Competitive Equilibrium

Econ 2100 Fall 2018

Lecture 16, October 24

Outline

1. Competitive (Walrasian) Equilibrium

Decentralized vs. Centralized Economic Systems

- So far, outcomes for an economy have been some sort of 'top-down' issue.
- Someone, somewhere, somehow, tells all consumers and firms what to do.
- This is sometimes called a "centralized" economic system.
- Next, we introduce a "decentralized" economic system: individuals are free to to choose what they want (given the constraints they face).
- The idea is that all transactions take place simultaneously in a place called the market.
- There, consumers sell their initial endowment and buy consumption bundles, while firms buy inputs and sell outputs.
- The main notion is that of a competitive (Walrasian) equilibrium. It is defined in three pieces: consumers maximize utility, firms maximize profits, and markets clear.

Markets

- We assume there is a maket for each of the L goods.
    - In these markets, goods can be bought and sold in infinitesimaly quantities.
- There is a unit of account for evaluating purchases and sales that may be thought of as money.
- The price of commodity l in terms of the unit of account is denoted by p_l.
- A price vector is p. No price can be negative, and at least one price must be positive: $p \in \mathbb{R}_+^L$.
    - Given prices $p \in \mathbb{R}_+^L$, the cost of consumption bundle $x \in \mathbb{R}_+^L$ is

$$p \cdot x = \sum_{l=1}^{L} p_l x_l \geq 0$$

    - Given prices $p \in \mathbb{R}_+^L$, the profits of a production vector $y \in Y \subset \mathbb{R}^L$ are

$$p \cdot y = \sum_{l=1}^{L} p_l y_l$$

        - This can be negative.

Markets, Choices, and Equilibrium

- Agents (consumers and firms) trading in the markets take the prices as given. From their point of view, p is fixed.

Given a price vector p:

- Each firm j maximizes profits, and thus chooses an output vector y_j^* from its supply correspondence:

$$y_j^* \in y_j^*(p) = \left\{ y \in Y_j : p^* \cdot y_j^* \geq p \cdot y \right\}$$

- Each consumer i maximizes her preferences, and thus chooses a consumption bundle x_i^* from her Walrasian demand correspondence:

$$x_i^* \in x_i^*(p) = \{ x_i^* \in B_i(p) : x_i^* \succsim_i x_i \quad \text{for each } x_i \in B_i(p) \}$$

  where

$$B_i(p) = \left\{ x \in \mathbb{R}_+^L : p \cdot x \leq p \cdot \omega_i + \sum_{j=1}^{J} \theta_{ij}(p \cdot y_j^*) \text{ where } y_j^* \in y_j^*(p) \right\}$$

  - *Consumers derive income from the profits of the firms they own, and from selling their initial endowment.*

- Equilibrium takes care of finding the "right" price vector: the price vector that makes all these independent choices mutually consistent.

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Competitive (Walrasian) Equilibrium

Definition

Given an economy $\{X_i, \succsim_i, \omega_i, \theta_i\}_{i=1}^{I}, \{Y_j\}_{j=1}^{J}$, a competitive (Walrasian) equilibrium is formed by an allocation $(x^*, y^*) \in \mathbb{R}^{L(I+J)}$ and a price vector $p^* \in \mathbb{R}_+^L$ such that:

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1. Firms' choices are optimal given the equilibrium prices;
2. Consumers' choices are optimal given the equilibrium prices; and
3. Demand cannot exceed supply, and if demand is strictly less then supply the corresponding good must be free.

Remark

- Equilibrium prices make $J + I$ optimization problems 'mutually compatible'.

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- If (x^*, y^*) and p^* form a Walrasian equilibrium, so do (x^*, y^*) and αp^*.
- This follows because $y_j^*(\alpha p^*) = y_j^*(p^*)$ and $x_i^*(\alpha p^*) = x_i^*(p^*)$, and the third condition does not change.
  - Since supply and demand are homogeneous of degree zero, only the direction of an equilibrium price vector matters, not its size.
- Thus one can "normalize" prices in different ways: assume one of them equals 1, or assume that their sum equals 1 are typical choices.

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- The zero-price condition, although redundant under some restrictions on preferences, can be important as some goods may not be desirable to consumers. In that case, one wants the price of those goods to be zero.
  - On the other hand, all kind of strange things can happen when the price of some good is zero...
    - Demand of that good (by consumers or firms) could be infinity, for example, thus preventing the existsence of a solution to the optimization problems.

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- There is some magic that is important to understand: prices perform a fantastic role in that they make all the individual decisions mutually compatible.
- If the prices are wrong, everyone can still optimize but demand will be larger than supply.
- Where do these magic prices come from? The model does not say.
  - Adam Smith talks about the "invisible hand", but that is not math.

Competitive (Walrasian) Equilibrium: Examples

- Robinson Crusoe: Equilibrium vs. non Equilibrium
- Exchange Economy: Equilibrium vs. non Equilibrium

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Calculating Competitive Equilibria

- How do we find a competitive equilibirum? In three easy (!) steps.

1. Get $y_j^*(p)$ from the J firms maximization problem.
2. Get $x_i^*(p)$ from the I consumers maximization problem.
3. Find the p^* such that the L inequalities $\sum_{i=1}^{I} x_i^*(p^*) \leq \sum_{i=1}^{I} \omega_i + \sum_{j=1}^{J} y_j^*(p^*)$ are all satisfied (in most cases these will be equalities).

- The last step (if given by equalities) asks you to solve a system of L equations (one per good) in L unknowns (the prices of each good).
- But we know that demand and supply are homogeneous of degree zero, so only relative prices can be found.
- This means we only have $L-1$ unknowns and L equations... not good.
- ... Unless one of the L equations is redundant: homework.

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3. Find the p^* such that the L inequalities $\sum_{i=1}^{I} x_i^*(p^*) \leq \sum_{i=1}^{I} \omega_i + \sum_{j=1}^{J} y_j^*(p^*)$ are all satisfied (in most cases these will be equalities).

- The last step (if given by equalities) asks you to solve a system of L equations (one per good) in L unknowns (the prices of each good).
- But we know that demand and supply are homogeneous of degree zero, so only relative prices can be found.
- This means we only have $L-1$ unknowns and L equations... not good.
- ... Unless one of the L equations is redundant: homework.

Calculating Competitive Equilibria

- How do we find a competitive equilibirum? In three easy (!) steps.

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Next Week

- Comparison of competitive equilibria and Pareto optimal allocations.
- First Welfare Theorem: any competitive equilibrium is Pareto efficient.
- Second Welfare Theorem: any Pareto optimal allocation can be made into a (special) competitive equilibrium.