Chapter 13

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

$$HHI = (S_{firm1})^2 + (S_{firm2})^2 + \ldots + (S_{firmN})^2$$

Market share for each firm in the industry.

Examples

1) Monopoly, S=100 → HHI = $100^2 = 10{,}000$

2) Very fragmented market, s = .001 for each of the 1,000 firms in the industry.

HHI= $1{,}000 \cdot (.001)^2 = .001$

Hence HHI ranges from 0 to 10,000

Close to Perfect comp — Monopoly

Herfindahl-Hirshman index of market concentration

TABLE 13.2 Four-firm Concentration Ratios and Herfindahl-Hirschman Indices for Selected U.S. Manufacturing Firms, 2002

Industry	NAICS Code[a]	Total Number of Companies	4CR	HHI
Guided missiles and space vehicles	336414	13	96.0	na[b]
Cigarette manufacturing	312221	15	95.3	na
Beer breweries	312120	349	90.8	na
Electric lamp bulb and parts manufacturing	335110	57	88.5	2,757.6
Glass container manufacturing	327213	22	88.3	2,582.1
Primary aluminum manufacturing	331312	26	85.3	na
Breakfast cereal manufacturing	311230	45	78.4	2,521.3
Dog and cat food manufacturing	311111	176	64.2	1,845.5
Ice manufacturing	312113	425	42.9	763.1
Automatic vending machine manufacturing	333311	106	42.3	679.0
Cement manufacturing	327310	131	38.7	568.5
Curtain and drapery mills	314121	1,778	16.1	111.0
Fabricated structural metal manufacturing	332312	3,569	8.9	39.5

[a]NAICS, the North American Industry Classification System, is the system the U.S. Census Bureau uses to classify industries.

[b]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.

Source: U.S. Census Bureau, *Concentration Ratios: 2002*, http://www.census.gov/epcd/www/concentration.html (accessed March 10, 2010).

Table 13.2

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

Firms choose their actions *simultaneously*

- Cournot
  - If competition in quantities
- Bertrand
  - If competition in prices

- Stackelberg
  - We will consider competition in quantities

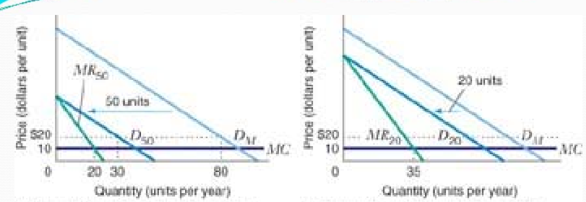
Firms choose their actions *sequentially*

Homogeneous Products *(no product differentiation)*

- 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



(a) Samsung's profit-maximization problem when LG produces 50

(b) Samsung's profit-maximization problem when LG produces 20

- 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} ⟶ $MR_{50} = MC$

- 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, is a function of my rival's output level, q_2 and we write it down as

$$q_1(q_2)$$

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_2 = 50.
  - Firm 1's residual demand is $p = 100 - q_1 - 50 = 50 - q_1$
  - MR associated to this residual demand is MR $= 50 - 2q_1$

$$MR_{res} = MC$$

$$50 - 2q_1 = 10 \Leftrightarrow 40 - 2q_1 \Leftrightarrow \boxed{q_1 = 20}$$

Optimal q1 when rival produces q2 = 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:

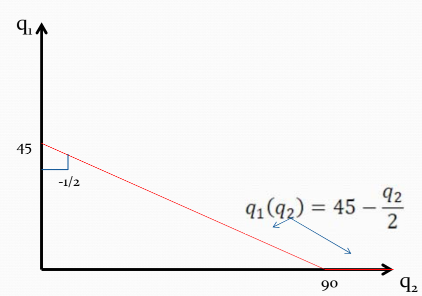
$$(100 - q_2) - 2q_1 = \$10$$

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

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_1 by directly solving firm 1's profit-maximization problem:

$$\max_{q_1} \underbrace{[(100-q_2)-q_2]*q_1}_{TR=p*q_1} - \underbrace{10q_1}_{TC=c*}$$

- Taking first order conditions with respect to q_1, we obtain:

$$(100-q_2)-2q_1-10=0$$

- Solving for q_1, yields

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

which coincides with the BRF_1 we found using the other approach.

