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Intermediate Microeconomics W3211

Lecture 25: Recap 2

Columbia University, Spring 2016
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Introduction

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The Story So Far….

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Topic	Topic
1	The Consumer's Problem
2	Market Equilibrium
3	Perfect Competition
4	Game Theory
5	Uncertainty/Incomplete Information

The Story So Far….

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Topic	Topic
1	The Consumer's Problem
2	Market Equilibrium
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- Consumer problem has been covered in previous recap
- Will concentrate on the other 4 areas
- Though will divide it up slightly differently

The Story So Far….

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Topic	Topic
1	The Consumer's Problem
2	Market Equilibrium
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4	Game Theory
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- Obviously not have time to do things in much depth
- Will try to give you an idea of where to concentrate, and how things fit together

Organization for the Week

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- I will put all relevant materiel on the website by this afternoon
- Including a set of practice problems
  - Focused on the second half of the class
- And solutions to those problems
- TA's will have office hrs as determined by their email
- I will have office hrs 10.30-12.30 Thursday
  - Not on Friday
- Will also try to be available outside those times
  - Don't leave things to the last minute!

Details for the Exam

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- Exam next Monday, 9th May
- Will last for 2.5 hrs
- Cover materiel from the whole course
- Closed book/notes
- No need for a calculator or anything like that
  - Just a pointy penil
- Use good exam technique!

General hints and tips

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- Use your revision time wisely!

1. Reading through notes/books is not the same as learning the materiel!
   - Exam will not be a memory test (really), but a test of your ability to apply techniques
   - Read through the notes once to get the basic concepts down
   - Then practice applying them
   - This is what you will have to do in the exam
2. Make sure that you are in a position to pick up the 'easy' points
   - In general, each question will have several sections, going from easy to hard
   - The 'easy' bits should be fairly straightforward
   - Relatively close to what you have seen in problem sets/notes
   - You want to be able to get these points
   - Don't concentrate all your revision in one section!
   - Know everything there is to know re the Edgeworth box and lose easy points because you don't know what a Nash Equilibrium is!

Market Equilibrium

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What you need to know

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- Market Equilibrium is what we predict to be the outcome of an economy
- What you need to know is

1. How to define an equilibrium
2. How to find an equilibrium
3. Welfare and Equilibrium
   - Definition of Pareto efficiency
   - How to find/check for Pareto efficiency
   - The First and Second Fundamental welfare theorems
   - Caveats to the welfare theorem
   - Consumer and Producer Surplus in partial equilibrium

How to Define An Equilibrium

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- An equilibrium is
  - An allocation (i.e. an amount of stuff that everyone gets)
  - A price vector (a set of prices for each good)
- Such that
  - The allocation is optimal for each economic agent
    - i.e. they cannot do any better given prices
  - Market Clearing (or feasibility)
    - Supply equals demand in every market
- We defined
  - Equilibrium for an endowment economy (lecture 7)
  - A partial equilibrium with firms and consumers (lecture 17)
  - General equilibrium with firms and consumers (lecture 18)
    - i.e. the Robinson Crusoe economy

How to Define An Equilibrium

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- How to find an equilibrium
- The following general recipe works
  - Figure out the **demand** for each consumer and each good as a function of prices
    - i.e. solve the consumer's problem
  - Figure out **supply** as a function of prices
    - i.e. solve the firm's problem (if there are any)
  - Figure out the prices which make supply equal demand
- We did this for the endowment economy (lecture 7)
- For partial equilibrium with firms (lecture 17)
- For general equilibrium with firms (lecture 18)

Equilibrium in the Edgeworth Box

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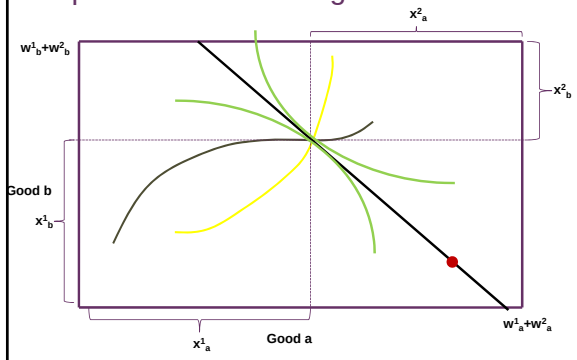

Partial Market Equilibrium

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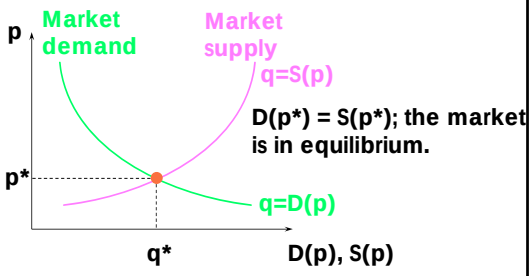

