# ECO 650: Firms' Strategies and Markets <br> Course 1: Multiproduct firms' pricing strategies 

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## MultiProduct Firms

- Retailers are intrinsically multiproduct
- A supermarket sells on average from 30000 (Sainsbury) to 120000 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;
- 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)!!


## Loss-Leading \& Monopoly

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

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

- A multiproduct monopoly who faces a demand $q_{i}\left(p_{i}, p_{j}\right)$ 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 $\left(\frac{\partial q_{i}\left(p_{i}, p_{j}\right)}{\partial p_{j}}>0\right.$ (ex: product within the same product category (Sodas, Fresh juices, Mineral water...)
- Products are complements ( $\frac{\partial q_{i}\left(p_{i}, p_{j}\right)}{\partial p_{j}}<0$ (ex: Fries and ketchup, meat and red wine, ...)
- Products are often "independents" (vegetables \& shampoo) but become "complements" due to shopping costs!!


## Loss-Leading \& Monopoly

- Formally, assume the marginal costs are $c_{i}$ and $c_{j}$;

The multiproduct monopoly maximizes: $\pi=\left(p_{i}-c_{i}\right) q_{i}+\left(p_{j}-c_{j}\right) q_{j}$ $=>$ FOC's $($ for $i=1,2)$

$$
\left(p_{i}-c_{i}\right) \frac{\partial q_{i}}{\partial p_{i}}=-q_{i}-\left(p_{j}-c_{j}\right) \frac{\partial q_{j}}{\partial p_{i}}
$$

which rewrites:

$$
\frac{\left(p_{i}-c_{i}\right)}{p_{i}}=L_{i}=\frac{1}{\epsilon_{i}}+\frac{\left(p_{j}-c_{j}\right)}{p_{i}} \frac{\frac{\partial q_{j}}{\partial p_{i}} \lessgtr 0}{-\frac{\partial q_{i}}{\partial p_{i}}>0}
$$

## 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!!

## 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 $S$ ( $B$ )
$\rightarrow S$ has a lower unit cost on $B$ (Hard-discount): $c_{B}^{L}>c_{B}^{S}$


## Large store: L (Supermarket)



$$
\mathrm{C}_{\mathrm{B}}^{\mathrm{L}}=4 \quad \mathrm{C}_{\mathrm{B}}^{\mathrm{S}}=2
$$

Small store: S
(Hard-discount)


## 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 $\left(p_{A}^{h} \leq U_{A}\right.$ and $\left.p_{B}^{h} \leq U_{B}\right)$. 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 $\left(p_{A} \leq U_{A}\right.$ and $\left.p_{B} \leq U_{B}\right)$. Its profit is $\pi_{L}=\left(p-c_{B}^{L}\right)=12$.


## 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

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 $\pi_{L}=\frac{1}{2}\left(p-c_{B}^{L}\right)=6$.


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

- One stop shoppers:
- Going to S to buy $\mathrm{B}: U_{B}-h-p_{S}=0$
- 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 $\left.U_{A}>p_{A}\right)$.
- 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 :
$\pi_{L}=\frac{1}{2}(12-4)+\frac{1}{2} 8=8$.
$L$ 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 $A\left(\right.$ as $\left.U_{A}>p_{A}\right)$.
- Go to $S$ to buy $B$ as $U_{B}-p_{S}=4>U_{B}-p_{B}=4-\epsilon$.
$\Rightarrow$ Although $L$ still looses multi-stop shoppers on $B, L$ gets even
more than the monopoly profit: $\pi_{L}=\frac{1}{2}(12-4)+\frac{1}{2} 10=9$.


## 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.


## 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.


## 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 ( $\theta_{A}, \theta_{B}$ ) 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.

## 1. Separate selling

- Demand for A is: $D_{A}=\int_{p_{A}}^{1} d \theta_{A}$ and thus $p_{A}$ is chosen to maximize $p_{A}\left(1-p_{A}\right)$
- 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 buv are not the same!

- 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 $p\left(1-\frac{p^{2}}{2}\right)=>p=\sqrt{\frac{2}{3}} \approx 0.82$
- 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: $\theta_{k}>p_{k}$
- 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 mix/36d bundling

- Demands are:

$$
\begin{aligned}
& D_{A}=D_{B}=\left(1-p_{s}\right)\left(p-p_{s}\right) \\
& D b=\left(1-p_{s}\right)^{2}+2\left(2 p_{s}-p\right)(1-p s)+\frac{\left(2 p_{s}-p\right)^{2}}{2}
\end{aligned}
$$

- The monopolist chooses ( $p_{s}, p$ ) which maximizes $\pi=p_{s}\left(D_{A}+D_{B}\right)+p D_{b}:$
- $p_{s}=\frac{2}{3}$ and $p=\frac{4-\sqrt{2}}{3} \approx 0.86$;
- The profit $\pi_{m b}=0.549>\pi_{b}>\pi-s$
- 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.
- 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.