Firm 2's BRF

- In order to find BRF_2:

This production level is given (firm 2 cannot control it)

  - Residual demand is $p=(100-q_1)-q_2$
  - MR for this Residual Demand is…

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

  - Setting MR = MC, we obtain:

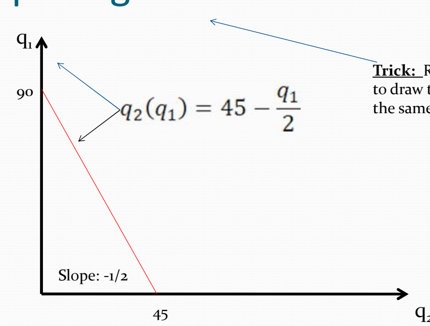
$$(100-q_1)-2q_2=10$$

  - Solving for q_2, we find firm 2's best response function

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

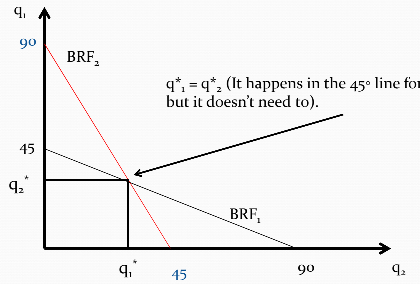
Figure→

Depicting Firm 2's BRF



Trick: Rotate the page to draw this BRF2 using the same axes as for BRF1

Putting BRF_1 and BRF_2 together…



This is the Cournot Equilibrium (where BRF_1 crosses BRF_2)

- Find Cournot Equilibrium in this example…

BRF1 $q_1 = 45 - \frac{q_2}{2}$

BRF2 $q_2 = 45 - \frac{q_1}{2}$

$\rightarrow Trick : q_1 = q_2 = q$

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

$$\pi_1 = p \cdot q_1 - c \cdot q_1 = \$40 \times 30 - 10 \times 30 = \$900$$

- Similarly for firm 2, π_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?

- $P(Q) = 100 - Q$
- $MR = MC$

  $100 - 2Q = 10 \rightarrow Q = 45$ 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 $\pi_1 = p \cdot q_1 - cq_1 = \$55 \times 22.5 - 10 \times 22.5 = \$1,012.5$
- Similarly for firm 2, π_2=$1,012.5.
- Aggregate profits are, hence, 1,012.5+1,012.5=$2,025.

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

  $\$55 = P_{monopoly} > P_{Cournot} = \$40$

  $\$45 = Q_{monopoly} < Q_{Cournot} = q_1 + q_2 = \$60$

  $\$2,025 = Profits_{monopoly} > Profits_1 + Profits_2 = \$1,800$

- Why is the last inequality occurring?
  - Because when firm 1 Δq_1, 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

$$p = a - bQ,\ \text{MC} = \$c$$

- Residual demand for firm 1

$$\rightarrow p = a - b(q_1 + X) \rightarrow p = (a - bX) - bq_1$$

where $X = \sum_{j \neq 1} q_j$

Then we can set MR=MC as follows:

$$\text{MR} = (a - bX) - 2bq_1 = c \quad = \text{MC}$$

Solving for q_1 ...

$$\Leftrightarrow \frac{a - bX - c}{2b} = q_1 \rightarrow q_1 = \underbrace{\frac{a-c}{2b} - \frac{1}{2}X}_{\text{This is BRF}_1}$$

This is BRF_1
(similar for all other N-1 firms)

By symmetry...

