Market Structure and Competition

Overview

- Chapter 13 explores different types of market structures. Markets differ on two important dimensions:
- the number of firms, and
- the nature of product differentiation.

- As special cases, we will analyze:
  - competitive markets (many sellers),
  - oligopoly markets (few sellers), and
  - monopoly markets (just one seller).

Herfindahl-Hirschman Index of Market concentration

\[ HHI = \left( S_{firm1}^2 + S_{firm2}^2 + \ldots + S_{firmN}^2 \right) \]

Market share for each firm in the industry.

Examples

1) Monopoly, \( S = 100 \) \( \Rightarrow \) \( HHI = 100^2 = 10,000 \)

2) Very fragmented market, \( S = .001 \) for each of the 1,000 firms in the industry.
   \( HHI = 1,000 \times (.001)^2 = .001 \)

Hence HHI ranges from 0 to 10,000
Close to Perfect comp \( \leftrightarrow \) Monopoly

Herfindahl-Hirschman index of market concentration

<table>
<thead>
<tr>
<th>Industry</th>
<th>NAICS Code</th>
<th>Total Number of Companies</th>
<th>CR</th>
<th>HHI</th>
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<tbody>
<tr>
<td>Guided missiles and space vehicles</td>
<td>306610</td>
<td>19</td>
<td>96.0</td>
<td>na*</td>
</tr>
<tr>
<td>Cigarette manufacturing</td>
<td>312221</td>
<td>15</td>
<td>91.3</td>
<td>na*</td>
</tr>
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<td>Beer breweries</td>
<td>312110</td>
<td>35</td>
<td>90.8</td>
<td>na*</td>
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<td>Electric lamp bulb and parts manufacturing</td>
<td>335111</td>
<td>57</td>
<td>88.5</td>
<td>2,762.6</td>
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<td>Glass container manufacturing</td>
<td>332111</td>
<td>22</td>
<td>88.3</td>
<td>2,662.3</td>
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<td>Primary aluminium manufacturing</td>
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<td>20</td>
<td>85.3</td>
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<td>Brass and copper manufacturing</td>
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<td>78.4</td>
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<td>Iron and steel manufactures</td>
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<td>425</td>
<td>42.7</td>
<td>763.1</td>
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<tr>
<td>For manufacturing</td>
<td>332111</td>
<td>425</td>
<td>42.7</td>
<td>763.1</td>
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<td>Automatic vending machine manufacturing</td>
<td>332121</td>
<td>165</td>
<td>62.3</td>
<td>679.0</td>
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<td>Cement manufacturing</td>
<td>327310</td>
<td>173</td>
<td>58.7</td>
<td>568.5</td>
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<td>Galvanizing and plating mills</td>
<td>344121</td>
<td>1,776</td>
<td>18.1</td>
<td>111.0</td>
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<td>Fabricated structural metal manufacturing</td>
<td>332312</td>
<td>3,510</td>
<td>8.9</td>
<td>79.5</td>
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</table>

*NAICS, the North American Industry Classification System, is the system the U.S. Census Bureau uses to identify industries.

For industries with only a few firms, the Census Bureau does not publish the HHI because of confidentiality concerns about disclosing data on the sales of individual companies.

Oligopoly Market

- A small number of firms sell products that have virtually the same attributes, performance characteristics, image.
  - Example: U.S. salt industry where Morton Salt, Cargill, and IMC sell virtually the same product.

Models we use to examine Oligopoly markets

- Cournot
  - If competition in quantities
- Bertrand
  - If competition in prices
- Stackelberg
  - We will consider competition in quantities

Firms choose their actions simultaneously

- Later on, we will allow for product differentiation.

Cournot Oligopoly Model

- Cournot model - refers to a homogenous products oligopoly. In the Cournot model, firms simultaneously and independently choose their production level.
- The market price adjusts to equilibrium after each firm sets the quantity it will produce.
- Main characteristics:
  1) \( N=2 \) firms
  2) Firms compete in quantities
  3) They both simultaneously submit their quantities

- The residual demand curve illustrates the relationship between the market price and a firm's quantity when rival firms hold their outputs fixed.
- This demand curve is simply the market demand curve shifted inward by the exact amount the rival produces.
• Given that my rival has already sold 50 units, the demand curve I face has been reduced by 50 units at every price.
• So, taking into account this “reduced demand” (Residual Demand), I act as a monopolist, setting...

