Thursday, Dec 2, Lecture 22 Oligopoly and Monopolistic Competition

Tomorrow's Office Hours changed:
Friday 9:45-10:45, 2:00-3:00

Oligopoly Models

- An ***oligopoly*** is a market with a small number of firms, linked by strategic interaction.
- Here, we use game theory to model ***duopoly***, a market with only two firms.
  - First, we describe the ***Bertrand duopoly*** model, in which firms compete by setting prices.
  - Then we model the ***Cournot duopoly***, in which the firms compete by setting output quantities.

A Bertrand Duopoly Model

- Two firms, ***Aux (A)*** and ***Beaux (B)***, each produce French white wine.
  - The two brands are perfect substitutes — no one can tell the difference.
  - The firms are price setters.
  - Each firm sets a price, (its strategy)…
  - …and the strategies of both firms determine the quantity that consumers demand from each firm.
- In setting its price, each firm is concerned with the price that its competitor will set.

- In a Bertrand duopoly, market demand is assumed to be perfectly inelastic.
  - (Total quantity demanded is constant and independent of price.)
  - If the firms' prices are different,
    - consumers buy everything from the low-price firm, …
    - and nothing from the high-price firm.
  - If the firms' prices are the same, consumers buy half their wine from each firm.

Example: A Bertrand Game

- Each firm has a constant marginal cost and no fixed cost, and $AC \equiv MC \equiv 10$.
- They each set a price: P_A and P_B (their strategies).
- P_A and P_B can be anywhere between \$10 and \$40.
  - Every possible price in that range is a different strategy.
  - The players would never want to set $P < 10$ [the AC], because they would be sure to lose money.
- If $P_A \neq P_B$, consumers buy
  - *10* units from the low-price firm,
  - and *0* from the high-price firm.
- If $P_A = P_B$, consumers buy
  - *5* from each firm.
- Each firm's payoff is its profit.

Note: we will not be able to represent the game as a matrix (table) as we did before, because each player has so many possible strategies.

Bertrand Game Profits

- Profits depend on the strategy profile $\langle P_A, P_B \rangle$.
- What are the profits, Y_A and Y_B, for the profile $\langle 30, 30 \rangle$?

\$30 *\$30*

- *A* and *B* are charging the same price, so they split the demand at *5* each.
- Each firm's profit on each unit is $30 - 10 = 20$, …
- so total profits are $Y_A = 100$ and $Y_B = 100$.

Bertrand Game Price Setting

- Suppose now that ***A*** cuts her price by $1 to create the profile ⟨**29**, **30**⟩. What are the profits, Y_A and Y_B, now?
  - ***A*** is charging a little less than ***B*** is, so ***A*** gets all the demand.
  - ***A***'s profit on each unit is ***29 − 10 = 19,*** and he sells ***10*** units for a total profit of $Y_A = 190$ *(compared with* $Y_A = 100$ *at* ⟨**30**, **30**⟩*).*
  - ***B*** is charging more than ***A***, so ***B*** has no sales and his profits are $Y_B = 0$.
  - ***A*** earns a lot more profits by charging slightly less than ***B***.

Equilibrium of the Bertrand Game

- A strategy profile ⟨P_A, P_B⟩ is a Nash equilibrium if
  - P_A is ***A***'s best response to P_B, and
  - P_B is ***B***'s best response to P_A.
- ***A***'s best response to ***B*** is to undercut (charge slightly less than) ***B***,…
- …and ***B***'s best response to ***A*** is to undercut ***A***.
- This means ⟨P_A, P_B⟩ cannot be an equilibrium if either price can be undercut profitably.
  - Each player would want to deviate and undercut the other one,…
  - …so the only possible equilibrium is ⟨***10***, ***10***⟩. Since ***AC ≡ MC ≡ 10***, neither player can undercut the other one without losing money.

- At the strategy profile ⟨**10**, **10**⟩, both firms have **0** profits because ***P* = *AC***.
  - But 10 is a best response to 10 because neither player can earn positive profits by deviating.
  - Therefore, ⟨**10**, **10**⟩ is an equilibrium—the only equilibrium.
- In a Bertrand game, a small number of firms producing the same product compete by setting prices.
- The equilibrium of the price-setting game is like the long-run equilibrium of perfect competition:
  - ***P* = *AC* = *MC***
  - Social surplus is maximized.
  - Economic profits are 0.

The Bertrand model and the real world

- Does the Bertrand model make sense?
  - In equilibrium, all firms charge **AC**, so each firm earns **0** profits.
  - So firms would be no worse off by raising their prices, just in case the other firms do the same.
  - Maybe all firms will coordinate on a price above **MC**.
  - But there might be a tendency to cut prices afterwards.