$q_1 = q_2 = \ldots = q_N$, which implies that $X = \underbrace{q_2 + q_3 + \ldots + q_N}_{} = (N-1)q_1$

$$q_1 = \frac{a-c}{2b} - \frac{1}{2}\overbrace{(N-1)q_1}^{X}$$

And by rearranging...

$$q_1 + \frac{1}{2}(N-1)q_1 = \frac{a-c}{2b}$$

$$\leftrightarrow \frac{2q_1 + (N-1)q_1}{2} = \frac{a-c}{2b}$$

$$\leftrightarrow \frac{q_1 + Nq_1}{2} = \frac{a-c}{2b} \rightarrow q_1(N+1) = \frac{a-c}{b}$$

$$\rightarrow q_1 = \frac{1}{N+1}\frac{a-c}{b}$$

where q_1 is a firm's optimal output in a Cournot market with *N* firms

- 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

$$q_1 = \frac{1}{N+1}\cdot\frac{a-c}{b} = \frac{1}{2+1}\cdot\frac{100-10}{1} = \frac{1}{3}\cdot\frac{90}{1} = \frac{90}{3} = 30 \text{ units}$$

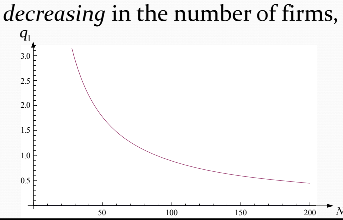
which is exactly the amount we found before when dealing with *N*=2 firms.

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_1 becomes:

$$q_1 = \frac{1}{N+1}\frac{100-10}{1} = \frac{90}{N+1}$$

which is *decreasing* in the number of firms, *N*.



- Note that if N=2 firms compete in this oligopoly…

$$q_1 = \frac{1}{N+1} \cdot \frac{a-c}{b} \underbrace{\rightarrow}_{n=2} \frac{a-c}{3b}$$

- What about total (aggregate) output, Q?

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

$\xrightarrow{n=2} \frac{2(a-c)}{3b}$

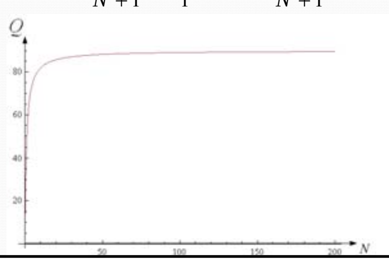
$\xrightarrow{n=\infty} \frac{a-c}{b}$ (As in Perfect Competition)

$\xrightarrow{n=1} \frac{a-c}{2b}$ (As in Monopoly)

Aggregate output as a function of N

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

$$Q = N\frac{1}{N+1}\frac{100-10}{1} = N\frac{90}{N+1}$$



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 $\longrightarrow \frac{a}{2} + \frac{1}{2}c = \frac{a+C}{2}$ (as in monopoly)

if N=2 $\longrightarrow \frac{a}{c} + \frac{2}{3} \cdot c = \frac{a+2c}{3}$

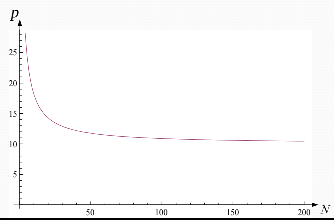
if N=∞ $\longrightarrow p = c$ (as in perfectly competitive markets)

Prices as a function of *N*

- Prices when a=100 and b=1, so that $p(q)$=100-q, and c=10.

$$p = \frac{100}{N+1} + \frac{N}{N+1}10 = 10 + \frac{90}{N+1}$$

- Hence, prices decrease as more firms compete in the market, approaching p=MC=$10 when N is large.



- We used IEPR in monopoly markets
- Can we use it in oligopoly markets as well?

  Yes!

