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## Intermediate Microeconomics W3211

### Lecture 9: Efficiency and Equilibrium 2

Columbia University, Spring 2016

Mark Dean: mark.dean@columbia.edu

## Introduction

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## The Story So Far....

- Last lecture we introduced the concept of **Pareto dominance** and **Pareto optimality**
  - Allocation  $x$  Pareto dominates allocation  $y$  if everyone weakly prefers  $x$  to  $y$  and some people strictly prefer  $x$  to  $y$
  - i.e. no one would vote against moving from  $y$  to  $x$
  - An allocation is Pareto optimal if there is no other feasible allocation which Pareto dominates it
- Argued that Pareto optimal outcomes are good
  - Or at least Pareto dominated outcomes are bad
  - Can make someone better off while making no-one worse off
- Introduced (and proved!) the First Fundamental Theorem of Welfare economics
  - Competitive equilibria are Pareto optimal (as long as preferences are monotonic)

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## Today's Aims

- Introduce the Second Fundamental Theorem of Welfare Economics
- Discuss some of the limitations of the FFTWE and SFTWE
- Describe one possible way around one of these limitations: Externalities
  - Property Rights and Coase Theorem
  - Ch. 35 of Varian, Chapter 17 of Feldman and Serrano

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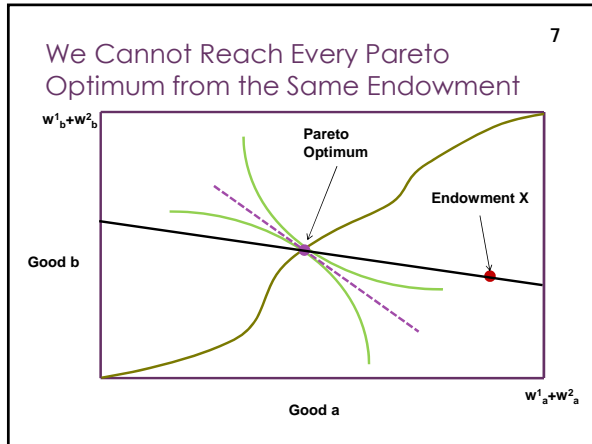
## Equilibrium and Pareto Optimality

The Second Fundamental Theorem of Welfare Economics

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## Equilibrium and Pareto Optimality

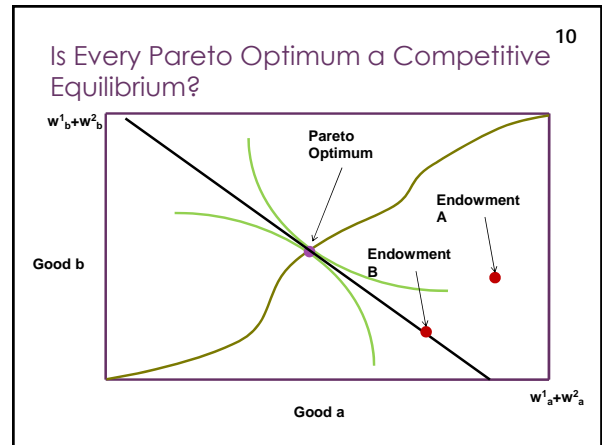
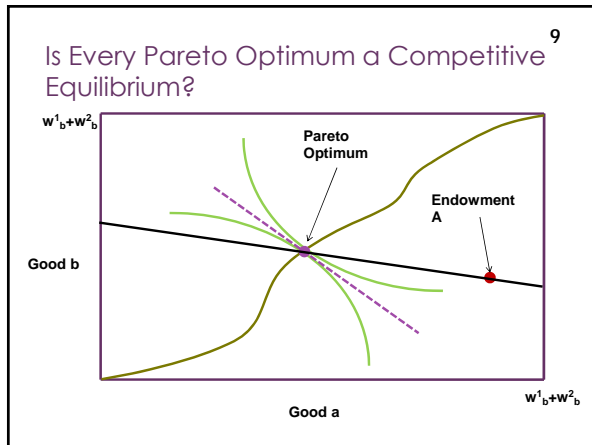
- So we now know that (in our stylized model) every equilibrium is Pareto efficient
- We might also want to know whether every Pareto efficient point is an equilibrium
- Why?
- Well, first of all let's think about exactly what the question means
- Does it mean "is every Pareto efficient point an equilibrium for the same initial endowment"?
- I hope not, because the answer to this question is clearly no.