Coming from Residual demand $D_{50} \rightarrow MR_{res} = MC$

• Similarly for any other output my rival produces (50,40,30,...)
• This describes my “Best Response Function” (Reaction Function) since it describes what is my profit-maximizing output decision, $q_1$, as a function of my rival’s output level, $q_2$, and we write it down as

$\eta(q_2)$

Example

Q = $q_1 + q_2$

• Market demand: $p = 100 - Q \rightarrow p = 100 - q_1 - q_2$
  $MC = 10$

• Find optimal $q_1$ where $q_1 = 50$.
  • Firm 1’s residual demand is $p = 100 - q_1 - 50 = 50 - q_1$
  • MR associated to this residual demand is $MR = 50 - 2q_1$

$MR_{res} = MC$

$50 - 2q_1 = 10 \Leftrightarrow 40 - 2q_1 \Leftrightarrow q_1 = 20$

Optimal $q_1$ when rival produces $q_2 = 50$

Let us now find the optimal $q_1$ for any arbitrary $q_2$ (not only $q_2 = 50$, as above)

• Since demand is $p = 100 - q_1 - q_2$, Firm 1’s residual demand is $p = (100 - q_2) - q_1$.

Setting $MR = MC$, we obtain:

$(100 - q_2) - 2q_1 = 10$

$(90 - q_2) = 2q_1 \Leftrightarrow q_1 = \frac{90 - q_2}{2} = 45 - \frac{q_2}{2}$

This is Firm 1’s BRF

$q_1(q_2) = 45 - \frac{q_2}{2}$

Depicting Firm 1’s BRF
Alternative approach

- Note that, alternatively, we can find BRF, by directly solving firm i’s profit-maximization problem:

\[
\max_{q_i} \left( (100 - q_i) - q_i \right) q_i - 10q_i
\]

\[
\text{TR}=p* q_i \quad \text{TC}=c*
\]

- Taking first order conditions with respect to \( q_i \), we obtain:

\[(100 - q_i) - 2q_i - 10 = 0\]

Solving for \( q_i \), yields

\[q_i(q_i) = \frac{90 - q_i}{2} = 45 - \frac{q_i}{2}\]

which coincides with the BRF, we found using the other approach.

Firm 2’s BRF

- In order to find BRF₂:

\[
\text{Residual demand is } p = (100 - q_1) - q_2
\]

\[
\text{MR for this Residual Demand is...}
\]

\[
MR = (100 - q_i) - 2q_2
\]

- Setting \( MR = MC \), we obtain:

\[(100 - q_i) - 2q_2 = 10\]

- Solving for \( q_2 \), we find firm 2’s best response function

\[q_2(q_1) = 45 - \frac{q_1}{2}\]

Figure→

Depicting Firm 2’s BRF

\[q_2(q_1) = 45 - \frac{q_1}{2}\]

Trick: Rotate the page to draw this BRF₂ using the same axes as for BRF₁.
Putting $\text{BRF}_1$ and $\text{BRF}_2$ together...

This is the Cournot Equilibrium (where $\text{BRF}_1$ crosses $\text{BRF}_2$)

Find Cournot Equilibrium in this example...

- $\text{BRF}_1$: $q_i = \frac{45 - q_j}{2}$
- $\text{BRF}_2$: $q_j = \frac{45 - q_j}{2}$

- Trick: $q_i = q_j = q$

- In symmetric Duopolies, where both firms’ cost function coincide

- $q = 45 - \frac{q}{2} \rightarrow \frac{3}{2}q = 45$

- And solving for $q$, we obtain $q=30$

Market Price is hence:

$p = 100 - q_1 - q_2 = 100 - 30 - 30 = $40

- Equilibrium profits in the Cournot model are hence

$\pi = p \cdot q_i - c \cdot q_i = $400 - 30 - 30 = $900$

- Similarly for firm 2, $\pi_2 = $900

What would happen if firms 1 and 2 coordinate their production decisions, i.e., if the collude as in a cartel that maximizes their joint profits?

- They would like to replicate what a single monopolist would do, producing $Q^m$

- Each firm producing half of $Q^m$, since their costs coincide.

