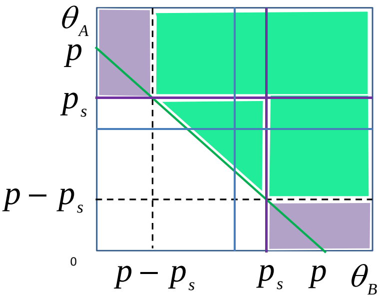

Optimal mixed bundling

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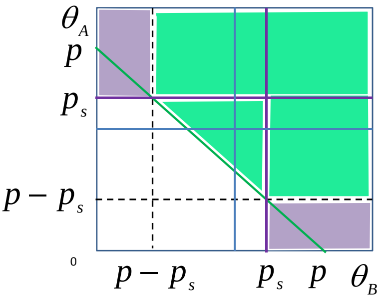

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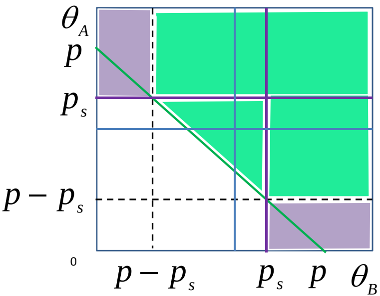

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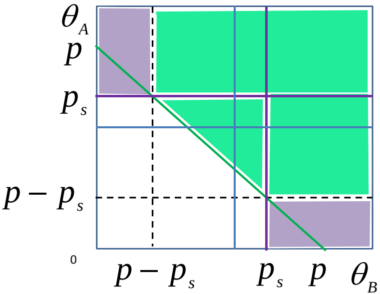

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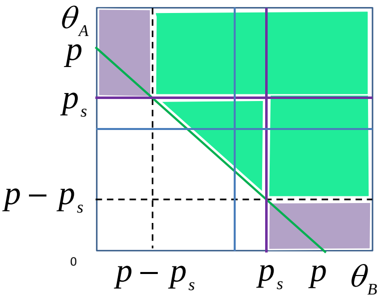

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- Demands are:

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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}
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- 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.

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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.
- It is a form of second degree price discrimination. Instead of setting a menu of prices to better cater for consumers' heterogeneity, bundling tends to reduce consumers' heterogeneity.
  - Bundling is more profitable when valuations for the two goods are perfectly negatively correlated.
    - In that case, every consumer has 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.

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.

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- Total profit with separate selling strategy is $7 + 14 + 10 = 31$.

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Highest price for type A: 28! Highest price for type B: 26!

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- In 5/9 subgames, no profit!!
  1. If 1 and 2 only sell A, $p_A = c_A$;
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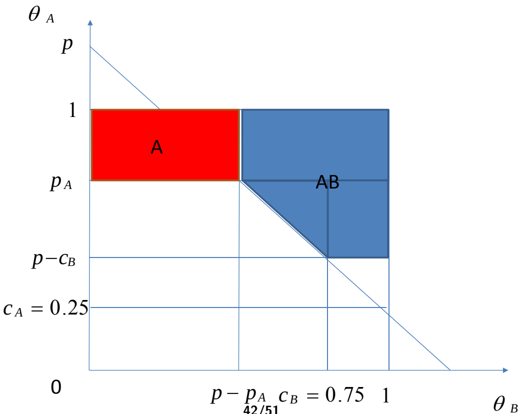

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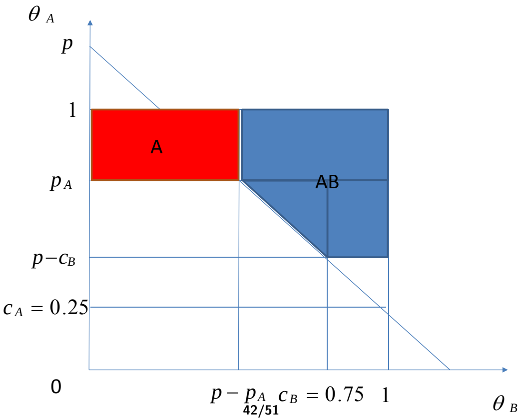

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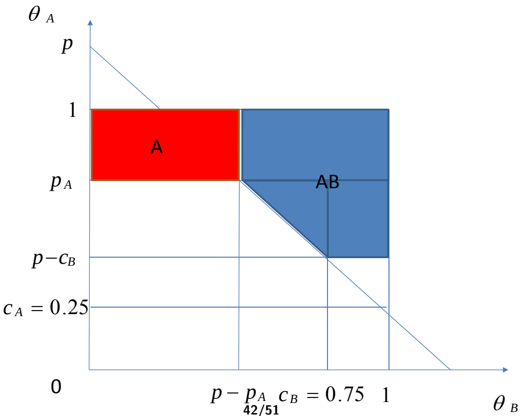