A Robinson Crusoe Equilibrium

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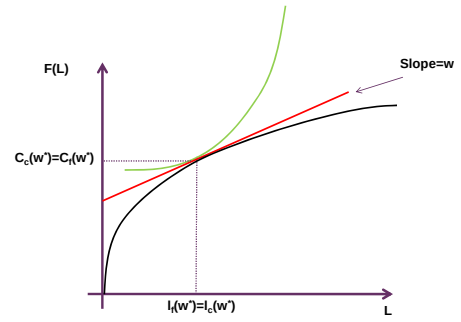

Welfare Properties of Market Equilibrium

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- How do we determine whether a particular allocation is good or not?
- We introduced the idea of **Pareto optimality** (lecture 8)
  - Allocation x Pareto dominates y if it is at least as good for everyone and better for some
  - Allocation x is Pareto optimal if it is not Pareto dominated by any other **feasible outcome**
- Note, that 'Pareto Dominates' is not a complete ranking
  - X may not Pareto dominate y
  - Y may not Pareto dominate x
  - So both may be Pareto optimal

How Do We Find Pareto Optima?

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- To find/check Pareto optima, we used the **social planner's** problem (Lecture 8)
- For example
  1. **CHOOSE** (x_a^1, x_b^1), (x_a^2, x_b^2)
  2. **IN ORDER TO MAXIMIZE** $u^1(x_a^1, x_b^1)$
  3. **SUBJECT TO**
     - $u^2(x_a^2, x_b^2) = \text{u}$
     - Feasibility $x_a^1+x_a^2 = w_a^1+w_a^2$ and $x_b^1+x_b^2 = w_b^1+w_b^2$
- This let us find the **contract curve** in the Edgeworth Box

The Contract Curve

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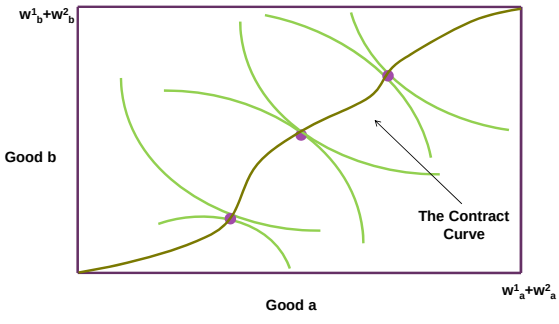

How Do We Find Pareto Optima?

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- Having defined the idea of a 'good' allocation, we wanted to know the relationship between market equilibrium and Pareto optimality
- For an endowment economy, we discussed

The First Fundamental Theorem of Welfare Economics: If preferences are monotonic, then any competitive equilibrium is Pareto efficient (lecture 8)

The Second Fundamental Theorem of Welfare Economics: If preferences are convex, monotonic (and continuous*) then, for every Pareto optimal allocation, there exists an initial endowment such that that allocation is an equilibrium (lecture 9)

- We also showed that the FFTWE held in the Robinson Crusoe Economy (Lecture 18)
- Intuition: Prices equate Marginal Rates of Substitution, which is what you need for efficiency

Equilibrium in the Edgeworth Box

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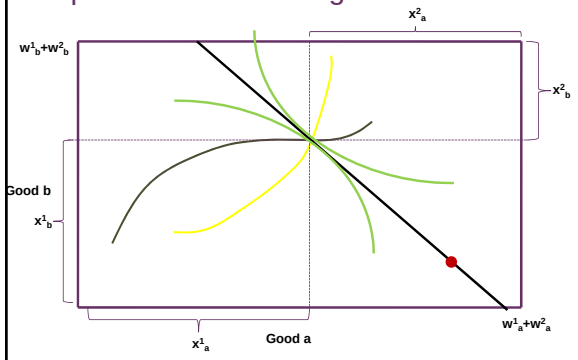

Caveats to the Welfare Theorems

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- There are basically two types of concern you should have with the fundamental welfare theorems (Lecture 9)

1. Is Pareto Efficiency the correct goal?
   - Equality vs Efficiency
2. Are the assumptions we made to get the First and Second Fundamental Theorems sensible?
   - No externalities
   - People choose the best option
   - Price taking
   - People are always selfish

- We discussed how assigning property rights can help overcome the problem of externalities (Lecture 9, Homework 9)

Partial Equilibrium, Consumer and Producer Surplus

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- When we are dealing with partial equilibrium, we can't really talk about Pareto optimality, because we don't know how changes in one market will affect others
- Instead we used **producer and consumer surplus** to do policy analysis (Lecture 16)
  - The amount that firms and consumers are prepared to pay to be allowed to trade an amount q at price p

