Lecture 22. Oligopoly & Monopolistic Competition

Course Evaluations on Thursday:

Be sure to bring laptop, smartphone, or tablet with browser, so that you can complete your evaluation in class.

Clicker Question

Nash equilibrium in the fiat-money game?

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Oligopoly

- 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 ***Bertrand duopoly***, in which the firms compete by setting prices.
  - Then we model ***Cournot duopoly***, in which the firms compete by setting output quantities.

A Bertrand Duopoly

- Two firms, ***Aux (A)*** and ***Beaux (B)***, each produce French white wine.
  - The two brands are perfect substitutes — no one can tell the difference.
  - Each firm sets a price,…
  - and then sells the quantity that consumers demand.
- 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.
  - 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.
- The profit of each firm is its payoff.

Note: we will not be able to use the game matrix as before, because each player has so many possible strategies.

Bertrand Game Profits

- Profits depend on the strategy profile ⟨P_A, P_B ⟩.
- What are the profits, Y_A and Y_B, for the profile ⟨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*.
  - *B* is charging more than *A*, so *B* has no sales and his profits are Y_B = *0*.
  - *A* earns more profits by charging slightly less than *B*.

Equilibrium of the Bertrand Game

- A strategy profile $\langle P_A, P_B \rangle$ 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.
- In general, A's best response to B is to undercut (charge slightly less than) B.
- But if each strategy in $\langle P_A, P_B \rangle$ is a best response to the other,
  - then if $P_A, P_B > 10$ (the minimum price), each must charge slightly less than the other, which is impossible,
  - so that there cannot be an equilibrium with $P_A, P_B > 10$.
  - The only possible equilibrium is $\langle 10, 10 \rangle$, where each player cannot undercut the other without losing money.

- At the strategy profile $\langle 10, 10 \rangle$, 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, $\langle 10, 10 \rangle$ 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 equilibrium of perfect competition:
  - $P = MC$
  - Social surplus is maximized.
  - Economic profits are 0.

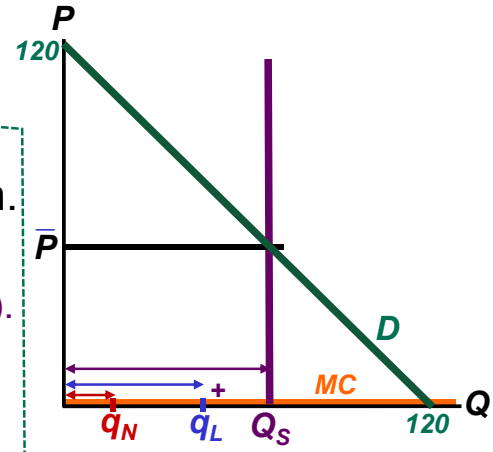
Clicker Question

In the previous Bertrand game, with ***MC = AC = 10***, and consumers that buy a total of ***10*** units…?

A Cournot Duopoly

- Two French firms ***L'Eau*** and ***N'Eau*** produce spring water.
  - The two brands are perfect substitutes — no one can tell the difference.
  - Each firm decides how much to produce,
  - and then sells its water at the market-clearing price (no excess demand or supply).
- In setting their quantities, each firm must consider how much the other firm is producing.

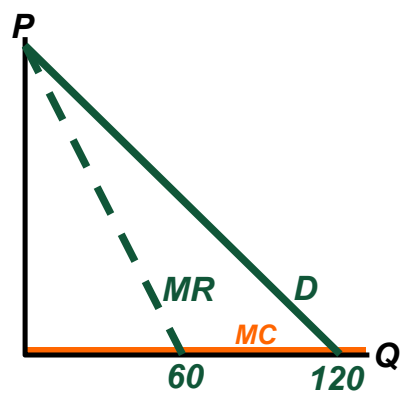
Example: A Cournot Game



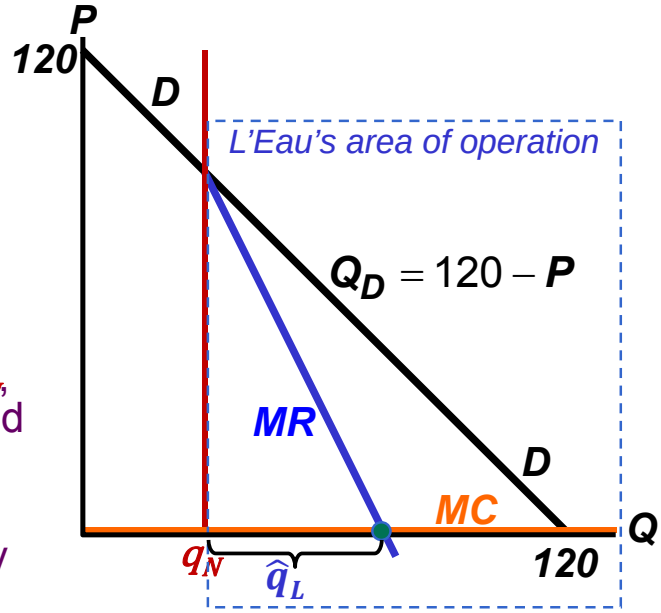
- The market demand curve for mineral water is $Q_D = 120 - P$.
- Each firm sets its own production.
  - *L'Eau* selects q_L (*L'Eau*'s strategy).
  - *N'Eau* selects q_N (*N'Eau*'s strategy).
- The total quantity supplied in the market is $Q_S \equiv q_L + q_N$
- For the strategy profile $\langle q_L,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

Clicker Question

If $AC \equiv MC \equiv 0$, what level of total production Q_S would maximize…?