    Does the Bertrand model make sense? Maybe.
- Do real firms behave like firms in the Bertrand model?
  - Sometimes we see "price wars" in which firms end up setting prices at marginal cost.

    Do real firms behave this way? Maybe.

Clicker Question

In the previous Bertrand game, with ***MC = AC = 10***, and consumers that buy a total of ***10*** units, what are profits for the strategy profile ⟨**15, 15**⟩ ?

a. 0, 0

b. 0, 200

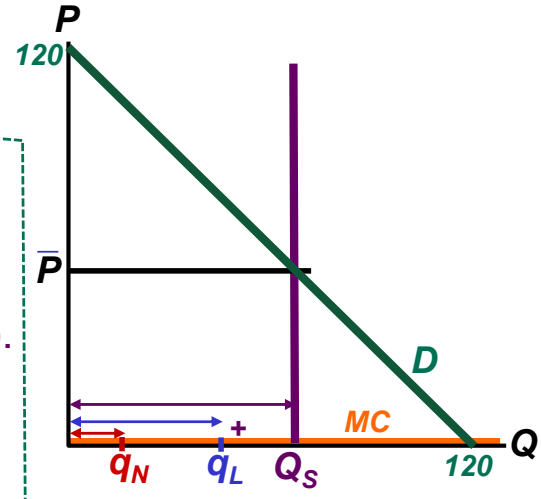
c. 25, 25

d. 75, 75

A Cournot Duopoly

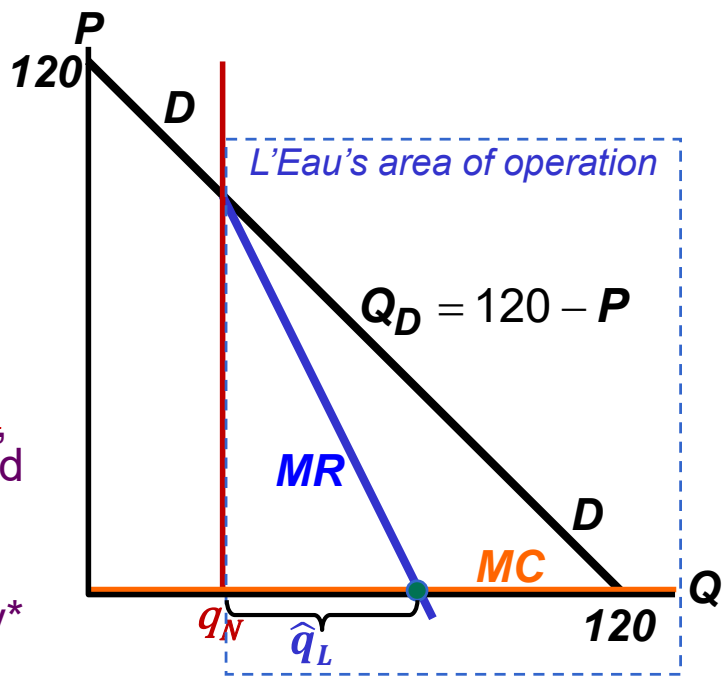
- French consumers like spring water.
- Two French firms ***L'Eau*** and ***N'Eau*** produce spring water and compete by setting quantities.
  - The two brands are perfect substitutes — no one can tell the difference.
  - Each firm decides the quantity it will produce (its strategy),…
  - …and their strategies determine the total quantity supplied.
  - The firms are price takers.
  - They accept the price that sets the total quantity supplied equal to the quantity demanded by French consumers.
- In setting its quantities, each firm must consider the quantity that the other firm is producing.

Example: A Cournot Game



- Suppose the market demand for spring water is $Q_D = 120 - P$.
- Each firm sets its own quantity.
  - *L'Eau* selects q_L (*L'Eau*'s strategy).
  - *N'Eau* selects q_N (*N'Eau*'s strategy).
- The total quantity supplied in the market is $Q_S \equiv q_L + q_N$
- For the strategy profile $\langle q_L, q_N \rangle$, what price $\bar{P}$ causes the quantity demanded Q_D to equal the quantity supplied Q_S?
  - $Q_S = Q_D$
  - $q_L + q_N = 120 - P$
  - Solving for P gives us the market price: $\bar{P} = 120 - (q_L + q_N)$.
- Spring water comes out of the ground, and we assume it costs nothing to produce, so $AC \equiv MC \equiv 0$.