Cournot IEPR

$$\underbrace{\frac{p-MC}{p} = -\frac{1}{\varepsilon_{Q_i,P}}}_{\text{In monopoly}} \rightarrow \underbrace{\frac{p-MC}{p} = \frac{1}{N}\cdot\frac{1}{\varepsilon_{Q_i,P}}}_{\text{In Cournot}}$$

$\uparrow N \Rightarrow \downarrow$ Mark Up ($\downarrow$market power)

- Therefore, the more firms there are, the less market power each firm has.
  - 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 $N\rightarrow\infty$, the right-hand side of the IEPR collapses to zero, and thus

$$\frac{p-MC}{p} = 0 \text{ implying } p = MC$$

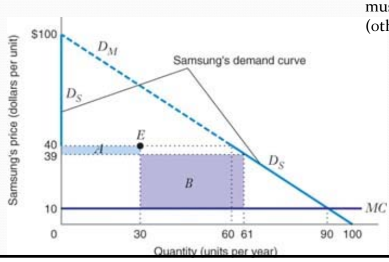
Bertrand Model

- Let us now analyze competition in <u>prices</u>; 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.

Bertrand Model

- 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 $p=MC$.
  - (Setting a price p<MC would imply losses).

Bertrand Conclusions

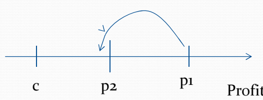
- So, the Bertrand model even with N=2 firms we have competitive industry prices
  - This didn't happen when firms compete in quantities (a la Cournot) (and N=2).

Example: $p = \frac{a+2c}{3} > c$

- Let's next show this result by systematically going over all possible price pairs (p_1,p_2) different from (c,c), i.e., whereby both firms' price coincides with their common cost, c.
- We will demonstrate that they cannot be equilibria of the of the Bertrand model of price competition.
  - In particular, we will show that they are "unstable" prices in the sense that at least one firm has incentives to deviate to another price.
- For presentation purposes:
  - We will first examine *asymmetric* price pairs, $p_1 \neq p_2$, and then
  - We examine *symmetric* price pairs, where $p_1 = p_2$

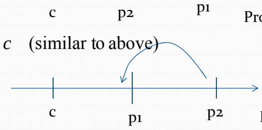
No Asymmetric Equilibrium

1) $p_1 > p_2 > c$



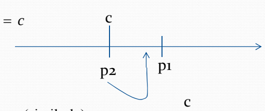
Profitable deviation of firm 1

2) $p_2 > p_1 > c$ (similar to above)

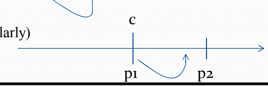


Profitable deviation of firm 2

3) $p_1 > p_2 = c$

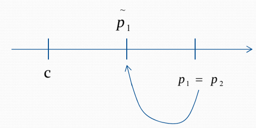


4) $p_2 > p_1 = c$ (similarly)



Symmetric equilibrium

1) $p_1 = p_2 > c$



, and similarly for firm 2

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 $P = 100 - Q = 100 - q_1 - q_2$

$MC = \$10$

1st step

- Follower (firm 2's) BRF2 $\rightarrow q_2 = 45 - \frac{q_1}{2}$ (Same BRF as in Cournot)

2nd step

- Leader (firm 1's) residual demand:

$$p = 100 - q_1 - q_2 = 100 - q_1 - \underbrace{(45 - \frac{q_1}{2})}_{q_2} = 55 - \frac{q_1}{2}$$

- Hence, the MR associated with this residual demand is

$$MR = 55 - 2 \cdot \frac{q_1}{2} = 55 - q_1$$
$$MC = \$10$$

- Setting MR=MC yields $55 - q_1 = 10$

$$45 = q_1$$

- We can now find the output of the follower

Plugging q_1 =45 into BRF_2

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

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

$$\pi_1 = p \cdot q_2 - c \cdot q_2 = \$40 \times 22.5 - 10 \times 22.5 = \$675$$