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### Equilibrium and Pareto Optimality

- A better question is whether, for each Pareto optimal point, there exists **some** endowment such that that point is an equilibrium



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### Equilibrium and Pareto Optimality

- A better question is whether, for each Pareto optimal point, there exists **some** endowment such that that point is an equilibrium
- Why is this an interesting question?
- Well, if the answer is yes, it means that we can get to any Pareto optimal point just by changing endowments
  - i.e. change the stuff that everyone gets to start with
  - Let them trade
- This is a (beguilingly) simple way of doing policy
- So is it true?

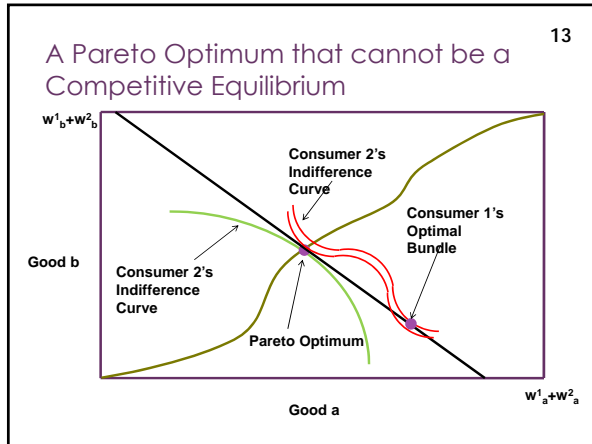
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### Equilibrium and Pareto Optimality

**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

\*For the maths fetishists

- The proof of this statement lies beyond the scope of this course
- But I can show you why the assumption of convexity is important



### Caveats to the Welfare Theorems

Or "Why you shouldn't start voting for Rand Paul just yet!"

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- ### Caveats
- The First and Second Welfare theorems can be very persuasive
    - Powerful
    - Elegant
    - (Seem to) require minimal assumptions
    - Have very nice policy implications (we can let the market do everything!)
  - And they **are** all of those things

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- ### Caveats
- But they should also be treated with extreme caution
  - As with everything you learn in this course they are not universal truths
    - They are helpful abstractions that allow us to think through problems
  - If you are not careful, the message 'markets are good' can remain long after the details of this course have faded
  - Don't let this happen to you!

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- ### Caveats
- There are basically two types of concern you should have with the fundamental welfare theorems
    1. Is Pareto Efficiency the correct goal?
    2. Are the assumptions we made to get the First and Second Fundamental Theorems sensible?

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- ### Caveats
- There are basically two types of concern you should have with the fundamental welfare theorems
    1. **Is Pareto Efficiency the correct goal?**
    2. Are the assumptions we made to get the First and Second Fundamental Theorems sensible?

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### Is Pareto Efficiency the Correct Goal?

- Pareto efficiency seems to be something of a no brainer as a property you would like
- But ask yourself the following question:

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### Do You Prefer Allocation A or Allocation B?

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### Is Pareto Efficiency the Correct Goal?

- Do you prefer allocation A or allocation B
  - A: Pareto efficient, but not equitable
  - B: Equitable but not Pareto efficient
- If you could only choose between those two outcomes then you might prefer B to A
- Implies that not all Pareto efficient allocations are preferred to all those that are not efficient
- In particular because Pareto efficiency says nothing about equality

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### Is Pareto Efficiency the Correct Goal?

- But what about the **Second** fundamental theorem?
- Doesn't that tell us that we can always hit some point which is Pareto dominant to B?

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### Do You Prefer Allocation A or Allocation B?

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### Is Pareto Efficiency the Correct Goal?

- Yes, but only if we play around with the endowments.
- This means that market solutions on their own may not be enough
  - Equilibrium may be Pareto efficient, but extremely unfair
  - E.g. a '99%' outcome may be Pareto optimal
  - If we want equality we need to actually change the endowments!
- Changing endowments may not be easy
  - Need to change what people get without distorting prices
  - So no income tax or sales tax
  - Requires Lump Sum taxation
  - Maggie Thatcher tried this in the UK in the 80s
  - Google 'Poll Tax Riots'

## Caveats

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- There are basically two types of concern you should have with the fundamental welfare theorems
- 1. Is Pareto Efficiency the correct goal?
- 2. Are the assumptions we made in our model sensible?