- Let’s see that next
What are the Monopoly P and Q in this setting?

- \( P(Q) = 100 - Q \)
- \( MR = MC \)
  \[ 100 - 2Q + 10 = Q \rightarrow Q = 45 \text{ units} \]
- \( q_1 = 22.5 \)
- \( q_2 = 22.5 \)

**In a cartel that maximizes joint profits each firm should produce half of monopoly output since they are symmetrical in costs**

- Hence, \( p = 100 - Q = 100 - 45 = \$55 \)
- Therefore, profits in the cartel become: \( \pi_1 = p - c = 55 \times 22.5 - 10 \times 22.5 = \$1,012.5 \)
- Similarly for firm 2, \( q_2 = 22.5 \)
- Aggregate profits are, hence, \( \$1,012.5 + \$1,012.5 = \$2,025 \).

Comparisons of Cournot vs. Collusion under a cartel that replicates monopoly outcomes:

- \( \$55 = P_{\text{monopoly}} > P_{\text{Cournot}} = \$40 \)
- \( \$45 = Q_{\text{monopoly}} < Q_{\text{Cournot}} = q_1 + q_2 = \$60 \)
- \( \$2,025 = \text{Profits}_{\text{monopoly}} > \text{Profits}_{\text{1}} + \text{Profits}_{\text{2}} = \$1,800 \)

- Why is the last inequality occurring?
  - Because when firm 1 \( \Delta q \) it produces a decrease in \( p \). Such a decrease in prices entails a reduction in firm 2’s profits which firm 1 doesn’t consider when selecting \( q_1 \).
  - Since all firms do that, aggregate profits are lower under Cournot (when firms do not coordinate their output decisions) than under monopoly (or cartel, where firm coordinate their output choices).

Extending the Cournot model to \( N \) firms:

- Let’s try Learning-by-Doing Exercise 13.2
  \[ p = a - bQ, \ MC = \$c \]
- Residual demand for firm 1:
  \[ p = a - b(q_1 + X) \rightarrow p = (a - bX) - bq_1 \]
  where \( X = \sum_{j=1}^{N} q_j \)

Then we can set \( MR = MC \) as follows:

\[ MR = (a - bX) - 2bq_1 = c = MC \]

Solving for \( q_1 \):

\[ \frac{a - bX - c}{2b} = q_1 \rightarrow q_1 = \frac{a - c}{2b} - \frac{1}{2}X \]

This is BRF,
(similar for all other \( N \)-1 firms)
By symmetry...

\[ q_i = q_2 = \ldots = q_N, \text{ which implies that } X = q_2 + q_3 + \ldots + q_N = (N - 1)q_i. \]

And by rearranging...

\[ q_i = \frac{a - c}{2b} - \frac{1}{2} \left( N - 1 \right) q_i. \]

For instance, in our previous numerical example where \( p=100-Q, \) i.e., \( a=100 \) and \( b=1, \) and where \( c=10 \) and \( N=2 \) firms, entails an individual output (per firm) of

\[ q_1 = \frac{1}{N+1} = \frac{1}{2+1} = \frac{100-10}{1} = \frac{1}{3} = \frac{90}{3} = 30 \text{ units} \]

which is exactly the amount we found before when dealing with \( N=2 \) firms.

Individual output as a function of \( N \)

For instance, when \( a=100 \) and \( b=1, \) so that \( p(q)=100-q, \) as in the demand curve of our previous numerical example; and \( c=10, \) then \( q_i \) becomes:

\[ q_i = \frac{1}{N+1} = \frac{100-10}{N+1} = \frac{90}{N+1} \]

which is decreasing in the number of firms, \( N. \)
Note that if \( N=2 \) firms compete in this oligopoly...

\[ q_1 = \frac{1}{N+1} \cdot \frac{a-c}{b} \sum_{n=2}^{3b} \]

What about total (aggregate) output, \( Q \)?

\[ Q = N \cdot q = N \cdot \left( \frac{1}{N+1} \cdot \frac{a-c}{b} \right) \]

As in Perfect Competition

\[ n = \frac{2(a-c)}{b} \]

As in Monopoly

\[ n = \frac{a-c}{b} \]

\[ n = \frac{a-c}{2b} \]