Total Surplus

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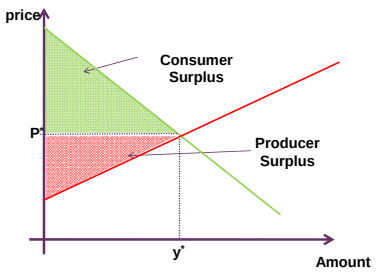

Partial Equilibrium, Consumer and Producer Surplus

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- We could use the concept of producer and consumer surplus to do analyze the impact of various policies on firms
- For example quantity taxes (Lecture 18)

Deadweight Loss and Own-Price Elasticities

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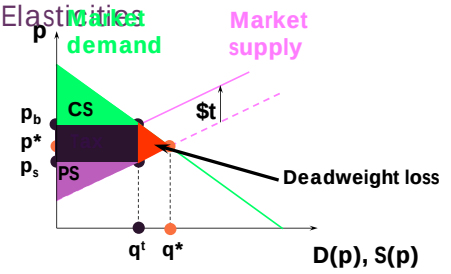

Theory of the Firm

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Theory of The Firm

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- The theory of the firm deals with the behavior of a new type of economic agents – **firms**
- These are agents which
  - Convert one type of thing (inputs) to another (outputs)
  - Do so in order to maximize profit
- In Lecture 11 we defined what we meant by a firm, and defined the firm's problem
- Variants of the Firm's problem
  - Fixed prices (perfect competition) vs Choose prices (monopolists)
  - Single input (short term) vs multiple inputs (long term)
  - Fixed costs (short term) vs no fixed costs (long term)

Theory of The Firm

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- What you need to know is
- How to set up the firm's profit maximization problem
  - The difference between monopoly and perfect competition
- How to solve the firm's cost minimization problem
- How returns to scale affect profit maximizing output
- The difference between the short run and the long run
- Tricks that monopolists might use

The Canonical Firm's Problem

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- Choose y in order to maximize

$$\pi(y) = p(y).y - c(y)$$

Profit=revenue-costs

- Canonical solution

Marginal Revenue = marginal cost

- Assuming interior solution!
- Why might there not be an interior solution?
  - Increasing/Fixed returns to scale
  - Better to exit the market

Perfect Competition Vs Monopoly

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- The difference between perfect competition and Monopoly (lecture 21) is on the revenue side
- Perfect competition: prices are treated as fixed, so marginal revenue is just price
- Monopolists can choose prices
  - But are still constrained by the demand function
  - D(p) – amount consumers will buy at price p
  - P(y) – price that can be charged if they want to sell y
  - Marginal revenue becomes

$$p(y) + y\frac{dp}{dy}$$

The Cost Function

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- In Lecture 12 we discussed how to figure out the firm's cost function
- A firm is defined by its **production function**, which says how much output it gets depending on what inputs it uses
  $f(x_1, x_2)$
- If the firm can only pick one input, then going from the production function to the cost function is pretty easy
  - Just invert the production function
- If the firm can use multiple inputs, there are many different ways of producing any given level of output
- Find the cost function by solving **cost minimization problem**
  - Lowest cost way of producing each level of output (Lecture 13)

Tangency Solutions

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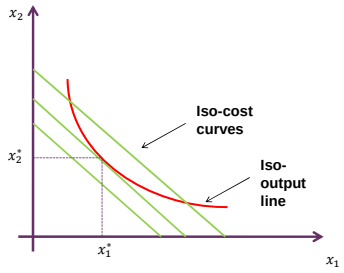

Returns to Scale

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- Depending on the technology of the firm, they may exhibit increasing, decreasing or constant returns to scale (Lecture 14)
- Diminishing returns to scale:
  - MC increasing
  - Optimal output is an **interior solution** as long as there is a y such that price equals marginal cost
- Increasing returns to scale:
  - MC decreasing
  - Interior solution **minimizes** profit
  - Optimal output is a **corner solution –** to produce infinite output - as long as there is a y such that price is above marginal cost
- Constant Returns to Scale
  - MC constant
  - Generally will not be an interior solution
  - Optimal output is a corner solution – either produce zero or infinity
  - Or anything if P=MC

Long Run Vs Short Run

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- The solution to the firm's problem may be different in the short run and the long run (Lecture 15)
- In the short run, some of the inputs may be fixed
  - For example, cannot change the number of factories in the short run, only the long run
- Long run
  - All factors variable
  - No fixed costs
- Short run
  - Some factors fixed
  - (In general) higher costs
    - Long run costs are the lower envelope of short run costs
  - Leads to fixed costs (i.e. a cost even if 0 is produced)