## Beware of Hidden Assumptions

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- It seems that we only had to make one assumption to state the FFTWE
  - Monotonicity
- But beware of assumptions hidden in the set up of the model
- Here are four that we might be worried about
  - No externalities
  - People choose the best option
  - Price taking
  - People are always selfish

## Beware of Hidden Assumptions

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## No Externalities

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- We have assumed that the amount of consumption of each good only affects those who consume it
- Maybe this is not the case
  - Smoking
  - Disco music
  - Deodorant
- For example, assume that the two goods in the economy are toast and cigarettes
  - Consumer 1 loves smoking, but consumer 2 hates it
  - Consumer 2 lives in the same house as consumer 1 and can smell their cigarettes
- Will the competitive equilibrium be Pareto optimal?
- Not Consumer 1 will take into account only the **private** benefit of smoking, not the **cost** to consumer 2
- (See next section)

## Beware of Hidden Assumptions

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## Choosing the Best Option

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- Implicitly, we are assuming that people choose the best option from the budget set
- This is crucial in the claim that there is no way to make people better off in a competitive equilibrium
- If they are making dumb choices it may well be possible to make them better off!

## Choosing the Best Option

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- But is this a good assumption?
  - Heroin addicts?
  - People who invested with Bernie Madoff?
  - You?
- May be a particular issue when decisions are very complicated
- This is currently a huge policy issue
  - E.g. health care exchanges
- If we think people do not make good decisions, what should we do?
  - Move away from the market model?
  - Provide more information?

## Beware of Hidden Assumptions

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## Price Taking

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- We have assumed so far that neither consumer gets to set prices
  - They emerge mysteriously in order to guarantee equilibrium
- This may be a strong assumption
- Perhaps one of the consumers gets to set the prices, and the other consumer is allowed to buy and sell as much as they want **only** at those prices
- i.e. they act as a **monopoly**
- Will this lead to Pareto efficiency?
- Generally no (see later in the course)
- Clearly this will be an important issue when we introduce firms

## Beware of Hidden Assumptions

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## People are Always Selfish

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- In our model we have assumed that people always choose what is best for them
  - They are not **altruistic**
  - They do nothing for the common good
- There are three possibilities
  - This is a good assumption
  - It is a bad assumption
  - Sometimes people behave like this, and sometimes they do not
- In the last case, it is possible that the economic system can itself affect the way in **which people make choices**
- Perhaps people act **selfishly** in market settings but not in others
  - See for example "A Fine is A Price" [Gneezy and Rustichini 2000]
- Opens up the possibility that market mechanisms change the way in which people make choices to the detriment of all

## Externalities, Property Rights and Coase Theorem

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## Externalities

- Let's think again about externalities
- Here is a simple example
- Two roommates: Ethel (1) and Gwen (2)
- Two goods: Cigarettes and Toast
- Both roommates like smoking and toast
- But Ethel likes smoking in the morning, which really irritates Gwen
- How can we describe this economy?

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## Externalities

- Let's start with the economy from Monday and modify it

1. The **endowment** of each agent
  - $w_c^1=3$
  - $w_t^1=2$
  - $w_c^2=1$
  - $w_t^2=5$
2. The **preferences** of each agent
  - $u^1(x_c^1, x_t^1)=x_c^1 x_t^1$
  - $u^2(x_c^2, x_t^2)=x_c^2 x_t^2 - x_c^1$

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## Externalities

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  - $u^1(x_c^1, x_t^1)=x_c^1 x_t^1$
  - $u^2(x_c^2, x_t^2)=x_c^2 x_t^2 - x_c^1$

- This is the externality: Ethel's consumption effects Gwen

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## Externalities

- What does the equilibrium of this economy look like?
- First, let's think about the consumer problems:

- Ethel's
 

Choose  $x_c^1, x_t^1$  to Maximize  $u^1(x_c^1, x_t^1)=x_c^1 x_t^1$

Subject to  $p_c x_c^1 + x_t^1 \leq p_c w_c^1 + w_t^1$
- Gwen's
 

Choose  $x_c^2, x_t^2$  to Maximize  $u^2(x_c^2, x_t^2)=x_c^2 x_t^2$

Subject to  $p_c x_c^2 + x_t^2 \leq p_c w_c^2 + w_t^2$

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## Externalities

- The consumer's problem is the same as if there was no externality!
- Why?
- Ethel can affect her consumption of cigarettes, but only cares about her own utility
  - Doesn't care about how the negative effect of her smoking on Gwen
- Gwen does care about the amount Ethel smokes, but cannot do anything about it
- Implies the consumer's problem for each person ignores the externality
  - Their demand functions will therefore be the same as if there were no externality
  - The equilibrium of the economy will also be the same