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

- 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:

$$p = 100 - q_1 - q_2 = 100 - 45 - 22.5 = \$32.50$$

Conclusions

PRICE→ $P_{stackelberg}$ =\$32.50< $P_{cournot}$ =\$40

LEADER→ $q_1^{Stackelberg}$ =45 > $q_1^{Cournot}$ =30

FOLLOWER→ $q_2^{Stackelberg}$ =22.5 < $q_2^{Cournot}$ =30

TOTAL OUTPUT→ $Q^{Stackelberg} > Q^{Cournot}$ =60

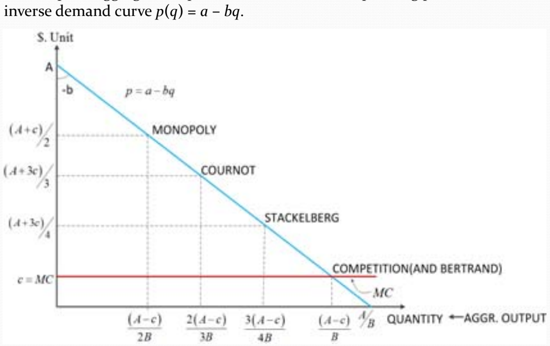
Profit for leader→ \$1,350= $Profits_1^{Stackelberg} > Profits_1^{Cournot}$ =\$900

Profit for the follower→ \$675= $Profits_2^{Stackelberg} < Profits_2^{Cournot}$ =\$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:
- $P = 50 - Q_{Market}$ or $P = (50 - Q_1) - Q_2$
  - This is the follower's residual demand curve, where the parenthesis highlight the terms the follower views as given.
  - $(50 - Q_1)$ is the vertical intersect, and -1 is the slope.
- The corresponding Marginal Revenue Curve is $P = (50 - Q_1) - 2Q_2$
  - The corresponding MR keeps the same vertical intercept but doubles the slope
- Then just equate the Marginal Revenue Curve to Marginal Cost, MC = $20

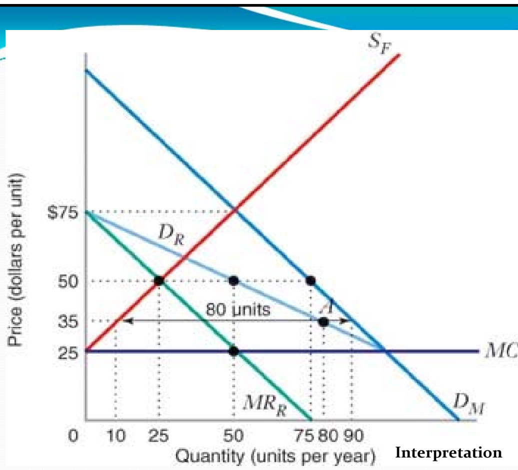
$$20 = (50 - Q_1) - 2Q_2$$
$$2Q_2 = 50 - Q_1 - 20$$
$$2Q_2 = 30 - Q_1$$

- Pages 501, 510-511 $Q_2 = 15 - \frac{2}{Q_2}$

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 → GE (71%), Sylvania (7%)...
Steel Market → US Steel
Aluminum Market → Alcoa



Interpretation →

Dominant Firm

- 1) D_M and S_{Fringe}, and MC for every firm is equal (same access to technology).
- 2) Residual demand for the dominant firm, D_R, is

  $D_R = D_M - S_{fringe}$
- When $S_{Fringe} = 0 \Rightarrow D_R$ coincides with D_M (see segment of D_M for prices between zero and $25, where $D_M = D_R$).

Dominant Firm

- 3) MR_R associated to D_R

  MR_R = 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 = $(p - MC)Q_R = (50-25)50 = \$1,250$
- 6) Fringe firms supply an output of 25 units when p = \$50

Exercise→

Exercise on Dominant Firms

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

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.