Aggregate output as a function of \( N \)

- Aggregate output when \( a=100 \) and \( b=1 \), so that \( p(q)=100-q \), and \( c=10 \).

\[ Q = N \cdot \left( \frac{1}{N+1} \cdot \frac{100-10}{1} \right) = N \cdot \frac{90}{N+1} \]

And what about Market Prices?

\[ p = a - b \cdot Q = a - b \left( \frac{N}{N+1} \cdot \frac{a-c}{b} \right) = \frac{a}{N+1} + \frac{N}{N+1} \cdot c \]

if \( N=1 \) → \( \frac{a+1}{2} + \frac{1}{2} \cdot \frac{c}{2} = \frac{a+c}{2} \) (as in monopoly)

if \( N=2 \) → \( \frac{a}{c} + \frac{2}{3} \cdot c = \frac{a+2c}{3} \)

if \( N=\infty \) → \( p = c \) (as in perfectly competitive markets)
Prices as a function of $N$

- Prices when $a=100$ and $b=1$, so that $p(q)=100-q$, and $c=10$.
  \[ p = 100 \frac{N}{N+1} + 10 = 10 + \frac{90}{N+1} \]
- Hence, prices decrease as more firms compete in the market, approaching $p=MC=10$ when $N$ is large.

**Cournot IEPR**

In monopoly
\[ \frac{p-MC}{p} = \frac{1}{c_{q,p}} \]
In Cournot
\[ \frac{p-MC}{p} = \frac{1}{N} \frac{1}{c_{q,p}} \]

- Note that this IEPR is the same as the Monopoly IEPR, except $(1/N)$ is added to the right-hand side.
- As $N$ approaches infinity the market approaches perfect competition.
  - Indeed, if $N\to\infty$, the right-hand side of the IEPR collapses to zero, and thus
  \[ \frac{p-MC}{p} = 0 \text{ implying } p = MC \]

**Bertrand Model**

- Let us now analyze competition in prices, which we refer to as the Bertrand model of price competition.
  - As opposed to the Cournot model, in which firms competed in quantities.
  - Will the equilibrium results coincide?
    - No, let’s see why.
Consider that firm 2 sets a price $p=40.

What price will its rival, firm 1, set?

Firm 1 (Samsung) must set $P_1 < 40$ (otherwise it sells nothing).

Example:
- Set $P_1 = 39$, losing area A, but gaining B.

Once Samsung has set a price of $39, then its rival must set a price $p < 39$, e.g., $38$.

But then Samsung should respond by setting a price lower than $38$ since otherwise it sells nothing.

Repeating this process.....

The process can be repeated until prices reach $p = \text{MC}$.

(Setting a price $p < \text{MC}$ would imply losses).

So, the Bertrand model even with $N=2$ firms we have competitive industry prices.

This didn't happen when firms compete in quantities (a la Cournot) (and $N=2$).

Example: $p = \frac{a + 2c}{3} > c$
No Asymmetric Equilibrium

1) $p_1 > p_2 > c$
   
2) $p_2 > p_1 > c$  (similar to above)
   
3) $p_1 > p_2 = c$
   
4) $p_1 > p_2 = c$  (similar)

Symmetric equilibrium

1) $p_1 = p_2 > c$
   
2) $p_1 = p_2 = c$  is the unique equilibrium in the Bertrand Model of Price Competition.

Cournot vs Bertrand:

How can their equilibrium predictions be so different?

- **1) Capacity constraints:**
  - Cournot → capacity is set firstly, then competition (LR capacity competition)
  - Bertrand → enough capacity to satisfy all market demand if necessary (SR price comp.)

