Economics 101A
(Lecture 23)

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Outline

1. Dynamic Games
2. Oligopoly: Stackelberg
3. General Equilibrium: Introduction
4. Edgeworth Box: Pure Exchange
5. Barter

1 Dynamic Games

- Nicholson, Ch. 8, pp. 268-277

- Dynamic games: one player plays after the other

- Decision trees
  - Decision nodes
  - Strategy is a plan of action at each decision node

- Example: battle of the sexes game

She \ He	Ballet	Football
Ballet	$2, 1$	$0, 0$
Football	$0, 0$	$1, 2$

- Dynamic version: she plays first

- **Subgame-perfect equilibrium.** At each node of the tree, the player chooses the strategy with the highest payoff, given the other players' strategy

- Backward induction. Find optimal action in last period and then work backward

- Solution

- Example 2: Entry Game

$1 \setminus 2$	Enter	Do not Enter
Enter	$-1, -1$	$10, 0$
Do not Enter	$0, 5$	$0, 0$

- Exercise. Dynamic version.

- Coordination games solved if one player plays first

- Can use this to study finitely repeated games

- Suppose we play the prisoner's dilemma game ten times.

$1 \setminus 2$	D	ND
D	$-4, -4$	$-1, -5$
ND	$-5, -1$	$-2, -2$

- What is the subgame perfect equilibrium?

- The result differs if infinite repetition with a probability of terminating

- Can have cooperation

- Strategy of repeated game:

  - Cooperate (ND) as long as opponent always cooperate

  - Defect (D) forever after first defection

- Theory of repeated games: Econ. 104

2 Oligopoly: Stackelberg

- Nicholson, Ch. 15, pp. 552-554
- Setting as in problem set
- 2 Firms
- Cost: $c(y) = cy$, with $c > 0$
- Demand: $p(Y) = a - bY$, with $a > c > 0$ and $b > 0$
- Difference: Firm 1 makes the quantity decision first
- Use subgame perfect equilibrium

- Solution:

- Solve first for Firm 2 decision as function of Firm 1 decision:

$$\max_{y_2} (a - by_2 - by_1^*) \, y_2 - cy_2$$

- F.o.c.:$a - 2by_2^* - by_1^* - c = 0$

- Firm 2 best response function:

$$y_2^* = \frac{a-c}{2b} - \frac{y_1^*}{2}.$$

- Firm 1 takes this response into account in the maximization:

$$\max_{y_1} \left(a - by_1 - by_2^*\left(y_1\right)\right) y_1 - cy_1$$

or

$$\max_{y_1} \left(a - by_1 - b\left(\frac{a-c}{2b} - \frac{y_1}{2}\right)\right) y_1 - cy_1$$

- F.o.c.:

$$a - 2by_1 - \frac{(a-c)}{2} + by_1 - c = 0$$

or

$$y_1^* = \frac{a-c}{2b}$$

and

$$y_2^* = \frac{a-c}{2b} - \frac{y_1^*}{2} = \frac{a-c}{2b} - \frac{a-c}{4b} = \frac{a-c}{4b}.$$

- Total production:

$$Y_D^* = y_1^* + y_2^* = 3\frac{a-c}{4b}$$

- Price equals

$$p^* = a - b\left(\frac{3}{4}\frac{a-c}{b}\right) = \frac{1}{4}a + \frac{3}{4}c$$

- Compare to monopoly:

$$y_M^* = \frac{a-c}{2b}$$

and

$$p_M^* = \frac{a+c}{2}.$$

- Compare to Cournot:

$$Y_D^* = y_1^* + y_2^* = 2\frac{a-c}{3b}$$

and

$$p_D^* = \frac{1}{3}a + \frac{2}{3}c.$$

- Compare with Cournot outcome

- Firm 2 best response function:

$$y_2^* = \frac{a-c}{2b} - \frac{y_1^*}{2}$$

- Firm 1 best response function:

$$y_1^* = \frac{a-c}{2b} - \frac{y_2^*}{2}$$

- Intersection gives Cournot

- Stackelberg: Equilibrium is point on Best Response of Firm 2 that maximizes profits of Firm 1

- Plot iso-profit curve of Firm 1:

$$\bar{\Pi}_1 = (a - c)\, y_1 - b y_1 y_2 - b y_1^2$$

- Solve for y_2 along iso-profit:

$$y_2 = \frac{a-c}{b} - y_1 - \frac{\bar{\Pi}_1}{b y_1}$$

- Iso-profit curve is flat for

$$\frac{dy_2}{dy_1} = -1 + \frac{\bar{\Pi}}{b\,(y_1)^2} = 0$$

or

$$y_1 =$$

Figure

3 General Equilibrium: Introduction

- So far, we looked at consumers
  - Demand for goods
  - Choice of leisure and work
  - Choice of risky activities

- We also looked at producers:
  - Production in perfectly competitive firm
  - Production in monopoly
  - Production in oligopoly

- We also combined consumers and producers:
  - Supply
  - Demand
  - Market equilibrium
- Partial equilibrium: one good at a time
- General equilibrium: Demand and supply for all goods!
  - supply of young worker$\uparrow \Longrightarrow$ wage of experienced workers?
  - minimum wage$\uparrow \Longrightarrow$ effect on higher earners?
  - steel tariff$\uparrow \Longrightarrow$ effect on car price

4 Edgeworth Box: Pure Exchange

- Nicholson, Ch. 13, pp. 458-460

- 2 consumers in economy: $i = 1, 2$

- 2 goods, x_1, x_2

- Endowment of consumer i, good j: ω_j^i

- Total endowment: $(\omega_1, \omega_2) = (\omega_1^1 + \omega_1^2, \omega_2^1 + \omega_2^2)$

- No production here. With production (as in book), (ω_1, ω_2) are optimally produced

- Edgeworth box

- Draw preferences of agent 1

- Draw preferences of agent 2

- Consumption of consumer i, good j: x_j^i

- Feasible consumption:

$$x_i^1 + x_i^2 \leq \omega_i \text{ for all } i$$

- If preferences monotonic, $x_i^1 + x_i^2 = \omega_i$ for all i

- Can map consumption levels into box

5 Barter

- Consumers can trade goods 1 and 2

- Allocation $\left((x_1^{1*}, x_2^{1*}), (x_1^{2*}, x_2^{2*})\right)$ can be outcome of barter if:

- **Individual rationality.**

$$u_i(x_1^{i*}, x_2^{i*}) \geq u_i(\omega_1^i, \omega_2^i) \text{ for all } i$$

- **Pareto Efficiency.** There is no allocation $\left((\hat{x}_1^1, \hat{x}_2^1), (\hat{x}_1^2, \hat{x}_2^2)\right)$ such that

$$u_i(\hat{x}_1^i, \hat{x}_2^i) \geq u_i(x_1^{i*}, x_2^{i*}) \text{ for all } i$$

with strict inequality for at least one agent.

- Barter outcomes in Edgeworth box

- Endowments (ω_1, ω_2)

- Area that satisfies individual rationality condition

- Points that satisfy pareto efficiency

- **Pareto set.** Set of points where indifference curves are tangent

- **Contract curve.** Subset of Pareto set inside the individually rational area.

- Contract curve = Set of barter equilibria

- Multiple equilibria. Depends on bargaining power.

- Bargaining is time- and information-intensive procedure

- What if there are prices instead?

6 Next lecture

- Example of Walrasian Equilibrium

- Theorems on welfare