Managerial Economics
Unit 5: Bundling and Intrafirm-Pricing

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OBJECTIVES

- Explain how managers can use bundling and tying strategies to increase profit when customers have heterogeneous tastes.
- Explain how firms use transfer pricing to provide incentives to subsidiaries and divisions and to shelter profit from taxes in a global environment.
Simple bundling:

- When managers offer several products or services as one package so consumers do not have an option to purchase package components separately
  - TV channels
  - CD as compared to a single
  - Restaurant Fixed Menu (maybe mixed)
  - Sports tickets
  - Funeral services and caskets (funeral homes are local monopolies)
Mixed bundling:

- Allows consumers to purchase package components either as a single unit or separately
  - The bundle price is generally less than the sum of the prices of the individual components.
  - Examples:
    - Season tickets to sporting events
    - Typical Restaurant
    - Quantity discount
    - Funeral services vs. funeral services and caskets
Conditions for bundling

- **Negative correlation of demand:** When some customers have higher reservation prices for one item in the bundle but lower reservation prices for another item in the bundle, whereas another group of customers has the reverse preferences.

- **Marginal costs** for production should be low.
Advantages of bundling

- Bundling can increase the seller’s profit as customers have varied tastes.
- Bundling can come close to first-degree price discrimination when it is not otherwise possible because individual reservation prices cannot be determined or laws prohibit price discrimination.
- Bundling does not require knowledge of individual consumers’ reservation prices, but only the distribution of consumers’ reservation prices.
Strategies

- Assumption: Goods are independent, so the value of a bundle is equal to the sum of the reservation prices of the goods in the bundle.

- Separate pricing: Goods are not bundled.
  - Prices are set equal to profit-maximizing monopoly prices.

- Pure bundling
  - Bundle price is set to maximize profit.

- Mixed bundling
  - Bundle price and individual good prices are set to maximize profit.

- Optimal strategy is one of the three
THE MECHANICS OF BUNDLING

Notation

- $r_i$ = Reservation price of good $i$
  - (Willingness-to-pay WTP)
- $p_i^\#$ = Price charged for good $i$
- $P_B^\#$ = Price of bundle
Consumers compare WTP and price

- Figure 9.1: Price Separately
  - If $r_1 < p_1^\#$ and $r_2 < p_2^\#$, then consumer buys neither good.
  - If $r_1 > p_1^\#$ and $r_2 < p_2^\#$, then consumer buys only good 1.
  - If $r_1 < p_1^\#$ and $r_2 > p_2^\#$, then consumer buys only good 2.
  - If $r_1 > p_1^\#$ and $r_2 > p_2^\#$, then consumer buys both goods.
Price Separately

Reservation price of good 2 = $r_2$

Consumer buys good 2 only
($r_2 > p_2^s$ and $r_1 < p_1^s$)

Consumer buys good 1 and good 2
($r_2 > p_2^s$ and $r_1 > p_1^s$)

Price charged for good 2 = $p_2^f$

Consumer buys neither good
($r_2 < p_2^f$ and $r_1 < p_1^f$)

Consumer buys good 1 only
($r_1 > p_1^f$ and $r_2 < p_2^f$)

Price charged for good 1 = $p_1^f$

Reservation price of good 1 = $r_1$

FIGURE 09-01
THE MECHANICS OF BUNDLING

Figure 9.2: Pure Bundling

- If \((r_1 + r_2) < P_B^\#\), then consumer does not buy the bundle.
- If \((r_1 + r_2) > P_B^\#\), then consumer buys the bundle.
Pure Bundling

Reservation price of good 2 = \( r_2 \)

Price charged for bundle = \( p_B^* \)

Consumer buys bundle
\((r_1 + r_2) > p_B^* \)

Consumer does not buy bundle
\((r_1 + r_2) < p_B^* \)

Price charged for bundle = \( p_B^* \)

Reservation price of good 1 = \( r_1 \)
Figure 9.3: Mixed Bundling

- Buy neither good nor bundle: \((r_1 + r_2) < P_B^#, r_1 < p_1^#, \text{ and } r_2 < p_2^#\)
- Buy bundle: \((r_1 + r_2) > P_B^#\)
- Buy good 1 only: \(r_1 > p_1^#, r_2 < p_2^#, \text{ and } r_2 < (P_B^# - p_1^#)\)
- Buy good 2 only: \(r_2 > p_2^#, r_1 < p_1^#, \text{ and } r_1 < (P_B^# - p_2^#)\)
Mixed Bundling

Reservation price of good 2 = r_2

Buy only good 2 because (r_2 - p_2^* > r_2 + r_1 - p_B^*); that is, r_1 < p_B^* - p_2^*.
Do not buy good 1 separately because r_1 < p_1^*.

