

# Economics 101A

## (Lecture 22)

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## Outline

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

# 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 \ 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:

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

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

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

- 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 $\uparrow$   $\implies$  wage of experienced workers?
  - minimum wage $\uparrow$   $\implies$  effect on higher earners?
  - steel tariff $\uparrow$   $\implies$  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  $j$ :  $\omega_j^i$
- 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),  $(\omega_1, \omega_2)$  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 Next lecture

- General Equilibrium
- Barter