- **2) Firm’s beliefs about the reaction of its competitor:**
  - Cournot model → competitors cannot adjust their production very much. e.g. mining or chemical processing
  - Bertrand model → all my competitors have enough production capacity to steal my customers. e.g. US airlines in the early 2000s

Stackelberg Model

- Competition is in quantities:
  - One firm acts as a quantity leader, choosing its quantity first, with other firms acting as followers.
    - 1) Leader and Follower
    - 2) The leader maximizes profits taking as given the follower’s BR (Reaction) function

- **Procedure:**
  - We first find the followers’ BR function, and then plug that into the leaders’ residual demand...
  - Example in the next slide.
Consider an inverse demand curve $p = 100 - q_2 = 100 - q_1 - q_2$

**MC = $10**

1st step
- Follower (firm 2's) BRF$_2$ $\rightarrow q_2 = 45 - \frac{q_1}{2}$ (Same BRF as in Cournot)

2nd step
- Leader (firm 1's) residual demand:
  $$ p = 100 - q_1 - q_2 = 100 - q_1 - (45 - \frac{q_1}{2}) = 55 - \frac{q_1}{2} $$

**Hence, the MR associated with this residual demand is**

$$ MR = 55 - 2 \cdot \frac{q_1}{2} = 55 - q_1 $$

**Setting MR=MC yields**

$$ 55 - q_1 = 10 $$

$$ q_1 = 45 $$

**We can now find the output of the follower**

Plugging $q_1 = 45$ into BRF$_2$

$$ q_2 = 45 - \frac{45}{2} = 22.5 \text{ Follower} $$

---

**Evaluating profits in the Stackelberg model**

Hence, the profits of the leader (firm 1) are

$$ \pi_1 = p \cdot q_1 - c \cdot q_1 = $40 \times 45 - 10 \times 45 = $1,350 $$

While the profits of the follower (firm 2) are only

$$ \pi_2 = p \cdot q_2 - c \cdot q_2 = $40 \times 22.5 - 10 \times 22.5 = $675 $$

This is usually referred to as the "leader’s advantage".

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Let us next compare prices, output, and profits in the Stackelberg and Cournot models.

- Before starting our comparison, we first need to find the price in the Stackelberg model of sequential quantity competition:

  $$ p = 100 - q_2 - q_2 = 100 - 45 - 22.5 = $32.50 $$
Conclusions

PRICE $32.50 $40

LEADER

FOLLOWER

TOTAL OUTPUT

Profit for leader $1,350
Profit for follower $675

Profit for leader $32.50 < Profit for follower $40

$1,350 = $900
$675 = $900

Intuitively, the leader produces a large amount, pushing the follower to produce a small amount.

This allows the leader to capture larger profits than the follower.

This result is usually referred to as "First-mover advantage".

Note that this output difference is not due to different costs.

Both firms have the same costs, yet the leaders position helps him flood the market, leaving little room (residual demand) for the follower to capture.

Note that the leader doesn't serve the entire market (inducing the follower to produce nothing, $q_2=0$), but instead $q_1>q_2>0$.

Comparing output and prices across different models:

We can place aggregate output levels and their corresponding prices in a standard linear inverse demand curve $p(q) = a - bq$.

Query #1

Stackelberg duopolists, Firm 1 and Firm 2, face inverse market demand $P = 50 - Q$. Both have marginal cost, $MC = 20$.

If the follower takes the leader’s output as fixed at $Q_1$, what is the equation of its reaction function?

a) $30 - Q_1 = Q_2$

b) $15 - Q_1 = Q_2$

c) $15 - 2Q_1 = Q_2$

d) $15 - \frac{Q_1}{2} = Q_2$
**Query #1 - Answer**

- Answer D
- The Stackelberg model of oligopoly pertains to a situation in which one firm acts as a quantity leader, choosing its quantity first, with all other firms acting as followers and making their decision after the leader.
- To find the follower’s reaction function, we first find its residual demand:
  - \( P = 50 - Q_{\text{leader}} \) or \( P = (50 - Q) - Q \)
  - This is the follower’s residual demand curve, where the parenthesis highlight the terms the follower views as given.
  - \( (50 - Q) \) is the vertical intercept, and \( k \) is the slope.
- The corresponding Marginal Revenue Curve is \( P = (50 - Q) - 2Q \)
  - The corresponding MR keeps the same vertical intercept but doubles the slope
- Then just equate the Marginal Revenue Curve to Marginal Cost, \( MC = 20 \)

\[
\begin{align*}
25 &= (50 - Q) - 2Q \\
2Q &= 50 - Q - 20 \\
2Q &= 30 - Q
\end{align*}
\]

- Pages 501, 510-511, \( Q^* = \frac{15}{2} \)

**Dominant Firms**

- 1) One dominant firm with a large market share dominates the market (has a significant market share compared to others)
- 2) Many small firms (Market competitive fringe)