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## Externalities

- (From previously) The equilibrium allocations were
 
$$x_c^1(p_c^*, w_c^1, w_t^1) = \frac{3}{2} + \frac{4}{7} = \frac{29}{14}$$

$$x_t^1(p_c^*, w_c^1, w_t^1) = \frac{21}{8} + 1 = \frac{27}{8}$$

$$x_c^2(p_c^*, w_c^2, w_t^2) = \frac{1}{2} + \frac{20}{14} = \frac{14}{14}$$

$$x_t^2(p_c^*, w_c^2, w_t^2) = \frac{7}{8} + \frac{5}{2} = \frac{27}{8}$$
- And equilibrium price was  $p_c^* = \frac{7}{4}$
- Is this Pareto optimal?

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### Externalities

- Let's check
- First, fix the utility of person 2 at the level achieved in equilibrium:
 
$$u^2(x_c^2, x_t^2) = \frac{27}{14} \frac{27}{8} - \frac{29}{14} = \frac{71}{16}$$
- Now figure out the maximal utility of consumer 1 given feasibility and making sure that consumer 2 gets the above utility

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### Externalities

- It is going to be easiest to solve first for  $x_c^2, x_t^2$
- CHOOSE**  $(x_c^2, x_t^2)$
- IN ORDER TO MAXIMIZE**  $u^1(x_c^1, x_t^1) = (4 - x_c^2)(7 - x_t^2)$
- SUBJECT TO**
  - $u^2(x_c^2, x_t^2) = x_c^2 x_t^2 - (4 - x_c^2) = \frac{71}{16}$
- First set up the Lagrangian:
 
$$L(x_c^2, x_t^2, \mu) = (4 - x_c^2)(7 - x_t^2) - \mu(x_c^2 x_t^2 - (4 - x_c^2) - \frac{71}{16})$$

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### Externalities

$$L(x_c^2, x_t^2, \mu) = (4 - x_c^2)(7 - x_t^2) - \mu(x_c^2 x_t^2 - (4 - x_c^2) - \frac{71}{16})$$

- Taking derivatives:
 
$$\frac{\partial L}{\partial x_c^2} = -(7 - x_t^2) - \mu(x_t^2 + 1) = 0$$

$$\frac{\partial L}{\partial x_t^2} = -(4 - x_c^2) - \mu(x_c^2) = 0$$

$$\frac{\partial L}{\partial \mu} = x_c^2 x_t^2 - (4 - x_c^2) - \frac{71}{16} = 0$$
- Using the first two equations gives
 
$$\frac{(7 - x_t^2)}{(4 - x_c^2)} = \frac{(x_t^2 + 1)}{(x_c^2)}$$
 or
 
$$x_c^2 = \frac{x_t^2}{2} + \frac{1}{2}$$

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### Externalities

$$x_c^2 = \frac{x_t^2}{2} + \frac{1}{2}$$

- Substituting back into the constraint gives
 
$$\frac{(x_t^2)^2}{2} + \frac{x_t^2}{2} - \left(4 - \frac{x_t^2}{2} - \frac{1}{2}\right) = \frac{71}{16}$$
 Or
 
$$\frac{(x_t^2)^2}{2} + x_t^2 - \frac{127}{16} = 0$$
 Gives  $x_t^2 \approx 3.11$

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### Externalities

Allocation	Market Equilibrium	Pareto Optimal
$x_c^1$	2.07	1.95
$x_t^1$	3.63	3.89
$x_c^2$	1.93	2.05
$x_t^2$	3.37	3.11

- Pareto optimum gives **less** cigarettes and **more** toast to Ethel than does the market equilibrium
  - You should check that Gwen gets the same utility from this allocation as in the market equilibrium, while Ethel gets more
- This makes sense: the social planner takes into account the cost of Ethel's smoking for Gwen, while the market equilibrium does not