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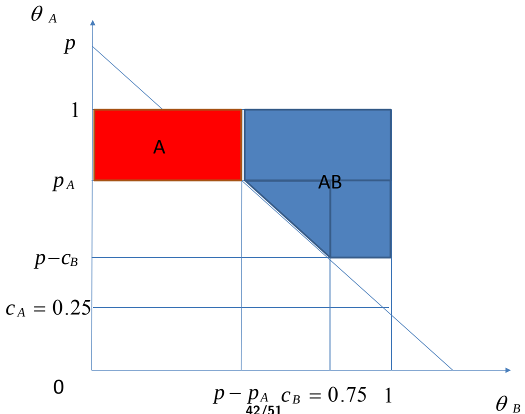

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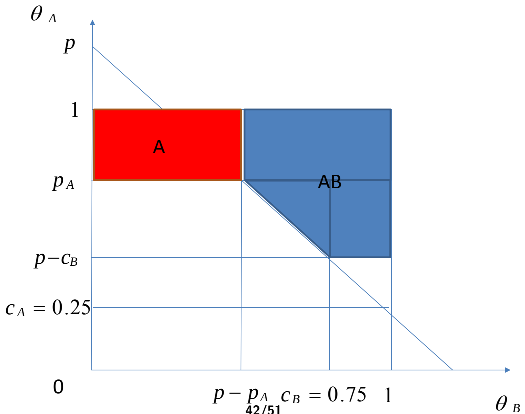

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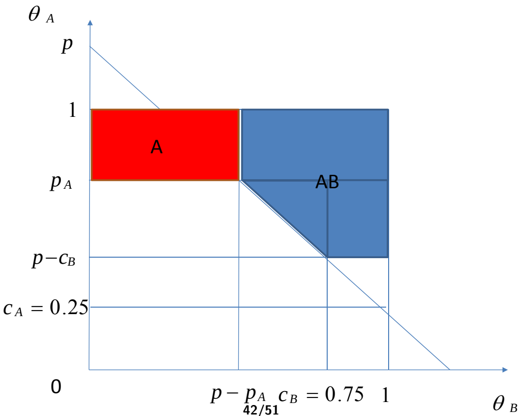

Bundling & Competition

- Demands are:

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

- Each firm maximizes its profit respectively $\pi_1 = (p_A - c_A)D_A$ and $\pi_2 = (p - c_A - c_B)D_{AB}$: There is not always a Nash equilibrium!
- 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.

Other equilibria

Conclusion:

Bundling strategies may enable to soften retail competition!

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Bundling as a barrier to entry: Nalebuff (2004)

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.

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 29).

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 a limit price $p_A = p_B = p$ to block entry $p(1-p) = F$. $\Pi_I = 2F$ and thus I blocks entry when $2F > \frac{1}{4}$, i.e. when $F > \frac{1}{8}$.

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44/51

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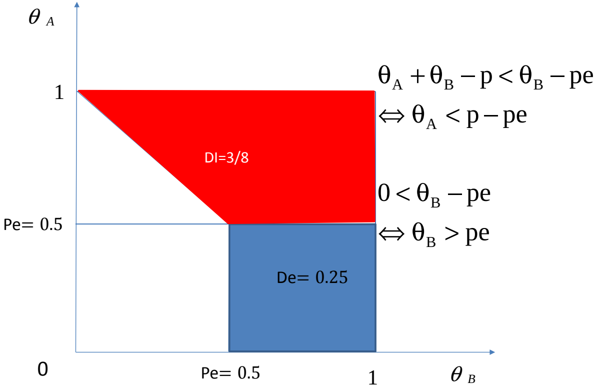
Bundling & Competition

Bundling has two effects vis-à-vis the entrant

Pure bundling effect & 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 $\frac{1}{8} < F < \frac{1}{4}$. I gets a profit $\Pi_I = \frac{3}{8}$.