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

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

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

$$Q_R = \underbrace{Q^d}_{D_M} - \underbrace{S_F}_{} = \overbrace{(110 - 10p)}^{D_M} - \overbrace{(2p - 10)}^{S_F} = 120 - 12p$$

D_M - S_F

c) Profit-maximizing output for the dominant firm

since Q_R=120-12p, then the inverse demand is

$$p = 10 - \frac{1}{12}Q \rightarrow MR_R = 10 - \frac{1}{6}Q$$ ← This is the MR associated with the res. demand (double slope)

setting MR_R=MC, we obtain

$$10 - \frac{1}{6}Q = 5 \rightarrow Q = 30 \text{ for dominant firm}$$

→Price is then $p = 10 - \frac{1}{12} \cdot 30 = \$7.50$

Fringe supply is… $Q^S = 2 \cdot \$7.50 - 10 = 5 \text{ units}$

Summarizing the results in the exercise

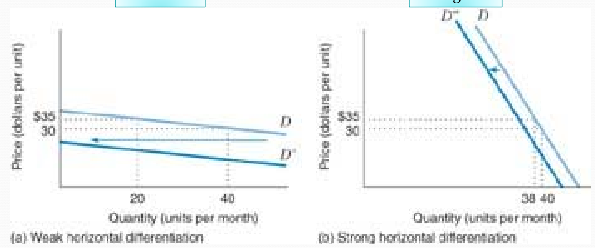
- Total Industry Supply: 30+5=35 units
- Fringe Market Share: 5/35 = 14.29%
- Dominant Firm Market Share: 30/35 = 85.71%

Product Differentiation

- **Vertical differentiation*:*** two products with differences in their quality
  - Duracell vs. Store-brand batteries
    - **At a given price (e.g., $5), <u>ALL</u> costumers 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.)

Horizontal differentiation

Weak H.D. | Strong H.D



Demand is sensitive to → own price (flat)
→ rival's price
(Large inward shift)

Demand is insensitive to → own price (steep)
→ rival's price
(small inward shift)

Weak vs. Strong Differentiation

- Graph A:
  - <u>Weak HD</u>: firm demand curve is very flat and therefore is very sensitive to its own price.
    - $\uparrow p \Rightarrow \downarrow\downarrow q$ along D_o
  - In addition, $\downarrow$price$_{rival}$ $\Rightarrow$ strong leftward shift in the demand curve, indicating that demand is sensitive to its rival's price.
- Graph B:
  - <u>Strong HD</u>: firm demand is less sensitive to its own price.
    - $\uparrow p \Rightarrow$ slight $\downarrow q$ D_o $\longleftarrow$ (insensitive to its own price)
  - In addition, $\downarrow$price$_{rival}$ $\Rightarrow$ slight leftward shift in the demand curve ($\downarrow q$), indicating that demand is insensitive to its rival's price.

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:

$$Coke: \ Q_1 = 64 - 4p_1 + 2p_2 \qquad MC_1 = \$5$$

$$Pepsi: \ Q_2 = 50 - 5p_2 + p_1 \qquad MC_2 = \$4$$

- These demand functions were estimated by a group of leading economists.
- ***Procedure***:
  - Find Pepsi's profit-maximizing price p_2 for any arbitrary price of Coke, p_1 → This gives you BRF2, as $p_2(p_1)$
  - 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 MC_1

$$MR_R = 20 - 0.5q_1 = 5 \leftarrow MC_1$$
$$15 = 0.50q_1 \to q_1 = 30$$

3) Substitute back into the demand function

$$p_1 = 20 - 0.25 \cdot 30 = \$12.50 \quad \text{(For Coke)}$$
$$p_2 = \$8 \quad \text{(For Pepsi)}$$

b) What is Coke's profit-maximizing price p_1 for <u>any</u> arbitrary p_2?

- 1) Residual Demand for Coke

$$Q_1 = 64 - 4p_1 + 2p_2 \to p_1 = \frac{64 + 2p_2 - q_1}{4} = \left(16 + \frac{p_2}{2}\right) - \frac{1}{4}q_1$$

- 2) Find MR, and set it equal to MC_1

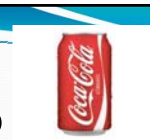
$$MR_R = \left(16 + \frac{p_2}{2}\right) - \frac{1}{2}q_1 = 5 \leftarrow MC_1$$
$$11 + \frac{p_2}{2} = \frac{q_1}{2} \to q_1 = 22 + \frac{p_2}{4}$$