Example: Light bulb market \( \rightarrow \) GE (71%), Sylvania (7%)...
Steel Market \( \rightarrow \) US Steel
Aluminum Market \( \rightarrow \) Alcoa

**Dominant Firm**

- 1) \( D_M \) and \( S_{\text{fringe}} \) and MC for every firm is equal (same access to technology).
- 2) Residual demand for the dominant firm, \( D_K \), is 
  \( D_k = D_M - S_{\text{fringe}} \)
- When \( S_{\text{fringe}} = 0 \Rightarrow D_k \) coincides with \( D_M \) (see segment of \( D_M \) for prices between zero and $25, where \( D_M = D_k \)).
Dominant Firm

3) MR associated to $D_R$

MR = MC determines the equilibrium $Q$ for the dominant firm.

In this case that occurs at $Q_R = 50$ units.

4) Market price: from $D_R$ not from $D_M$, hence, $p = 50$

5) Profit = ($p - MC$)$Q = (50 - 25)50 = $1,250

6) Fringe firms supply an output of 25 units when $p = 50$

Exercise on Dominant Firms

Consider a demand curve: $Q' = 110 - 10p$

MC = 5 (dominant firm's MC)

200 firms in the fringe, each firm with $MC = 5 + 100q$

a) Supply of firms in the Fringe, $S_F$

$p = MC \rightarrow p = 5 + 100q \rightarrow q = \frac{D - 5}{100}$ (which is positive as long as $p > 5$

$S_F = 200 \left( \frac{p - 5}{100} \right) = 2p - 10$

a) We now find the residual demand for the dominant firm, $Dem_R(Q_R)$

\[
Q_R = Q' - SF = (110 - 10p) - (2p - 10) = 120 - 12p
\]

Summarizing the results in the exercise

- Total Industry Supply: 30 + 5 = 35 units
- Fringe Market Share: 5/35 = 14.29%
- Dominant Firm Market Share: 30/35 = 85.71%
**Product Differentiation**

- **Vertical differentiation**: two products with differences in their quality
  - Duracell vs. Store-brand batteries
    - At a given price (e.g., $5), **ALL** customers regard one good superior to another.

- **Horizontal differentiation**: two products with differences in some attributes, a matter of substitutability.
  - Pepsi vs. Coke (some consumers like one more than the other even if their prices coincide.)

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**Horizontal Differentiation**

\[ \text{Demand is sensitive to } \rightarrow \text{own price (flat)} \]

\[ \rightarrow \text{rival’s price (Large inward shift)} \]

\[ \text{Demand is insensitive to } \rightarrow \text{own price (steep)} \]

\[ \rightarrow \text{rival’s price (small inward shift)} \]

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**Weak vs. Strong Differentiation**

- **Graph A**:
  - **Weak HD**: firm demand curve is very flat and therefore very sensitive to its own price.
    - \[ p \rightarrow |q| \text{ along } D_1 \]
  - In addition, \[ |p_\text{ref} \rightarrow |q| \] strong leftward shift in the demand curve, indicating that demand is sensitive to its rival’s price.

- **Graph B**:
  - **Strong HD**: firm demand is less sensitive to its own price.
    - \[ |p| \rightarrow \text{slight } |q| \quad (\text{insensitive to its own price}) \]
  - In addition, \[ |p_\text{ref} \rightarrow \text{slight leftward shift in the demand curve (} |q|) \], indicating that demand is insensitive to its rival’s price.

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**Bertrand Competition with Horizontal Product Differentiation**

- **H.D. entails that demands for Coke and Pepsi are different**
  - Which do you like the most? It’s a matter of taste, not quality:

  \[
  \text{Coke}: \quad Q_1 = 64 - 4p_1 + 2p_2 \quad MC_1 = $5 \\
  \text{Pepsi}: \quad Q_2 = 50 - 5p_2 + p_1 \quad MC_2 = $4
  \]
These demand functions were estimated by a group of leading economists.

