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

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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.

MultiProduct Firms
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Loss-Leading & Monopoly
Loss-Leading & Competition

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...).

Not explored today: Predatory strategy (dynamic strategy) and Advertising strategy (Imperfect information issue)!!

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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:

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

▶ 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:

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

Multiproduct monopoly pricing

A multiproduct firm monopoly sets:

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

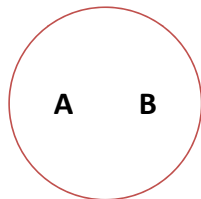▶ lower prices than separate monopolies when goods are complements

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)

A   B

B

$c_B^L = 4$

$c_B^S = 2$

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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.

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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 $\pi_L = \frac{1}{2}(p - c_B^L) = 6$.

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 $\pi_L = 8$

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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 : $U_B - h - p_S = 0$
  ▶ Going to L buy A and B : $U_A + U_B - p_A - p_B = h$.
  ▶ All go to L.

▶ Multi-stop shoppers:
  ▶ Go to L to buy A (as $U_A > p_A$).
  ▶ Go to S to buy B as $U_B - p_B = 2 < U_B - p_S = 4$.

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

- ▶ One stop shoppers
    - ▶ Going to S to buy B : $U_B - h - p_S = 0$
    - ▶ Going to L to buy A and B : $U_A + U_B - p_A - p_B = h$.
    - ▶ All go to L.

- ▶ Multi-stop shoppers
    - ▶ Go at L to buy A (as $U_A > p_A$).
    - ▶ Go to S to buy B as $U_B - p_S = 4 > U_B - p_B = 4 - \epsilon$.

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

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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.

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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.

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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
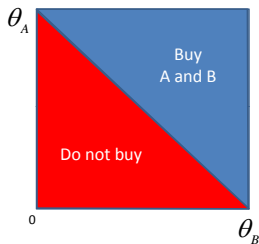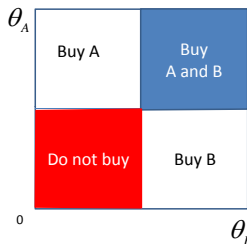
▶ Consider a monopoly firm producing two goods A and B at zero cost.

▶ 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,
2. Pure bundling,
3. Mixed bundling.

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Bundling & Monopoly
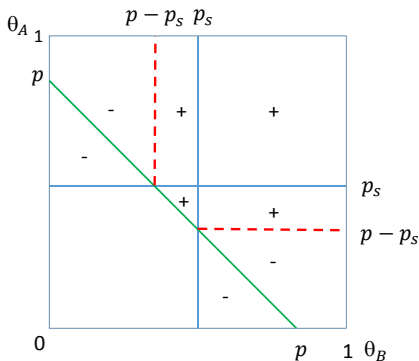Bundling & Competition

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!
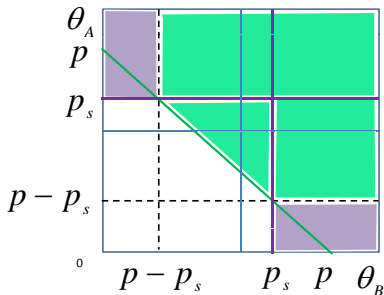- ▶ Profit is the same but consumers who buy are not the same!

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▶ 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

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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: $\theta_k > p_k$
▶ Consumers who prefer buying the bundle rather than k alone are:
$\theta_A + \theta_B - p > \theta_A - p_s => \theta_B > p - p_s$
▶ Consumers who prefer buying the bundle rather than B alone are:
$\theta_A > p - p_s$
▶ Consumers who prefer buying the bundle than nothing are:
$\theta_A + \theta_B - p > 0$

Optimal mixed bundling

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▶ Demands are:

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

▶ 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.

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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.

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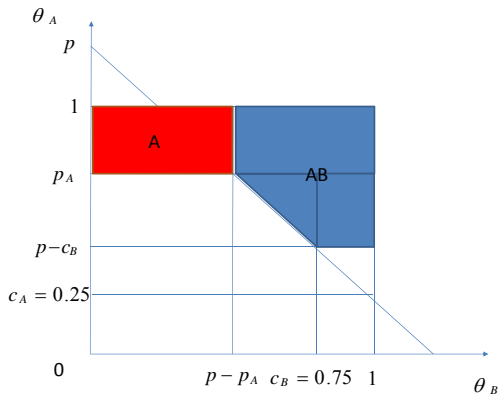**Bundling & Competition**

Bundling & Competition

▶ Bundling can be used to soften retail competition- Chen (1997)

▶ Bundling may be an effective deterrence strategy/ exclusionary device - Nalebuff (2004)

    ▶ 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)

    ▶ Exclusionary devices: The Google cases!!

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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: $p_A = c_A$, $p = c_A + c_B$

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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: $\theta_A + \theta_B - p \geq 0$.
- A/nothing : $\theta_A - p_A \geq 0$

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▶ Demands are:

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

▶ 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 $(c_A, c_B) = (\tfrac{1}{4}, \tfrac{3}{4})$, $p_A^* = 0.529$ 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 $\pi_I^M = \frac{1}{2}$.