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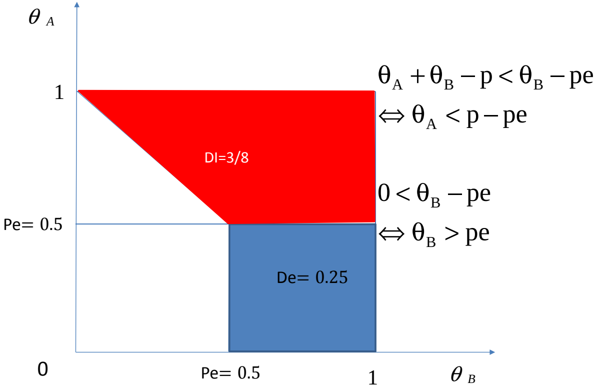
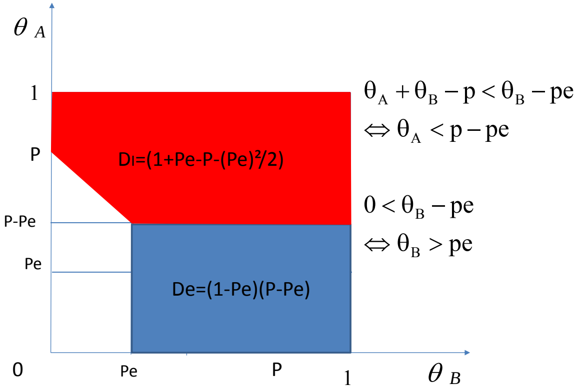


Bundling & Competition

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 $\pi_b = \frac{2}{3}\sqrt{\frac{2}{3}} \approx 0.544$. 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

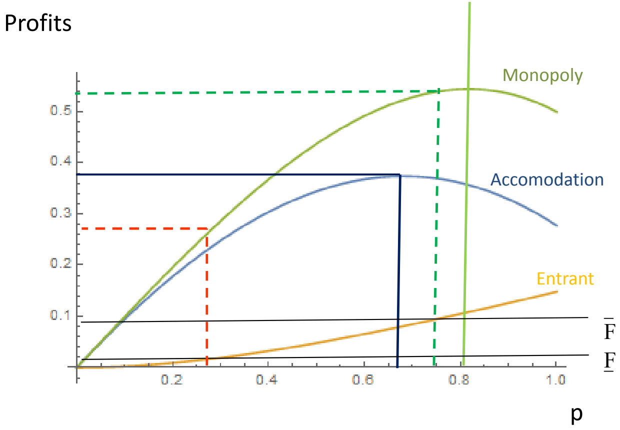
- The entrant E maximizes its profit $\pi_e = p_e(1 - p_e)(p - p_e)$ according to the level of p.

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

- I maximizes $\pi_I(p, p_e(p)) = p(1 - p + p_e - \frac{p_e^2}{2})$ if he accommodates entry.
- I sets p such that $\pi_e(p, p_e(p)) = F$ if he blocks entry.

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 $p = 0.68$ the optimal accomodation price, and E enters.



Remember

- Chen (1997) shows that bundling strategies may soften competition enabling firms to differentiate their assortment rather than competing head-to-head (it rather favors entry in that case).
- Nalebuff (2004) shows that an incumbent may use bundling to prevent an efficient entry. (But ex ante commitment on one price is key !)
- The antitrust debate
  - 1950: The leverage theory: a firm can, through bundling, leverage its market power on one market to monopolise or gain market power in another market.
  - The **Chicago School Critique** heavily criticized this theory arguing that such a firm could not find profitable to do so (too costly if the rival is more efficient).
  - Nalebuff (2004) opposes the Chicago School argument in a context of entry!!

Main References

- Adams, W. and J.Yellen (1976), "Commodity Bundling, and the Burden of Monopoly", *The Quarterly Journal of Economics*, p.475-498.
- Chen (1997), Equilibrium Product Bundling, *Journal of Business*, 70, p 85-103.
- Chen and Rey (2012), "Loss Leading as an Exploitative Practice", in *The American Economic Review*, 102, 7, p. 3462-3482.
- Nalebuff (2004), "Bundling as an Entry Barrier", *The Quaterly Journal of Economics*, 159-187.
- Bliss (1988), A Theory of Retail Pricing, *The Journal of Industrial Economics*, 36,4, 375-391.

To prepare:"Google bundling practices"

- `https://voxeu.org/article/economics-google-android-case`
- `https://ec.europa.eu/commission/presscorner/detail/en/IP_16_2532`

Other equilibria

If 1 sells the bundle (AB) and 2 offers (A,AB)

- $p = c_A + c_B = 1$
- $D_A^S = (p - p_A^S)(1 - p_A^S) = (1 - p_A^S)^2$
- Maximizing $(p_A^S - c_A)D_A^S$, we obtain $p_A^S = \frac{1}{2}$ and $\Pi_2 = \frac{1}{16} < 0.09$ whereas $\Pi_1 = 0$.

back