**Procedure:**
- Find Pepsi’s profit-maximizing price \( p_1 \), for any arbitrary price of Coke, \( p_2 \). This gives you BRF2, as \( p_1(p_2) \).
- Similarly, find Coke’s profit-maximizing price \( p_1 \), for any arbitrary price of Pepsi, \( p_2 \). This gives you BRF1, as \( p_1(p_2) \).
- Substitute one BRF into another, and find optimal prices \( p_1 \) and \( p_2 \).

a) What is Coke’s profit-maximizing price \( p_1 \), when \( p_2 = \$8 \)

1) Find Residual Demand for Coke

\[ Q_1 = 64 - 4p_1 + 2 \cdot 8 = 64 + 16 - 4p_1 = 80 - 4p_1 \]
\[ p_1 = 20 - 0.25q_1 \]

2) Find MR, and set it equal to MC1
\[ MR_R = 20 - 0.5q_1 = 5 \leftarrow MC_1 \]
\[ 15 = 0.50q_1 \rightarrow q_1 = 30 \]

3) Substitute back into the demand function
\[ p_1 = 20 - 0.25 \cdot 30 = \$12.50 \] (For Coke)
\[ p_2 = \$8 \] (For Pepsi)

b) What is Coke’s profit-maximizing price \( p_1 \), for any arbitrary \( p_2 \)?

1) Residual Demand for Coke
\[ q_1 = 64 - 4p_1 + 2p_2 \rightarrow p_1 = \frac{64 + 2p_2 - q_1}{4} = \frac{16 + p_2}{2} - \frac{1}{4} q_1 \]

2) Find MR, and set it equal to MC1
\[ MR_R = \frac{16 + p_2}{2} - \frac{1}{2} q_1 = 5 \leftarrow MC_1 \]
\[ 11 + \frac{p_2}{2} = q_1 = 22 + \frac{p_2}{4} \]

3) Substitute back into the demand function
\[ p_1 = \left( 16 + p_2 \right) - \frac{1}{4} \left( 22 + p_2 \right) \rightarrow p_1 = 10.5 + \frac{p_2}{4} \]
Similarly for Pepsi, we can find its BRF as...

\[ p_2(p_1) = 7 + \frac{P_1}{10} \]

Remember to use the same axis as in the previous figure.

In order to find the crossing point of BRF1 and BRF2, plug one inside the other...

\[ p_1(p_2) = 10.5 + \frac{p_2}{4} \]
\[ p_2(p_1) = 7 + \frac{P_1}{10} \]

Hence, \[ p_1 = 10.5 + \frac{8.26}{4} = 12.56 \]

And outputs are (plugging prices on the demand function):

\[ Q_1 = 64 - 4 \cdot 12.56 + 2 \cdot 8.26 = 30.28 \text{ units} \]
\[ Q_2 = 50 - 5 \cdot 8.26 + 12.56 = 21.26 \text{ units} \]

A few more points...

\[ 12.56 - P_{\text{Coke}} > P_{\text{Pepsi}} - 8.26 \]

Because:

1) \[ MC_{\text{Coke}} > MC_{\text{Pepsi}} \]

2) \[ e_{\text{Coke}} < e_{\text{Pepsi}} \]

Note that their price markups are different but unambiguously large:

\[ \text{Coke} \rightarrow \frac{p_1 - MC_1}{p_1} = \frac{12.56 - 5}{12.56} = 0.60(60\%) > 0 \]
\[ \text{Pepsi} \rightarrow \frac{p_2 - MC_2}{p_2} = \frac{8.26 - 4}{8.26} = 0.52(52\%) = 0 \]

That is, product differentiation "softens" price competition \( \leftarrow \) as opposed to the Bertrand Model with no product differentiation, where \( p=MC \text{ and } \text{Profits}=0 \)
Another application of product differentiation

- Channel Tunnel between Dover, UK and Calais, France.
- Competing against the traditional ferries operating in the same route.

Application

- Channel Tunnel:
  - The author estimated the reaction function of each firm (only data for trucks) obtaining the following figure.
  - Equilibrium occurs at the crossing point: £87 for the channel and £150 for the ferries.

Cournot Model of Horizontal Product Differentiation

- What if firms still sell a horizontally differentiated product, but rather than competing in prices (as in the Coke vs Pepsi example), they compete in quantities?
  - 2 firms
  - Simultaneously competing in quantities
  - Selling horizontally differentiated products,
    - Exercise 13.29 in your textbook for practice.