Buy bundle because r_1 + r_2 - p_B^* > r_2 - p_2^*; that is, r_1 > p_B^* - p_2^*.
Do not buy good 1 separately because r_1 < p_1^*.

Buy bundle because [r_1 + r_2 - p_B^* > (r_1 - p_1^*)
+ (r_2 - p_2^*) or p_1^* + p_2^* > p_B^*]
(Note that if this equation is not true, customers make their own bundles by buying good 1 and good 2 separately).

Buy neither good nor bundle because (r_1 + r_2 < p_B^*,
and r_1 < p_1^* and r_2 < p_2^*).

Buy bundle because r_1 + r_2 - p_B^* > r_1 - p_1^*;
that is, r_2 > p_B^* - p_1^*.
Do not buy good 2 separately because r_2 < p_2^*.

Buy only good 1 because (r_1 - p_1^* > r_2 + r_1 - p_B^*);
that is, r_2 < p_B^* - p_1^*. Do not buy good 2 separately because r_2 < p_2^*.

Reservation price of good 1 = r_1

FIGURE 09-03
Start with some examples

- **Example 1**
  - **Assumptions**
    - Perfect negative correlation among consumer reservation prices
    - No variation in total bundle valuation; all indiv. value the bundle at $100.
    - Unit cost of production for each good = $1.
  - **Table 9.1: Consumer Reservation Prices**
  - **Table 9.2: Optimal Separate Prices for Good 1 and Good 2: Profit = $264**
<table>
<thead>
<tr>
<th>Consumer</th>
<th>Reservation Price</th>
<th>Bundle Price</th>
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<tbody>
<tr>
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<td>Good 1</td>
<td>Good 2</td>
</tr>
<tr>
<td>A</td>
<td>90</td>
<td>10</td>
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<tr>
<td>B</td>
<td>60</td>
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<tr>
<td>C</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
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### Table 9.2

**Optimal Separate Prices for Good 1 and Good 2**

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Price 1</th>
<th>Cost/unit</th>
<th>Profit/unit</th>
<th>Number of units</th>
<th>Profit</th>
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<tbody>
<tr>
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<td>1</td>
<td>89</td>
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<table>
<thead>
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<td>89</td>
<td>1</td>
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</table>
Example 1

- Table 9.3: Optimal Pure Bundle Price for Consumers A, B, C, and D: Profit = $392
- Table 9.4: Optimal Mixed Bundle Prices: Profit = $392
- Table 9.5: Optimal Mixed Bundle Prices When Consumers Buy Bundle and at Least One of the Separately Priced Goods: Profit = $373.98
<table>
<thead>
<tr>
<th>Consumer</th>
<th>Bundle Price</th>
<th>Cost/Bundle</th>
<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
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<td>4</td>
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### Optimal Mixed Bundle Prices

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<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
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<tbody>
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</table>

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<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
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<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
</tr>
</thead>
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<tr>
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<td>89.01</td>
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<td>0</td>
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</tbody>
</table>
- Trick: try a price slightly above and below 90.
- Same arguments will be valid for other prices

**TABLE 9.5**

Optimal Mixed Bundle Prices When Consumers Buy Bundle and at Least One of the Separately Priced Goods

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Bundle Price</th>
<th>Cost/Bundle</th>
<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
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<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
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<tbody>
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<td>88.99</td>
<td>1</td>
<td>88.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consumer</th>
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<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D$</td>
<td>89.99</td>
<td>1</td>
<td>88.99</td>
<td>1</td>
<td>88.99</td>
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</table>
Criteria for successful bundling

- **Credibility of the bundle:** When managers correctly anticipate which customers will purchase the bundle or the goods separately

- **Extraction:** When the manager extracts the entire consumer surplus from each customer

- **Exclusion:** When the manager does not sell a good to a customer who values the good at less than the cost of producing it

- **Inclusion:** When a manager sells a good to a consumer who values the good at greater than the seller’s cost of producing the good
Successful bundling

- Extraction, exclusion, and inclusion are all satisfied by perfect price discrimination.
- Pricing separately will satisfy exclusion but will not result in complete extraction or inclusion.
Successful bundling

- **Pure bundling** can result in complete extraction, but if consumer reservation prices do not have a perfect negative correlation, extraction will be less than complete. It is also possible for pure bundling to fail to attain full inclusion and exclusion.