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### Externalities

- The market equilibrium equalizes the MRS of the two consumers
 
$$\frac{\frac{\partial u^1}{\partial x_c^1}}{\frac{\partial u^1}{\partial x_t^1}} = \frac{\frac{\partial u^2}{\partial x_c^2}}{\frac{\partial u^2}{\partial x_t^2}}$$
- i.e. the **private** benefit of changing between cigarettes and toast for consumer 1 is equal to the **private** benefit of changing between cigarettes and toast for consumer 2
- The social planner solves
 
$$\frac{\frac{\partial u^1}{\partial x_c^1} + \mu \frac{\partial u^2}{\partial x_c^2}}{\frac{\partial u^1}{\partial x_t^1}} = \frac{\frac{\partial u^2}{\partial x_c^2}}{\frac{\partial u^2}{\partial x_t^2}}$$
- The **total benefit** of changing between cigarettes and toast for consumer 1 is equal to the **total benefit** of changing between cigarettes and toast for consumer 2



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## Solving the Problem of Externalities

- Externalities are a huge real world problem
  - Think of carbon production and global warming
- What can we do about them?
- One favored way for economists: assign property rights and allow people to trade
- What does this mean?
- In the above example, either
  1. Ethel has the right to smoke, but Gwen can pay her to limit her smoking
  2. Gwen has the right to clean air, but Ethel can pay her to be allowed to smoke
- Like a 'cap and trade' policy for climate emissions

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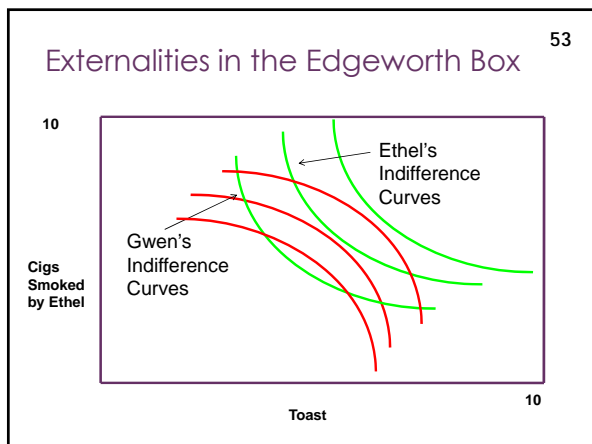
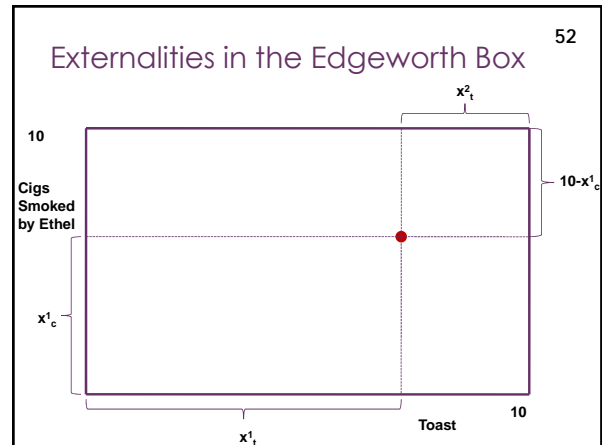
## Solving the Problem of Externalities

- Claim: Assigning property rights in this way leads to a Pareto efficient outcome
- This is (essentially) Coase theorem
- Note that, as with the FFTWE and SFTWE Coase Theorem is elegant, powerful and can be mis-used

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## Coase Theorem: An Example