- 3) Substitute back into the demand function

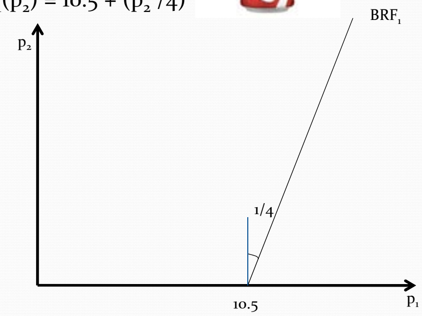
$$p_1 = \left(16 + \frac{p_2}{2}\right) - \frac{1}{4}\underbrace{\left(22 + \frac{p_2}{4}\right)}_{q_1} \to \overbrace{p_1 = 10.5 + \frac{p_2}{4}}^{BRF_1}$$

FIGURE →

Coke's BRF



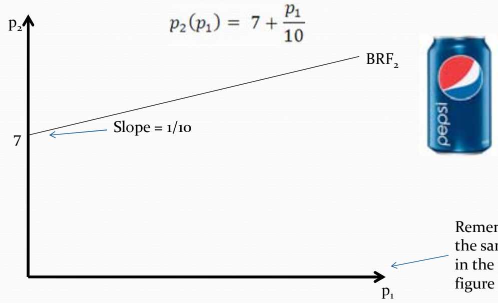
- $p_1(p_2) = 10.5 + (p_2/4)$

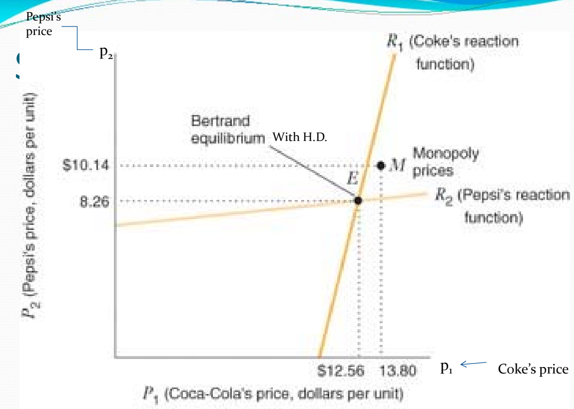


Practice how to find BRF2 by setting $MR_R = MC$ for Pepsi

- Similarly for Pepsi, we can find its BRF_2 as…

$$p_2(p_1) = 7 + \frac{p_1}{10}$$





- In order to find the crossing point of BRF_1 and BRF_2, plug one inside the other…

$$\left.\begin{array}{l} p_1(p_2) = 10.5 + \frac{p_2}{4} \\ p_2(p_1) = 7 + \frac{p_1}{10} \end{array}\right\} p_2 = 7 + \frac{\left(10.5 + \frac{p_2}{4}\right)}{10} \rightarrow p_2 = \$8.26$$

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

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

$$Q_1 = 64 - 4 \cdot 12.56 + 2 \cdot 8.26 = 30.28 \text{ units} \quad \text{(Coke)}$$

$$Q_2 = 50 - 5 \cdot 8.26 + 12.56 = 21.26 \text{ units} \quad \text{(Pepsi)}$$

A few more points…

$12.56 = $P_{coke} > P_{pepsi}$ =$8.26 Because:

1) $MC_{coke} > MC_{pepsi}$ …

2) $\varepsilon_{coke} < \varepsilon_{pepsi}$

- Note that their price markups are different but unambiguously large:

Coke → $\frac{p_1 - MC_1}{p_1} = \frac{12.56 - 5}{12.56} = 0.60(60\%) \neq 0$

Pepsi → $\frac{p_2 - MC_2}{p_2} = \frac{8.26 - 4}{8.26} = 0.52(52\%) \neq 0$

- That is, product differentiation "softens" price competition ← as opposed to the Bertrand Model with no product differentiation, where p=MC and Profits=0