- The profit from **mixed bundling** is always equal to or better than that of pricing separately or pure bundling.
  - Problem: mixed bundling prices are difficult to find
The importance of costs

Example 2

Assumptions

- Perfect negative correlation among consumer reservation prices
- No variation in total bundle valuation; all value the bundle at $100.

Now:
- Unit cost of production for each good = $11.
Example 2

- Table 9.6: Optimal Separate Prices for Good 1 and Good 2: Profit = $204
- Table 9.7: Optimal Pure Bundle Price for Consumers A, B, C, and D: Profit = $312
- Table 9.8: Optimal Mixed Bundle Prices: Profit = $312
- Table 9.9: Optimal Mixed Bundle Prices When Consumers Buy Bundle and at Least One of the Separately Priced Goods: Profit = $313.98
### TABLE 9.6

**Optimal Separate Prices for Good 1 and Good 2**

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Price 1</th>
<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
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<tbody>
<tr>
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<td>11</td>
<td>79</td>
<td>1</td>
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<tr>
<td>C</td>
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<tr>
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<th>Profit/Unit</th>
<th>Number of Units</th>
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</tr>
<tr>
<td>Consumer</td>
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<td>Cost/Bundle</td>
<td>Profit/Bundle</td>
<td>Number of Bundles</td>
<td>Profit</td>
</tr>
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<td>------------</td>
<td>--------------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------------------</td>
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# Table 9.8

## Optimal Mixed Bundle Prices

<table>
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<tr>
<th>Consumer</th>
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<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C, D</td>
<td>100</td>
<td>22</td>
<td>78</td>
<td>4</td>
<td>312</td>
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<table>
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<th>Profit/Unit</th>
<th>Number of Units</th>
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<th>Profit/Unit</th>
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<th>Profit</th>
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<td>Profit</td>
</tr>
<tr>
<td>----------</td>
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<th>Cost/Unit</th>
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<th>Number of Units</th>
<th>Profit</th>
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</table>
Example 3

Assumptions

▶ Perfect negative correlation among consumer reservation prices
▶ No variation in total bundle valuation; all value the bundle at $100.

Now

▶ Unit cost of production for each good = $55.
Example 3

- Table 9.10: Optimal Separate Prices for Good 1 and Good 2: Profit = $70

- Table 9.11: Optimal Pure Bundle Price for Consumers A, B, C, and D: Profit = $-40

- Table 9.12: Optimal Mixed Bundle Prices (pure bundle price will be higher than $100 - So no bundle is purchased): Profit = $70
### Optimal Separate Prices for Good 1 and Good 2

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Price 1</th>
<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
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<td>Consumer</td>
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<td>Profit/Bundle</td>
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<td>4</td>
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</table>
TABLE 9.12

Optimal Mixed Bundle Prices at Any Pure Bundle Price over $100 (So No Bundle Is Purchased)

<table>
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<tr>
<th>Consumer</th>
<th>Price 1</th>
<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
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<tbody>
<tr>
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<td>35</td>
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<td>B</td>
<td>90</td>
<td>55</td>
<td>35</td>
<td>1</td>
<td>35</td>
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</table>
The importance of costs

Conclusions from Examples 1-3:
(Reservation prices are negatively correlated)

- When production cost is low, pure bundling will extract all consumer surplus.
- When production cost rises, mixed bundling is best.
- When production cost rises further, separate pricing may be best.
  - Mixed bundling would give the same profit, but only if the right price found
THE MECHANICS OF BUNDLING

- The optimal separate prices are always equal to consumers’ reservation prices.
- The optimal pure bundle price is always equal to the sum of consumers’ reservation prices.
- The optimal mixed bundle prices are not necessarily equal to reservation prices or their sum.

- Bundling very attractive if marginal costs are low or very low
  - Reason is that consumers are incentivized to consume more
  - Example TV channels for cable company (almost zero MC)
Bundling is possible even if correlation in demand is zero

Example 4

Assumptions

- Distribution of reservation prices is uniform over the range $0 to $100 for each good.
- **Correlation is zero.**
- There are 10,000 customers.
- Production cost is zero.