Long Run Vs Short Run

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- The presence of fixed costs means that firms will choose to produce zero under different circumstances in the short and the long run (Lecture 16)
- In the long run, firms who produce 0 make zero profit, so will produce a positive amount if there is a y such that

$$py - c(y) > 0, \text{ or}$$
$$p > \frac{c(y)}{y} = AC(y)$$

- In the short run, firms who produce 0 have to pay fixed costs F, so will produce a positive amount if

$$py - c(y) > -F, \text{ or}$$
$$p > \frac{c(y) - F}{y} = AVC(y)$$

- In the long run, firms can also enter or exit the industry (Lecture 17)
  - At a given price, number of firms determined as the maximum number that can make positive profits
  - Can use this to determine the **industry supply curve**

More on Monopolies

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- Up until now, we have assumed that firms can only charge a fixed per unit price per unit sold
- Monopolists might want to do other things to increase profits (Lecture 22)
  - Two part tariff
  - Price Discrimination

Game Theory

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Game Theory

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- What you need to know is
- How to define a game
- How to solve a game
  - Deletion of dominated strategies
  - Nash equilibrium
- Mixed strategies
- Cournot competition
- Sequential games
  - SPNE
  - Backward induction

Game Theory

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- In many situations, the best thing for person A to do depends on what person B does and visa versa
- This is the realm of game theory.
- In lecture 19 we defined a game

1. A list of players
2. A list of actions that each player can take
3. The payoff that each player gets, depending on the actions of all players

An Example of a Two-Player Game

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		Player B L	Player B R
Player A	U	(3,9)	(1,8)
	D	(0,0)	(2,1)

This is the game's payoff matrix.

Player A's payoff is shown first.
Player B's payoff is shown second.

Game Theory

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- And talked about ways of solving games
- Iterated deletion of strictly dominated strategies
- Nash Equilibrium

A Nash Equilibrium is an action for each player such that each player has no incentive to deviate given what everyone else has done

- We showed (using the prisoner's dilemma) that, unlike market settings, Nash Equilibria are not necessarily efficient

Nash Equilibria

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- Nash Equilibria are not necessarily unique
- Nor are they guaranteed to exist in **pure strategies**
- In lecture 20 we introduced the notion of mixed strategies
  - Can play each action with some probability
- Nash Equilibria always exist in mixed strategies

Cournot Games

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- In Lecture 21 we used the notion of Nash equilibrium to figure out what would happen in a market with two firms that competed on quantity

$$\Pi_1(y_1;y_2) = p(y_1 + y_2)y_1 - c_1(y_1).$$

- Figured out the best response function of each firm
  - What firm 1 would do as a best response to firm 2 and visa versa
- Find the Nash Equilibrium by solving these two equations simultaneously

Sequential Games

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- In Lecture 20 we discussed sequential games
  - Where players play in turns (rather than all at once)
- Showed that not all Nash Equilibria are 'credible'

Sequential Games

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	Enter	Stay Out
Fight	-1,-1	10,0
Relent	5,5	10,0

- What is the Nash Equilibrium of this game?
- There are two (Fight, Stay Out) and (Relent, Enter)
- Do we think that each of these is equally likely?
- Remember, the incumbent will decide whether to fight or not AFTER the entrant has decide whether to enter

Sequential Games

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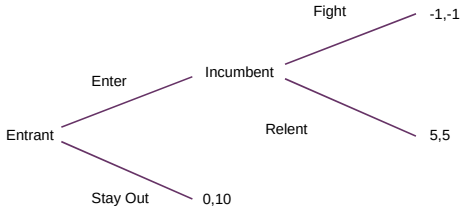

- This is the **sequential form** of the game
- What would the Incumbent choose to do if the Entrant enters?

Sequential Games

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- In Lecture 20 we discussed sequential games
  - Where players play in turns (rather than all at once)
- Showed that not all Nash Equilibria are 'credible'
- Introduced the notion of subgame perfect Nash Equilibria
- Can be solved using backward induction

Uncertainty and Information

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Expected Utility Maximization

- In our final topic we asked how economic agents might deal with uncertainty
- First guess: maximize expected value
- Probably not right – diminishing marginal utility of wealth
- Instead expected **utility** (lecture 23)
- For people to behave as if they are maximizing expected utility requires them to obey the **independence axiom** (lecture 24)
- Also, utility is now more meaningful

Theorem: Take two **expected** utility functions u and v. They both represent the same preferences if and only if there is an a and $b > 0$ such that

$$v(x) = a + bu(x)$$

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Market Unravelling

- Finally, we thought about what would happen if we added uncertainty to markets
- Particularly problematic is **asymmetric information**
  - One side knows what is happening and one side does not
- Can lead to **market unravelling (lecture 24)**
  - Only low quality goods get sold