- 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:

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

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

- By substitution,

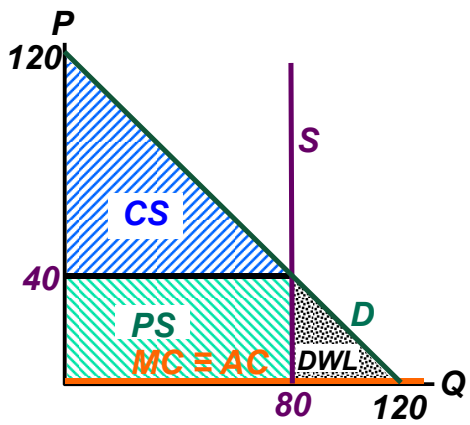
$$q_N^* = \frac{1}{2}(120 - \frac{1}{2}(120 - q_N^*)) \qquad 3q_N^* = 120$$

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

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

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 the efficient level of output is **120**.
  - Cournot equilibrium is NOT efficient!



- $P^* = 120 - Q_S^* = 120 - 80 = 40 >$ AC, MC.
- We can now show
  - 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.

Does Bertrand or Cournot Make Sense?

- Bertrand competition?
  - 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.
- Cournot competition?
  - 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.
  - Maybe it's better to let the market set prices.
- There are many variations of these models.

The Nash-Equilibrium Concept

- In equilibrium, after finding out what the other players have done, each player is happy with the strategy that she chose.
  - If there are 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.

Using Nash Equilibrium to Predict

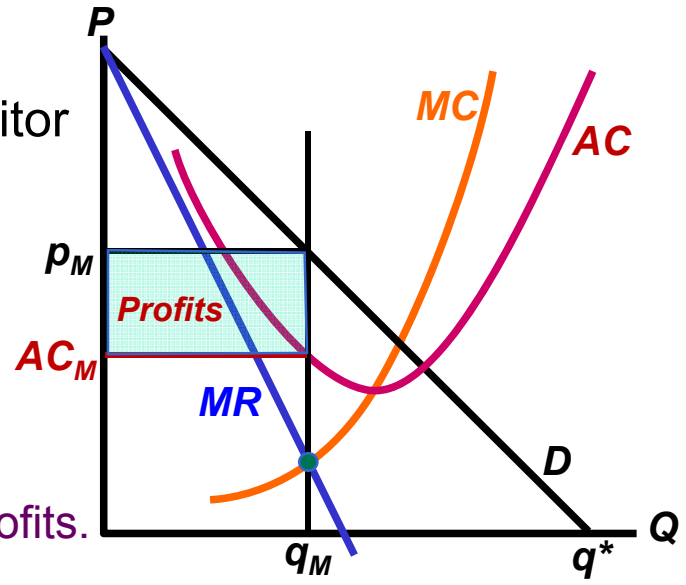
- A problem with the Nash-equilibrium concept is that the formation of beliefs about the strategies of other players is not explained.
  - In particular, it isn't always clear why beliefs about the strategies of other players ought to be correct.
  - If players have incorrect beliefs, there's no reason that they would choose Nash-equilibrium strategies,…
  - …although if players choose strategies that yield a Nash equilibrium, they would be likely to stay there.
  - (Accurate beliefs are easy to form if each player has a strictly dominant strategy, but that isn't a common situation.)
- In the next lecture we will introduce a new equilibrium concept in which beliefs are less important,…
- …because the new concept applies to situations in which players have more information about the strategies of others.

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.

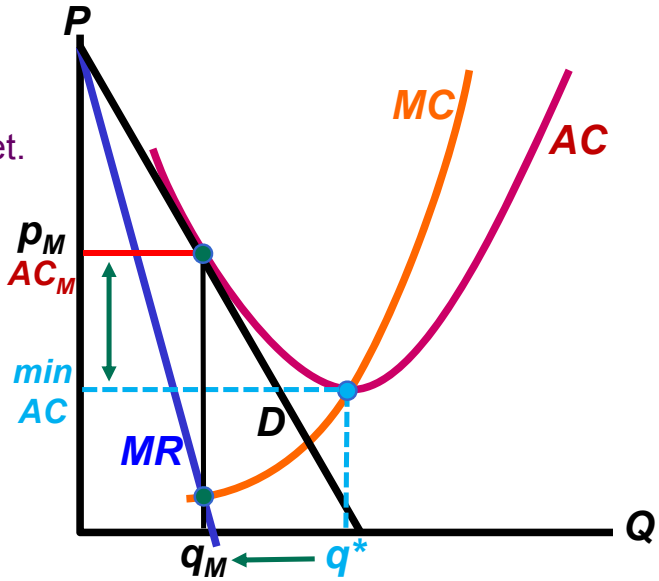
- In the short run, monopolistically competitive firms behave like monopolies.
  - Instead of producing all units with marginal cost less than price (as in perfect competition),
  - they produce only those units with marginal cost less than marginal revenue (as a monopoly does).
- But in the long run, monopolistic competition has free entry, much like perfect competition.
  - Firms enter the market when economic profits are available,
  - and exit when they are faced with losses.
  - In long-run equilibrium, firms receive zero economic profits.
- Monopolistic competitors do not interact strategically, because each firm cares only about the general price level, not about the strategies of individual firms.

- 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.
- When 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,

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