Figure 9.5: Optimal Separate Prices

- Profit = $500,000
Optimal Separate Prices in the Case of Uniformly Distributed Consumer Reservation Prices

- 2,500 customers buy only good 2, for revenues of $50 \times 2,500 = $125,000 (Area D)
- 2,500 customers buy both goods, for revenues of $100 \times 2,500 = $250,000 (Area C)
- 2,500 customers buy neither good, for revenues of $0 \times 2,500 = $0 (Area A)
- 2,500 customers buy only good 1, for revenues of $50 \times 2,500 = $125,000 (Area B)
Example 4

- Figure 9.6: Optimal Pure Bundle Price
  - Profit = $544,331.10

- why?
  - $E = 0.5y^2$ and $F = 10000 - 0.5y^2$
  - $TR = 0.5y^2 \times 0 + (10000 - 0.5y^2) \times y = 10000y - 0.5y^2$
  - $\frac{\partial TR}{\partial y} = 10000 - 1.5y = 0 \rightarrow y = 81.65$

- Mixed bundling also possible

- Ideal prices more difficult to find
Optimal Pure Bundle Price in the Case of Uniformly Distributed Consumer Reservation Prices

Reservation price $100 of good 2 = r_2

$81.65

(Area F)
6,666.67 customers buy the bundle, for revenues of $81.65 \times 6,666.67 = $544,331.10

(Area E)
3,333.33 customers do not buy the bundle, for revenues of $0 \times 3,333.33 = $0

FIGURE 09-06
Quantity discounting as a bundle

Example 5

Assumptions

★ Quantity discounting is a form of mixed bundling.
★ Unit cost of production for each good = $1.

Table 9.13: Reservation Prices for the First and Second Units of a Good by Consumers A and B

Table 9.14: Optimal Separate Prices for the Good: Profit = $6
### TABLE 9.13

Reservation Prices for the First and Second Units of a Good by Consumers $A$ and $B$

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Reservation Price of Good</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Unit</td>
</tr>
<tr>
<td>$A$</td>
<td>4</td>
</tr>
<tr>
<td>$B$</td>
<td>3.99</td>
</tr>
</tbody>
</table>
### Optimal Separate Prices for the Good

<table>
<thead>
<tr>
<th>Price of Good</th>
<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3.99</td>
<td>1</td>
<td>2.99</td>
<td>2</td>
<td>5.98</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>1.5</td>
<td>1</td>
<td>0.5</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
Example 5

- Table 9.15: Optimal Pure Bundle Price for Two Units of the Good: Profit = $7

- Table 9.16: Optimal Mixed Bundling Prices for the Case of a Single Good: Profit = $7.99
### TABLE 9.15

Optimal Pure Bundle Price for Two Units of the Same Good

<table>
<thead>
<tr>
<th>Price of Bundle</th>
<th>Cost/Bundle</th>
<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>2</td>
<td>3.5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>6.99</td>
<td>2</td>
<td>4.99</td>
<td>1</td>
<td>4.99</td>
</tr>
</tbody>
</table>
TABLE 9.16

Optimal Mixed Bundling Prices for the Case of a Single Good

<table>
<thead>
<tr>
<th>Price of Bundle</th>
<th>Cost/Bundle</th>
<th>Profit/Bundle</th>
<th>Number of Bundles</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.99</td>
<td>2</td>
<td>4.99</td>
<td>1 (B)</td>
<td>4.99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price of Good</th>
<th>Cost/Unit</th>
<th>Profit/Unit</th>
<th>Number of Units</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1 (A)</td>
<td>3</td>
</tr>
</tbody>
</table>
BUNDLING AS A PREEMPTIVE ENTRY STRATEGY

- Bundling can be used to deter entry.

- Your firm is producing two or more goods
  - Potential entry of a rival offering only ONE of those goods
  - Bundling may be a good strategy to deter entry: your bundle of these goods may be more attractive than single offers from rival firms
Summary bundling

- Pure bundling profitable if negative correlation of demand
- Market research valuable: you only need to know that there are different groups, not individual WTP
- Pure bundling: sum up WTP of different groups to set price
- Bundling very sensible, if MC very low
- Mixed bundling: prices more difficult to find
- Bundling as quantity discount or deterrence of entry
Tying

- Occurs when a firm sells a product, the use of which requires the consumption of a complementary product.

- The consumer is required to buy the complementary product from the firm selling the product itself.

- Examples: Toner for computer printer, spare parts for cars.