- Suppose *N'Eau*'s strategy is to produce quantity q_N.
- What is *L'Eau*'s profit-maximizing (best) response?
  - *L'Eau* cannot control q_N, so his demand curve and marginal revenue curve begin at q_N.
  - *MR* crosses *MC* halfway* between q_N and *120*,…



  - so *L'Eau*'s best response to q_N is $\hat{q}_L = \frac{1}{2}(120 - q_N)$.
  - Likewise, *N'Eau*'s best response to q_L must be $\hat{q}_N = \frac{1}{2}(120 - q_L)$.

*If D is a straight line, the slope of MR is twice the slope of D.

Equilibrium of the Cournot Game

- How can we find the equilibrium of the Cournot game?
- If $\langle q_L^*, q_N^* \rangle$ is an equilibrium, then q_L^* must be a best response to q_N^* and *vice versa*.
- The best-response equations must be satisfied:

$$q_L^* = \frac{1}{2}(120 - q_N^*)$$

$$q_N^* = \frac{1}{2}(120 - q_L^*)$$

- We solve for the unknowns, q_L^* and q_N^*. By substitution,

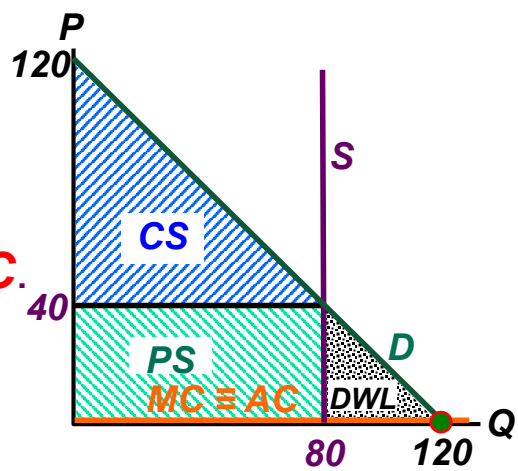
$$q_N^* = \frac{1}{2}(120 - \frac{1}{2}(120 - q_N^*)) \qquad 3q_N^* = 120$$

$$4q_N^* = 2(120 - \frac{1}{2}(120 - q_N^*)) \qquad q_N^* = 40$$

$$4q_N^* = 240 - 120 + q_N^* \qquad q_L^* = \frac{1}{2}(120 - 40) = 40$$

Cournot Equilibrium Properties

- Is the Cournot equilibrium efficient?
  - We know that the total quantity supplied is $Q_S^* = q_L^* + q_N^* = 40 + 40 = 80$.
  - But ***80*** is only ***2/3*** of the efficient level of output ***120***, with $P^* = MC$.
  - Cournot equilibrium is NOT efficient!



- For this example, $P^* = 120 - Q_S^* = 120 - 80 = 40$.
- And we have
  - producer surplus,
  - consumer surplus,
  - and deadweight loss.

Efficiency with Many Cournot Competitors

- If the market demand curve is a downward-sloping straight line, and ***MC*** is constant, then
  - a monopoly would produce ***1/2*** of the efficient (competitive) level of output.
  - ***2*** Cournot competitors would produce a total of ***2/3*** of the efficient (competitive) level of output.
  - ***3*** Cournot competitors would produce a total of ***3/4*** of the efficient (competitive) level of output.
  - ***99*** Cournot competitors would produce a total of ***99/100*** of the efficient (competitive) level of output.
- **Conclusion:** A very large number of Cournot competitors behave like perfect competitors and are almost efficient.
  - This is because they are price takers.

The Cournot model and the real world

- Does the Cournot model make sense?
  - If the price is greater than **AC**, why doesn't one firm cut its price and take the whole market away from other firms?
  - Perhaps there is fear of starting a price war.
  - Or maybe after the firms set their quantities, they don't have the capacity produce more… *See Kreps & Scheinkman, 1983*
  - …so cutting prices would be useless.

    Does the Cournot model make sense? Maybe.
- Do real firms behave like firms in the Cournot model?
  - Sometimes firms choose their size and continue to produce the same quantity even if prices change.

    Do real firms behave this way? Maybe.

The Nash-Equilibrium Concept

- A strategy profile is a Nash equilibrium is each player's strategy is a best response to the strategies of the other players.

- In equilibrium, after finding out what the other players have done, each player is happy with the strategy that she chose.
  - If any player has regrets, then the strategy profile is not an equilibrium.