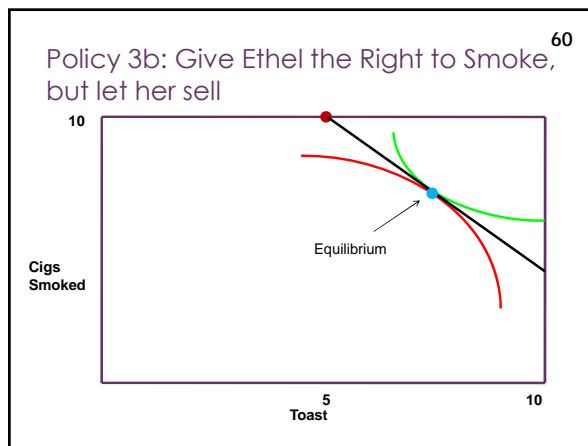
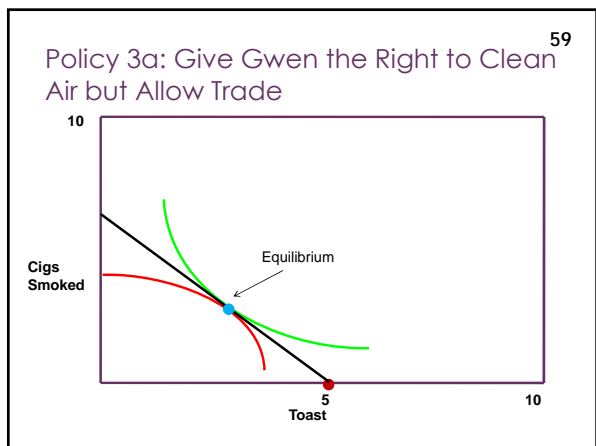
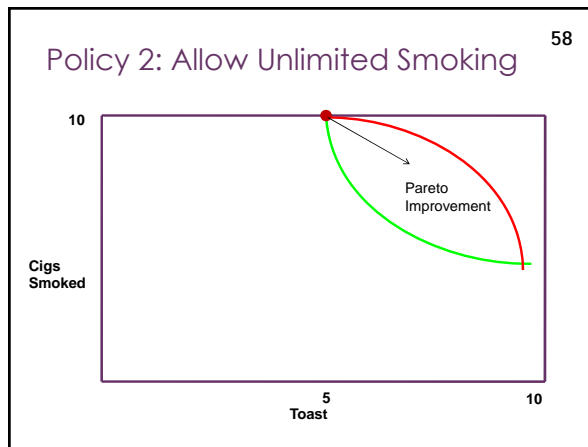
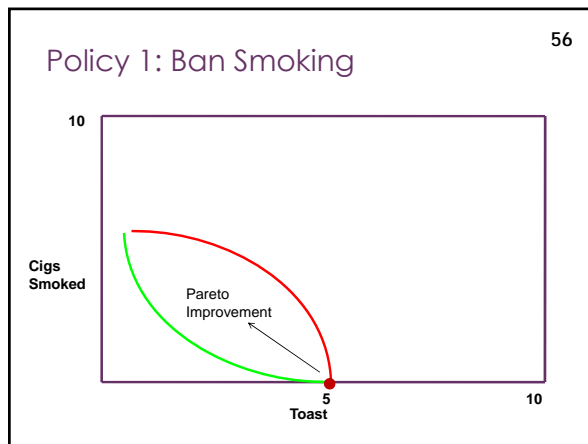
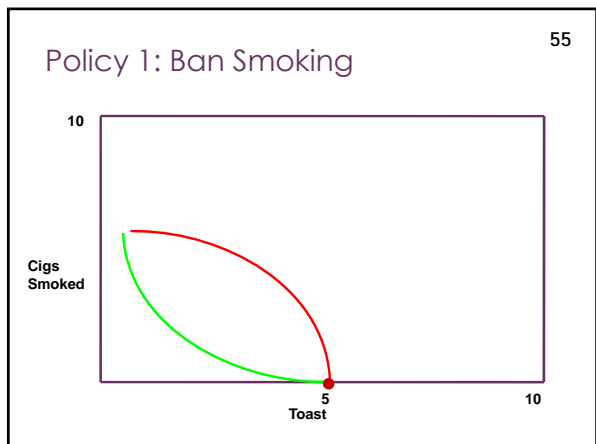
- Consider the following simplified example
- Ethel and Gwen both have 5 slices of toast
- There are 10 cigarettes that can be smoked or not by Ethel
- In this example, Ethel likes smoking, but Gwen hates it, so their utilities are given by
  - $u^1(x_c^1, x_t^1)$  monotonically increasing
  - $u^2(10 - x_c^1, x_t^2)$  monotonically increasing in both arguments
- We can represent preferences in an Edgeworth Box-type setting



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## Coase Theorem: An Example

- What is the best policy?
  1. Ban smoking
  2. Allow as much smoking as Ethel like
  3. Assign property rights and let them trade at the cost of  $p_c$  per cigarette



## Coase Theorem

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- Generally, completely banning or completely allowing an activity will not lead to a Pareto Efficient outcome
- Assigning property rights and allowing people to trade will
- You will fill in the details for homework
- Note that the usual caveats apply
  - E.g. assigning corporations the right to pollute may lead to some people being very badly off
  - How property rights are assigned can have huge equality implications
- Plus some new ones
  - Repugnant transactions: should people be allowed to sell organs?
  - How property rights are assigned can have huge equality implications

## Summary

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## Summary

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- Today we have done the following
1. Introduced the SFTWE: Any Pareto efficient outcome can be supported as an equilibrium
  2. Discussed caveats to the two welfare theorems
  3. Discussed the problem of externalities, and how this problem can be solved by assigning property rights