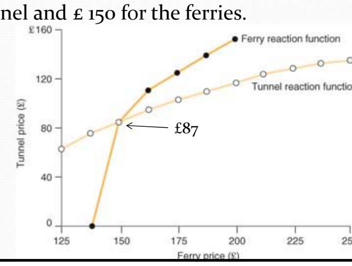
Another application of product differentiation

- Channel Tunnel between Dover, UK and Callais, 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

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

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

- 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

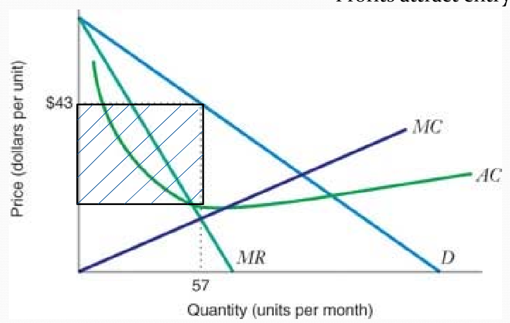
Monopolistic Competition (free entry)

- 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.

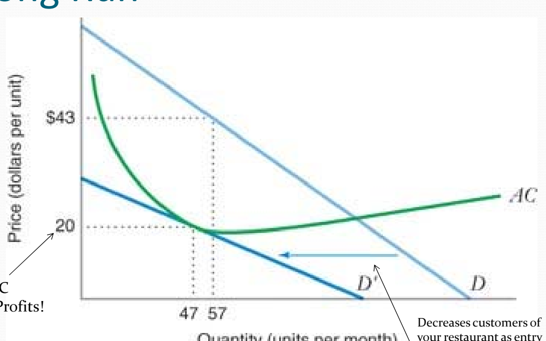
- In the ***short run***, profits might be positive, but…
- In the ***long run***, firms are attracted to positive profits, and economic profits become zero.
  - (Accounting profits are positive, but just comparable to those in order industries).

Short run, but…

Profits attract entry



Long Run

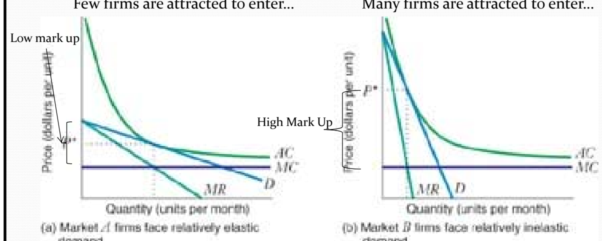


P=AC
No Profits!

Decreases customers of your restaurant as entry occurs. Fewer sales per firm.

Monopolistic Competition and Price Elasticity

Few firms are attracted to enter… Many firms are attracted to enter…



Ex. Liquor Stores, Hardware Stores

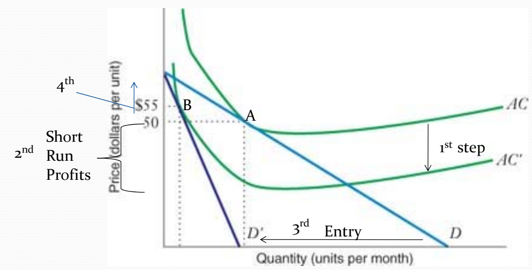
Ex. Flower shops, Jewelry stores

True at Chicago or Pittsburgh, probably true in Spokane and Seattle
- Ultimately, we observe more flower shops than liquor stores.

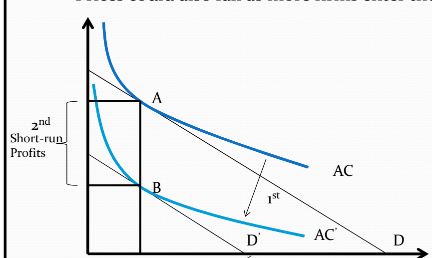
- Can prices go up as a consequence of the entry of more firms? Yes!

- 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.

- Can prices actually go up as a consequence of the entry of more firms? Yes!



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



Fall in prices, from A to B

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.