Economics 101A
(Lecture 23)

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Outline

1. Stackelberg II
2. General Equilibrium: Introduction
3. Edgeworth Box: Pure Exchange
4. Barter
5. Walrasian Equilibrium
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1 Stackelberg II

- 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:

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

- Solve for y_1 along iso-profit:

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

- Iso-profit curve is flat for

$$\frac{dy_1}{dy_2} = -1 + \frac{\bar{\Pi}}{b\,(y_2)^2} = 0$$

or

$$y_2 =$$

- Figure

2 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

3 Edgeworth Box: Pure Exchange

- Nicholson, Ch. 12, pp. 335–338, 369–370 [OLD: Ch. 16, pp. 422-425]

- 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

4 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?

5 Walrasian Equilibrium

- Prices p_1, p_2

- Consumer 1 faces a budget set:

$$p_1 x_1^1 + p_2 x_2^1 \leq p_1 \omega_1^1 + p_2 \omega_2^1$$

- How about consumer 2?

- Budget set of consumer 2:

$$p_1 x_1^2 + p_2 x_2^2 \leq p_1 \omega_1^2 + p_2 \omega_2^2$$

or (assuming $x_i^1 + x_i^2 = \omega_i$)

$$p_1(\omega_1 - x_1^1) + p_2 \left(\omega_1 - x_2^1\right) \leq p_1 \left(\omega_1 - \omega_1^1\right) + p_2 \left(\omega_2 - \omega_2^1\right)$$

or

$$p_1 x_1^1 + p_2 x_2^1 \geq p_1 \omega_1^1 + p_2 \omega_2^1$$

- **Walrasian Equilibrium.** $\left((x_1^{1*}, x_2^{1*}), (x_1^{2*}, x_2^{2*}), p_1^*, p_2^*\right)$ is a Walrasian Equilibrium if:

  - Each consumer maximizes utility subject to budget constraint:

$$\begin{aligned} (x_1^{i*}, x_2^{i*}) &= \arg\max_{x_1^i, x_2^i} u_i\left((x_1^i, x_2^i)\right) \\ s.t.\ p_1^* x_1^i + p_2^* x_2^i &\leq p_1^* \omega_1^i + p_2^* \omega_2^i \end{aligned}$$

  - All markets clear:

$$x_j^{1*} + x_j^{2*} \leq \omega_j^1 + \omega_j^2 \text{ for all } j.$$

- Compare with partial (Marshallian) equilibrium:
  - each consumer maximizes utility
  - market for good i clears.
  - (no requirement that all markets clear)

- How do we find the Walrasian Equilibria?

- **Graphical method.**

  1. Compute first for each consumer set of utility-maximizing points as function of prices

  2. Check that market-clearing condition holds

- *Step 1.* Compute optimal points as prices p_1 and p_2 vary

- Start with Consumer 1. Find points of tangency between budget sets and indifference curves

- Figure

- **Offer curve** for consumer 1:

$$\left(x_1^{1*}\left(p_1, p_2, (\omega_1, \omega_2)\right), x_2^{1*}\left(p_1, p_2, (\omega_1, \omega_2)\right)\right)$$

- Offer curve is set of points that maximize utility as function of prices p_1 and p_2.

- Then find offer curve for consumer 2:

$$\left(x_1^{2*}\left(p_1, p_2, (\omega_1, \omega_2)\right), x_2^{2*}\left(p_1, p_2, (\omega_1, \omega_2)\right)\right)$$

- Figure

- *Step 2.* Find intersection(s) of two offer curves

- Walrasian Equilibrium is intersection of the two offer curves!
  - Both individuals maximize utility given prices
  - Total quantity demanded equals total endowment

- Relate Walrasian Equilibrium to barter equilbrium.

- Walrasian Equilibrium is a subset of barter equilibrium:
  - Does WE satisfy Individual Rationality condition?
  - Does WE satisfy the Pareto Efficiency condition?

- Walrasian Equilibrium therefore picks one (or more) point(s) on contract curve.

6 Example

- Consumer 1 has Leontieff preferences:

$$u(x_{1,}x_2) = \min\left(x_1^1, x_2^1\right)$$

- Bundle demanded by consumer 1:

$$\begin{aligned} x_1^{1*} &= x_2^{1*} = x^{1*} = \frac{p_1\omega_1^1 + p_2\omega_2^1}{p_1 + p_2} = \\ &= \frac{\omega_1^1 + (p_2/p_1)\,\omega_2^1}{1 + (p_2/p_1)} \end{aligned}$$

- Notice: Only ratio of prices matters (general feature)

- Consumer 2 has Cobb-Douglas preferences:

$$u(x_{1,}x_2) = \left(x_1^2\right)^{.5}\left(x_2^2\right)^{.5}$$

- Demands of consumer 2:

$$x_1^{2*} = \frac{.5\left(p_1\omega_1^1 + p_2\omega_2^1\right)}{p_1} = .5\left(\omega_1^1 + \frac{p_2}{p_1}\omega_2^1\right)$$

and

$$x_2^{2*} = \frac{.5\left(p_1\omega_1^1 + p_2\omega_2^1\right)}{p_2} = .5\left(\frac{p_1}{p_2}\omega_1^1 + \omega_2^1\right)$$

- Impose Walrasian equilibrium in market 1:

$$x_1^{1*} + x_1^{2*} = \omega_1^1 + \omega_1^2$$

This implies

$$\frac{\omega_1^1 + (p_2/p_1)\,\omega_2^1}{1 + (p_2/p_1)} + .5\left(\omega_1^1 + \frac{p_2}{p_1}\omega_2^1\right) = \omega_1^1 + \omega_1^2$$

or

$$\frac{.5 - .5\,(p_2/p_1)}{1 + (p_2/p_1)}\omega_1^1 + \frac{.5\,(p_2/p_1) + .5\,(p_2/p_1)^2 - 1}{1 + (p_2/p_1)}\omega_2^1 = 0$$

or

$$\left(\omega_1^1 - 2\omega_2^1\right) + \left(\omega_1^1 + \omega_2^1\right)(p_2/p_1) + \omega_2^1\,(p_2/p_1)^2 = 0$$

- Solution for p_2/p_1:

$$\frac{p_2}{p_1} = \frac{-\left(\omega_1^1 - 2\omega_2^1\right) + \sqrt{\begin{array}{c}\left(\omega_1^1 + \omega_2^1\right)^2 \\ -4\left(\omega_1^1 - 2\omega_2^1\right)\omega_2^1\end{array}}}{2\left(\omega_1^1 - 2\omega_2^1\right)}$$

- Some complicated solution!

- Problem set has solution that is much easier to compute (and interpret)