UNIVERSITY OF COPENHAGEN

Mikro II, lecture 8a

The anatomy of an economic model

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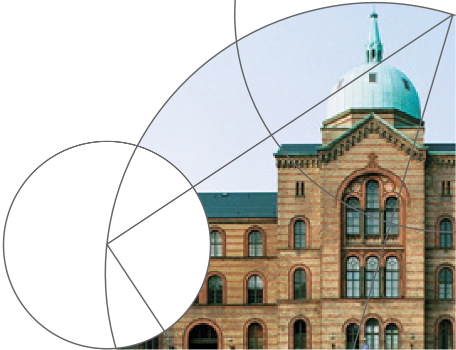

Plan for the lecture

1. Present the anatomy of an economic model
2. Application

Introduction

- Different to Micro I, throughout Micro II we look at a range of different economic models
- We now discuss the anatomy of an economic model (a framework to put different models into) in order to:
  - Clarify the structure, similarities and differences of models
  - Help to understand the solution of models
  - A guide but not a formal mathematical breakdown

Parts of an economic model

- A model is a collection of definitions and assumptions

  1. Technology and Preferences
     - Exogenous variables / functions / relationships: Utility functions, production technology, initial endowments, budget sets, etc.
     - Endogenous variables: Consumption, production and sales, labor supply, etc.

  2. Behavior and Equilibrium
     - Agents' decisions: Maximizing what? With regard to what? What is taken as given? $\Rightarrow$ Solution provides conditional behavior
     - Equilibrium conditions: What should apply such that the agents' decisions are in an equilibrium with each other?

A model's anatomy

Technology and Preferences	Behavior and Equilibrium
Exogenous functions / var. / relationships:	*The decisions of the agents:*
	$\hookrightarrow$ *Conditional behavior:*
Endogenous variables:	
	Equilibrium Conditions:

Example: Edgeworth economy

- Edgeworth economy with 2 goods and 2 consumers with Cobb-Douglas preferences:
  - Two agents: A and B; two goods, 1 and 2; consumption plans: (x_1^A, x_2^A), (x_1^B, x_2^B)
  - Cobb-Douglas utility functions:
    $$u_A(x_1^A, x_2^A) = \left(x_1^A\right)^{\alpha}\left(x_2^A\right)^{1-\alpha} \quad \text{and} \quad u_B(x_1^B, x_2^B) = \left(x_1^B\right)^{\beta}\left(x_2^B\right)^{1-\beta}$$
  - Endowments: (e_1^A, e_2^A), (e_1^B, e_2^B)
  - Possible states (sometimes only implicitly assumed):
    $$e_1^A + e_1^B = x_1^A + x_1^B \quad \text{and} \quad e_2^A + e_2^B = x_2^A + x_2^B$$
    $$x_1^A, x_2^A, x_1^B, x_2^B \geq 0$$

Example: Edgeworth economy

Technology and Preferences	**Behavior and Equilibrium**
Exogenous func./var./relationships: $u_A(x_1^A, x_2^A) = (x_1^A)^{\alpha}(x_2^A)^{1-\alpha}$ $u_B(x_1^B, x_2^B) = (x_1^B)^{\beta}(x_2^B)^{1-\beta}$ $\alpha, \beta, e_1^A, e_2^A, e_1^B, e_2^B$ Restrictions on possible states *Endogenous variables:* $(x_1^A, x_2^A),\ (x_1^B, x_2^B)$	*The decisions of the agents:* $\hookrightarrow$ *Conditional behavior:* *Equilibrium Conditions:*

Interesting analyses are possible already

- Only left side filled: No assumptions about behavior and equilibrium yet
- *Important point*: We can already answer interesting questions:
  - What (possible) states are efficient? (Contract curve)
  - Comparative statics: how does the contract curve change if β increases (or if other parameters change)

Example: Walras equilibrium in an Edgeworth econonomy

- Standard assumptions about behavior and equilibrium: Walras equilibrium
  - Prices p_1, p_2 are taken as given by the agents
  - The agents choose consumption by maximizing utility given prices and budget condition, e.g. for A:

$$\max_{x_1^A, x_2^A} u_A(x_1^A, x_2^A) \quad \text{s.t.} \quad p_1 x_1^A + p_2 x_2^A = p_1 e_1^A + p_2 e_2^A$$

giving rise to demand functions: $x_1^{A*}(p_1, p_2), x_2^{A*}(p_1, p_2)$

  - Prices adjust such that there is equilibrium in the goods markets:

$$x_1^{A*}(p_1^*, p_2^*) + x_1^{B*}(p_1^*, p_2^*) = e_1^A + e_1^B$$
$$x_2^{A*}(p_1^*, p_2^*) + x_2^{B*}(p_1^*, p_2^*) = e_2^A + e_2^B$$