## 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!!


## 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 $A B, p=c_{A}+c_{B}$;
3. If 1 and 2 sell $A$ and the bundle $A B, p_{A}=c_{A}, p=c_{A}+c_{B}$
4. If 1 or 2 specializes while the other adopts mixed bundling: $p_{A}=c_{A}$, $p=c_{A}+c_{B}$

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

- Bundle/A: $\theta_{A}+\theta_{B}-p>\theta_{A}-p_{A}=>\theta_{B}>p-p_{A}$;
- Bundle/B: $\theta_{A}+\theta_{B}-p>\theta_{B}-c_{B}=>\theta_{A}>p-c_{B}$;
- Bundle/A and B: $\theta_{A}+\theta_{B}-p>\theta_{A}+\theta_{B}-p_{A}-c_{B}=>p \leq c_{B}+p_{A}$;
- Bundle/nothing: $\theta_{A}+\theta_{B}-p \geq 0$.
- A/nothing : $\theta_{A}-p_{A} \geq 0$



## Bundling \& Competition

- Demands are:

$$
\begin{aligned}
D_{A} & =\left(1-p_{A}\right)\left(p-p_{A}\right) \\
D_{A B} & =\left(1-p_{A}\right)\left(1-p+p_{A}\right)+\frac{1}{2}\left(2+p_{A}-p-c_{B}\right)\left(c_{B}-p+p_{A}\right)
\end{aligned}
$$

- Each firm maximizes its profit respectively $\pi_{1}=\left(p_{A}-c_{A}\right) D_{A}$ and $\pi_{2}=\left(p-c_{A}-c_{B}\right) D_{A B}$ : There is not always a Nash equilibrium!
- For $\left(c_{A}, c_{B}\right)=\left(\frac{1}{4}, \frac{3}{4}\right), p_{A}^{*}=0.529$ and $p^{*}=1.213$; $\left(p_{A}^{*}+c_{B}=1.279>p^{*}\right)$
- 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!

## 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 $\pi_{l}^{M}=\frac{1}{2}$.
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 $p(1-p)=F . \Pi_{I}=2 F$ and thus $/$ blocks entry when $2 F>\frac{1}{4}$, i.e. when $F>\frac{1}{8}$.

## 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 $\Pi_{l}=\frac{3}{8}$.


## 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 $\pi_{e}=0.105<\frac{1}{8}$


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## Bundling \& Competition

## Bundling discount effect

- The entrant E maximizes its profit $\pi_{e}=p_{e}\left(1-p_{e}\right)\left(p-p_{e}\right)$ according to the level of $p$.

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

- I maximizes $\pi_{l}\left(p, p_{e}(p)\right)=p\left(1-p+p_{e}-\frac{p_{e}^{2}}{2}\right)$ if he accommodates entry.
- I sets $p$ such that $\pi_{e}\left(p, p_{e}(p)\right)=F$ if he blocks entry.

| $p$ | $p_{e}$ | l's profit\|No entry | l'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 $F=\bar{F}$, 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

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## Exercice 1

- Two stores H (Hypermarket) and S (Supermarket)
- $H$ sells $A$ and $B-S$ sells $A$
- $\alpha \in\left[0, \frac{1}{2}\right]$ 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 $A$ at store $S$.
Determine the demand at each store.
3. Determine the two candidates Nash equilibria in pure strategy.
4. Assume $b \rightarrow 0$ 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?

## 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.

## Other equilibria

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

- $p=c_{A}+c_{B}=1$
- $D_{A}^{S}=\left(p-p_{A}^{S}\right)\left(1-p_{A}^{S}\right)=\left(1-p_{A}^{S}\right)^{2}$
- Maximizing $\left(p_{A}^{S}-c_{A}\right) D_{A}^{S}$, we obtain $p_{A}^{S}=\frac{1}{2}$ and $\Pi_{2}=\frac{1}{16}<0.09$ whereas $\Pi_{1}=0$.


## 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 $\operatorname{good} \mathrm{B}$ 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 $p_{A B}^{1}$ such that the customer is indifferent， i．e．$v^{A}+v^{B}-p_{A B}^{1}=v^{B}-\underline{c} \Leftrightarrow p_{A B}^{1}=v^{A}+\underline{c}$ ．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！