- Form of bundling for complementary products.
Tying - Reasons

- Brand name is protected
- Insurance that product works properly
- Price differently for consumer who use the good more/less intensively (a monopolist would set price for printer very high and sell toner cheap)
- First item bought is more visible (if there are rival printers, sell printer cheap, but price toners highly)
- Build network effects, consumers have switching costs
- Used to protect a monopoly
Example: Microsoft

- Tying of operating system and internet browser
  - Antitrust case
    - abuse of monopoly power (90% market share)
    - Microsoft stated that the merging of Microsoft Windows and Internet Explorer was the result of innovation and competition
    - Internet Explorer vs. Netscape
    - In 2001, the US Dep. Of Justice reached an agreement with Microsoft to settle the case. The proposed settlement required Microsoft to share its application programming interfaces with third-party companies and appoint a panel of three people who will have full access to Microsoft’s systems, records, and source code for five years in order to ensure compliance
Example: Hewlett Packard

- Tying in the printer market
  - HP made half of its revenues with cartridges in 2002
  - Possibility to refill old cartridges arose
  - New chip in cartridges made it impossible to refill
  - New EU law prohibiting this
TRANSFER PRICING

- Transfer price: Payment that simulates a market where no formal market exists.
  - Refers to intra-firm pricing among wholly owned subsidiaries or divisions.
  - The purpose of transfer prices:
    - Encourage profit-maximizing or cost-minimizing behavior by providing an incentive.
    - Measure the performance of semi-autonomous divisions.
TRANSFER PRICING

- Assume:
  - 2 divisions of a firm
  - Upstream plant/division produces an input for a downstream monopolist

- Question: What is the optimal transfer price?
  - Distinguish two cases:
    - No external market for the product of the upstream division
    - External market price is available (both upstream and downstream division have an outside market)
**If no market exists** → transfer price should be equal to the marginal cost at the optimal output of the upstream product division

- Downstream operation is subject to market discipline
- Managers need to ensure that profit-maximizing output is produced: 
  \[ Q^* = Q_D(P) = Q_U(P) \]
- Upstream division is told to get a price \( P_U \) → it becomes a price taker: the optimal price \( P_U \) equals the marginal cost at the optimal output \( Q^* \)
- Has consequences on the within-firm profits.
Determination of the Transfer Price, Given No External Market for the Transferred Good

\[ MC = MC_D + MC_U \]

\[ MC_t = MC_D + P_U \]

\[ Q_D^* = Q_U^* = Q^* \]
TRANSFER PRICING

- If a market exists for the intermediate product, transfer price should be market price.

- Upstream firm and downstream firm may produce different amounts of output:
  - Upstream firm may sell excess output at the market.
  - Downstream firm may buy necessary input at the market.

- Upstream firm produces quantity that is optimal given the outside market:
  - If we assume perfect competition at the upstream market, prices are equal to marginal cost.
Determination of the Transfer Price, Given a Perfectly Competitive External Market for the Transferred Product

\[ MC_t = MC_D + P_U \]

FIGURE 09-10
Japan’s Tax Revenue Leans on Foreign Firms

- Japan’s tax authority claims that foreign companies have a propensity to avoid the country’s high corporate taxes by illegally shifting profit off their books in Japan.

- The tax authority has filed claims against at least 50 multinationals totalling approximately $492.4 million in lost taxes.
  - Among these firms: Coca-Cola, DaimlerChrysler, Procter & Gamble, Goodyear Tire and Rubber, Roche Holding AG.
  - DaimlerChrysler recently paid Japan an extra $45.87 million for taxes allegedly owed in Japan that were shifted to Germany via transfer payments.

- Japan keeps about 50% of yearly earnings compared to 41% in the US and 33% in UK.

- Japan believes that some non-Japanese parent companies overcharge their Japanese subsidiaries.
The global use of transfer pricing

Managers can use transfer pricing to shift profits between divisions to minimize tax liability.

- Increase profit in low-tax countries and decrease profit in high-tax countries
THE GLOBAL USE OF TRANSFER PRICING

Notation and implication

- Assume there is no external market for the upstream product and that all profits are expressed in the same currency.
  \[ \alpha = \text{Tax rate in a downstream country} \]
  \[ \beta = \text{Tax rate in an upstream country, where } \alpha > \beta \]
Notation and implication (Continued)

- After-tax profit in the downstream country =
  \[ (1 - \alpha)(TR_D - TC_D - PU QU) \]

- After-tax profit in the upstream country =
  \[ (1 - \beta)(PU QU - TC_U) \]

- Total after-tax profit =
  \[ (1 - \alpha)(TR_D - TC_D) - (1 - \beta)(TC_U) + (\alpha - \beta)(PU QU) \]

- Increasing the transfer price \((PU)\) will increase after-tax profit.
THE GLOBAL USE OF TRANSFER PRICING

- Reasons for the importance of global transfer prices:
  - Increased globalization
  - Different level of taxation in various countries
  - Greater scrutiny by tax authorities
  - Inconsistent rules and laws in different tax jurisdictions