Example: Walras equilibrium in an Edgeworth economy

Technology and Preferences	Behavior and Equilibrium
Exogenous func./var./relationships:	*The decisions of the agents:*
$u_A(x_1^A, x_2^A) = (x_1^A)^{\alpha} (x_2^A)^{1-\alpha}$	A maximizes $u_A(x_1^A, x_2^A)$ wrt.
$u_B(x_1^B, x_2^B) = (x_1^B)^{\beta} (x_2^B)^{1-\beta}$	(x_1^A, x_2^A) given budget and prices
$\alpha, \beta, e_1^A, e_2^A, e_1^B, e_2^B$	B maximizes $u_B(x_1^B, x_2^B)$ wrt.
Restrictions on possible states	(x_1^B, x_2^B) given budget and prices
	$\hookrightarrow$ *Conditional behavior:*
Endogenous variables:	$x_1^{A*}(p_1, p_2), x_2^{A*}(p_1, p_2)$
(x_1^A, x_2^A), (x_1^B, x_2^B)	$x_1^{B*}(p_1, p_2), x_2^{B*}(p_1, p_2)$
$\boldsymbol{p_1, p_2}$	*Equilibrium Conditions:*
	$x_1^{A*}(p_1^*, p_2^*) + x_1^{B*}(p_1^*, p_2^*) = e_1^A + e_1^B$
	$x_2^{A*}(p_1^*, p_2^*) + x_2^{B*}(p_1^*, p_2^*) = e_2^A + e_2^B$

Solution and further analysis

- From the decision assumptions we can derive the demand functions for A and B
- Along with the equilibrium condition, this gives the Walras equilibrium $\Rightarrow$ the model's prediction of what is going to happen
- Can also answer other interesting questions
  - Compare the Walras equilibrium with the efficient states (first welfare theorem)
  - Comparative statics: how does the equilibrium price change if e_1^A increases? What if e_1^B increases?

Socrative Quiz question

Think of the principal agent model in slides 5a in which the principal tries to distinguish between high and low productivity workers. Which of the following is *not* exogenous in the model?

- a) q (fraction of high productivity workers)
- b) $u_H(w_H, e_H)$ (utility function of the high type)
- c) r_L Outside option of the low type
- d) e_L Effort of the low type
- e) $f(e)$ Product of effort

Example: Monopoly with constant MC

- Simple monopoly model from previous monopoly Slides:
  - Price and quantity, p and x
  - Inverse demand: $p(x)$
  - Cost Function $C(x) = c \cdot x$

Monopoly with constant MC I

Technology and Preferences	**Behavior and Equilibrium**
Exogenous func./var./relationships: $p(x), C(x) = c \cdot x$ c (implicitly also $x \geq 0$) *Endogenous variables:* x, p	*The decisions of the agents:* $\hookrightarrow$ *Conditional behavior:* *Equilibrium Conditions:*

Interesting analyses possible already

- Left side only filled: No assumptions about behavior and equilibrium yet
- But again: We can already answer interesting questions:
  - What will the profit and consumer surplus be if 5 units are sold at a price of 4?
  - What is the efficient level for the quantity traded?
  - Comparative statics: how does the efficient level change if c rises?

Monopoly with constant MC II

Technology and Preferences	**Behavior and Equilibrium**
Exogenous func./var./relationships: $p(x), C(x) = c \cdot x$ c (implicitly also $x \geq 0$, $p \geq 0$) *Endogenous variables:* x, p	*The decisions of the agents:* Profit maximization: $\max_{x,p} p \cdot x - C(x)$ s.t. $p = p(x)$ $\hookrightarrow$ *Conditional behavior:* The monopolist's quantity choice x^* and price choice $p^* = p(x^*)$ *Equilibrium Conditions:*

Monopoly with constant MC II, alternative version

Technology and Preferences	Behavior and Equilibrium
Exogenous func./var./relationships:	*The decisions of the agents:*
$p(x), C(x) = c \cdot x$	Profitmax: $\max_x p(x)x - C(x)$
c	
(implicitly also $x \geq 0$)	
	$\hookrightarrow$ *Conditional behavior:*
Endogenous variables:	The monopolist's quantity choice x^*
x, p	
	Equilibrium Conditions:
	Equilibrium price follows from the demand curve $p^* = p(x^*)$

The anatomy is not unique

- One can argue that $p^* = p(x^*)$ is the behavior of the monopolist or that it is an equilibrium condition

- This depends on how we interpret the math:
    - The monopolist chooses how much he wants to sell and offers this in the market (e. g. through an auction) and an equilibrium price arises

    - ... or the monopolist chooses how much he wants to sell and also chooses his price

- Point: There is not necessarily just one way of putting the model into the chart

What have we learned?

- An anatomy (a framework) that we can use to categorize and compare our different models