Query #2

Which of the following is true in markets with horizontally differentiated products?

a) Bertrand competitors will generally earn zero profits in equilibrium.
b) Firms always act as monopolists when products are horizontally differentiated.
c) IEPR does not apply to markets with horizontal product differentiation.
d) Bertrand competitors will generally earn positive profits in equilibrium.
Query #2 - Answer

- Answer D
- Bertrand competitors will generally earn positive profits in equilibrium.
- The IEPR does apply to markets with horizontal product differentiation.
- Pages 518-520

Query #3 - Answer

- Answer B
- The Demand Curves can be rewritten as:
  - \( Q_A = (100 + 0.5P_B) - P_A \)
  - \( Q_B = (100 + 0.5P_A) - P_B \)
- Plugging \( P_A = 70 \) into the equation for \( Q_B \) we obtain:
  - \( Q_B = (100 + 0.5(70)) - P_B \)
  - \( P_B = 135 - Q_B \)
- Then, we can find the associated Marginal Revenue Curve
  - \( MR = 135 - 2Q_B \)
  - Same vertical intercept as \( P_B \) but double slope

Query #3 - Query

Let firm A face demand curve \( Q_A = 100 - P_A + 0.5P_B \) and firm B face demand curve \( Q_B = 100 - P_B + 0.5P_A \).
- Products A and B both have constant marginal cost of production of 10 per unit (and no fixed cost).
- Each firm acts as a Bertrand competitor.
What is firm B’s profit-maximizing price when firm A sets a price of $70 for its good?
- a) $70
- b) $72.5
- c) $74
- d) $76.5

- Equate MR and MC, \( MC = \$10 \)
  - \( 135 - 2Q_B = 10 \)
  - \( Q_B = 62.5 \)
- Now that we know \( Q_B \), we can plug this back into our original demand curve to find \( P_B \)
  - \( Q_B = (100 + 0.5P_A) - P_B \)
  - \( 62.5 = (100 + 0.5(70)) - P_B \)
  - \( P_B = \$72.5 \)
- Page 521
Monopolistic Competition (free entry)

- Many firms.
- Sell a horizontally differentiated product.
  - Example: restaurants in Seattle
- Entry and exit are possible but, unlike P.C. markets, the product is horizontally differentiated.

- In the short run, profits might be positive, but...
- In the long run, firms are attracted to positive profits, and economic profits become zero.
  - (Accounting profits are positive, but just comparable to those in order industries).

Short run, but...

Profits attract entry

Long Run

Monopolistic Competition and Price Elasticity

Few firms are attracted to enter...
Many firms are attracted to enter...

Ex. Liquor Stores, Hardware Stores
Ex. Flower shops, Jewelry stores

True at Chicago or Pittsburgh, probably true in Spokane and Seattle
- Ultimately, we observe more flower shops than liquor stores.
Can prices go up as a consequence of the entry of more firms? Yes!

Consider the following figure where:

- The market is initially in a long-run equilibrium at a price of $50, and with each firm facing demand curve D (point A).
- Technological improvement reduces the average cost curve of all firms, from AC to AC'.
- Firms now start earning positive short-run profits, which attract the entry of more firms.
- Due to entry, the demand curve for each firm shifts inwards, from D to D'.
- In the new long-run equilibrium (point B) firms don't make profits.
- Prices are higher than at the initial equilibrium (point A). They increase from $50 to $55.

Of course, this doesn’t need to be the case:
- Prices could also fall as more firms enter the industry.

Application 13.8: Primary Physicians as an example of Monopolistic Competition
- 92 metropolitan areas in the U.S.
- An increase in the number of physicians per square mile was associated with an increase in the average price per office visit.
- Notice that an increase in the number of physicians is equivalent to the entry of new competitors in this industry (local market of physicians).
Application 13.8: Primary Physicians as an example of Monopolistic Competition

- Why?
  - Search costs: comparison shopping becomes more difficult as you increase the number of physicians.
  - Additional confirmation: physicians’ prices were higher in markets in which a large proportion of the population had recently moved (and thus had poorer information about local doctors) than in markets in which households were more settled.

- Hence, the entry of new doctors in this market lead to an inward shift in the demand curve of each doctor (from D to D’), leading prices up, as in the figure we described three slides ago.