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?

\[
\begin{array}{c|cc}
& A & R \\
\hline
A & 1 & 0 \\
Ma & 1 & -1 \\
R & -1 & 0 \\
\end{array}
\]

Huang
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.

Each firm has a constant marginal cost and no fixed cost, and $AC = MC = 10$.

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.
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 \( \langle 30, 30 \rangle \)?
  - \( A \) 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 \( \langle 29, 30 \rangle \). 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 \( Q_S \)?
  - \( Q_S = Q_D \)
  - \( q_L + q_N = 120 - \bar{P} \)
  - Solving the above for \( \bar{P} \) 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 $D$."

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**Equilibrium of the Cournot Game**

How can we find the equilibrium of the Cournot game?

If $(q_L^*, q_N^*)$ 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,

$$3 q_N^* = 120$$

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

$$4 q_N^* = 240 - 120 + q_N^*$$

$$q_N^* = 40$$

$$q_L^* = \frac{1}{2} (120 - 40) = 40$$
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.

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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 \( q_M \), \( MR = MC \),
- \( p_M = ACM \)
- 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,