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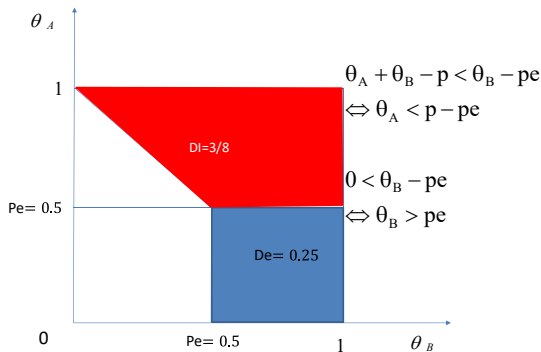
If I changes its behavior to prevent entry: I sets a limit price $p_A = p_B = p$ to block entry $p(1 - p) = F$. $\Pi_I = 2F$ and thus I blocks entry when $2F > \frac{1}{4}$, i.e. when $F > \frac{1}{8}$.

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Bundling & Competition

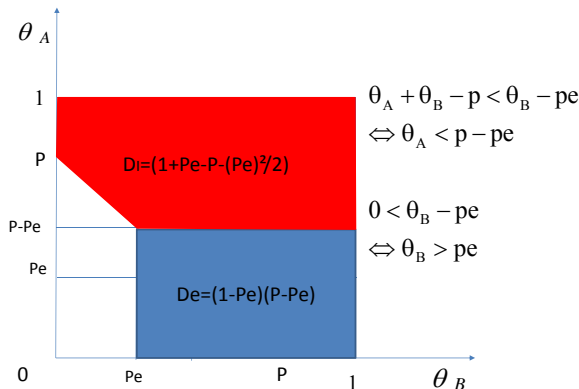### Bundling has two effects vis-à-vis the entrant

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 $\Pi_I = \frac{3}{8}$.

$$\theta_A + \theta_B - p < \theta_B - p_e$$
$$\Leftrightarrow \theta_A < p - p_e$$

$$0 < \theta_B - p_e$$
$$\Leftrightarrow \theta_B > p_e$$

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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 $\pi_e = 0.105 < \frac{1}{8}$

$\theta_A + \theta_B - p < \theta_B - pe$
$\Leftrightarrow \theta_A < p - pe$

$0 < \theta_B - pe$
$\Leftrightarrow \theta_B > pe$

$D_I = (1 + Pe - P - (Pe)^2/2)$

$De = (1-Pe)(P-Pe)$

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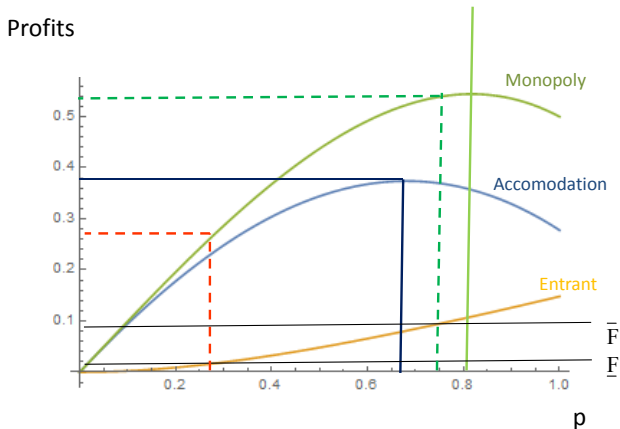
Bundling & Competition

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

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- 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.

Profits

p

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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). The Chicago Critique

▶ Nalebuff (2004) opposes the Chicago School argument in a context of entry!!

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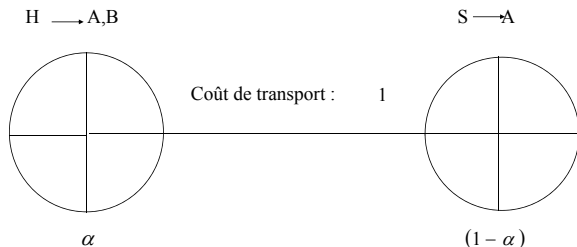**Bundling & Competition**

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

MultiProduct Firms
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Exercice 1
Exercice 2

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.

H $\longrightarrow$ A,B   S $\longrightarrow$ A

Coût de transport :   1

α $(1 - \alpha)$

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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 A at store S.
   Determine the demand at each store.

3. Determine the two candidates Nash equilibria in pure strategy.

4. Assume $b \to 0$ and $\alpha = \frac{1}{9}$; 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?

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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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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

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The Chicago Critique

- **Assumptions**:
  - 1 sells good A produced at cost 0 and B produced at cost $\bar{c}$. 2 sells good B produced at cost $\underline{c} < \bar{c}$.
  - A consumer values one unit of good A at $v^A > 0$ and one unit of good B at $v^B > \bar{c}$.

- **Absent bundling**: 1 offers a price $p_A = v^A$. There is a Bertrand competition for B: 1 offers $p_B^1 = \bar{c}$ whereas 2 wins in offering $p_B^2 = \bar{c} - \epsilon$. The customer obtains a surplus $v^B - \bar{c}$. Firm A obtains a profit v^A and Firm B earns $\bar{c} - \underline{c}$.

- **With bundling**: The consumer must choose between purchasing A and B at firm 1 or B alone at firm 2. Firm 2 offers a price $p_B^2 = \underline{c}$ and 1 wins with a tariff p_{AB}^1 such that the customer is indifferent, i.e. $v^A + v^B - p_{AB}^1 = v^B - \underline{c} \Leftrightarrow p_{AB}^1 = v^A + \underline{c}$. The consumer obtains a surplus $v^B - \underline{c}$, firm 2 obtains 0 but firm 1 obtains a profit $v^A + \underline{c} - \bar{c} < v^A$.

It is never profitable for 1 to bundle its product!