- We can think about a Nash equilibrium like this:
  - Each player chooses a best response to what she believes will be the strategies of the other players.
  - And her ***beliefs*** about the strategies of other players turn out to be correct. ***But why should her beliefs turn out to be correct???***

Monopolistic Competition

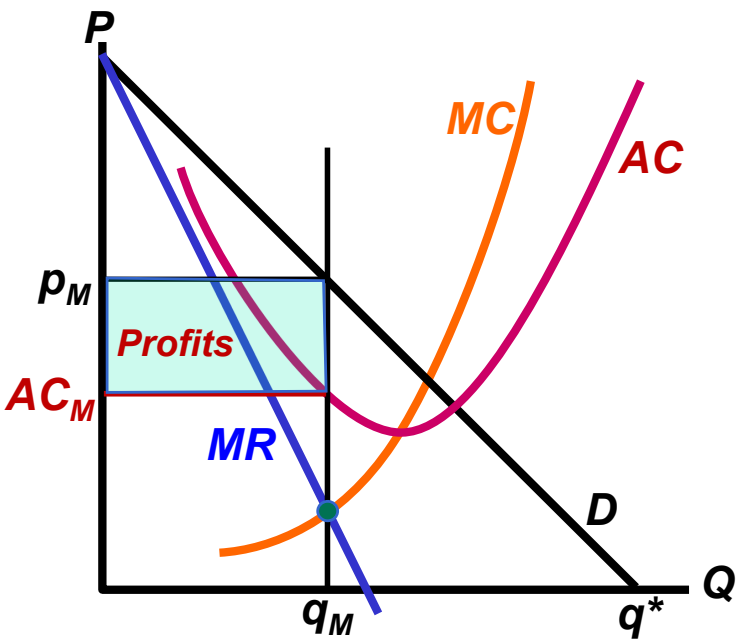
- Monopolistic competition describes a market in which firms produce differentiated products.

- These products are substitutes in consumption, but not perfect substitutes.

- **Example:** Thai restaurants in Brookline.

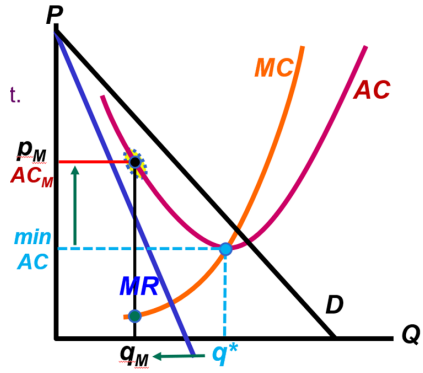
- In the short run, monopolistically competitive firms behave like monopolies.
  - Instead of producing all units with marginal cost less than price (as in perfect competition),
  - they produce only those units with marginal cost less than marginal revenue (as a monopoly does).
- But in the long run, monopolistically competitive markets have free entry.
  - Firms enter the market when profits are available,…
  - …and exit when they are faced with losses.
  - In long-run equilibrium, firms receive zero economic profits.
- Because there are a large number of small firms, each firm has little effect on the market. Therefore, monopolistic competitors do not interact strategically.

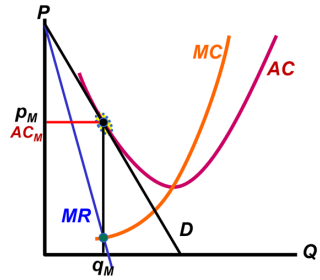
- In the short run, a monopolistic competitor
  - produces until ***MR* = *MC***,
  - sets price at the demand curve,
  - and if price exceeds average cost, the firm receives monopoly profits.
- But if firms have **positive** profits,…



- …then, in the long run, more firms will enter and take market share from existing firms.

- As entry occurs,
  - ***demand*** and ***MR*** shift left, because each firm is getting a smaller share of the market.
- Suppose the firm sets output q_M where demand is tangent to the ***AC*** curve.
  - At output q_M, ***MR*** = ***MC***,
  - $p_M = AC_M$
  - and profits are zero.
- This is the long-run equilibrium because no more firms will enter.





- In the long-run equilibrium of monopolistic competition,
  - firms produce at an average cost greater than the minimum average cost…,
  - … because there are too many firms,…
  - … each producing at an inefficiently low level.

Examples: Monopolistic Competition

- Lawyers
  - Too many places in law schools
  - High priced legal services
  - Too many lawyers with not enough clients
  - Many lawyers take other jobs.
- Beauty shops: hair, nails
  - Too many beauty shops
  - Many specialize in manicures and pedicures.
  - Not enough customers most of the time

Clicker Question

In the long-run equilibrium of monopolistic competition,

a. there are too many firms.
b. each firm produces at an inefficiently low level.
c. economic profits are zero.
d. ALL of the above

End of Lecture 22