An Intro to the Economics of Climate Policy

- What are we going to cover today?
  - Introduction to "cost-effective" policy solutions to CO_2 emission reductions.
    - Develop a baseline standards approach
    - Compare two popular approaches
      - Emission taxes (carbon tax)
      - Tradable emissions permits

New Course this Fall!

- ECON 445 “International Environmental Economics and Climate Change”
- Fall 2009, Tuesday & Thursday 11:10 AM – 12:30 PM
- Satisfies a component of the Climate Change and Society portion of the Climate Change Studies minor.
- Topics:
  - Climate change economics
  - The economics of international trade in waste
  - Trans-boundary pollution
  - The Pollution Haven Hypothesis

An Intro to the Economics of Climate Policy

- Stern and IPCC estimates (as well as others) of the cost of climate change mitigation are approximately 1% of world GDP per year if we are to achieve a stabilization of atmospheric CO2 concentrations of 500-550 ppm.
- In 2008, world GDP was $70.6 trillion…the U.S. GDP was $14.6 trillion.
- This implies that the world will need to spend $706 billion/year, and the U.S. needs to spend $146 billion/year to achieve the 550 ppm CO_2 concentration target.
- The estimates assume that policies to abate CO_2 emissions are ***cost-effective***.

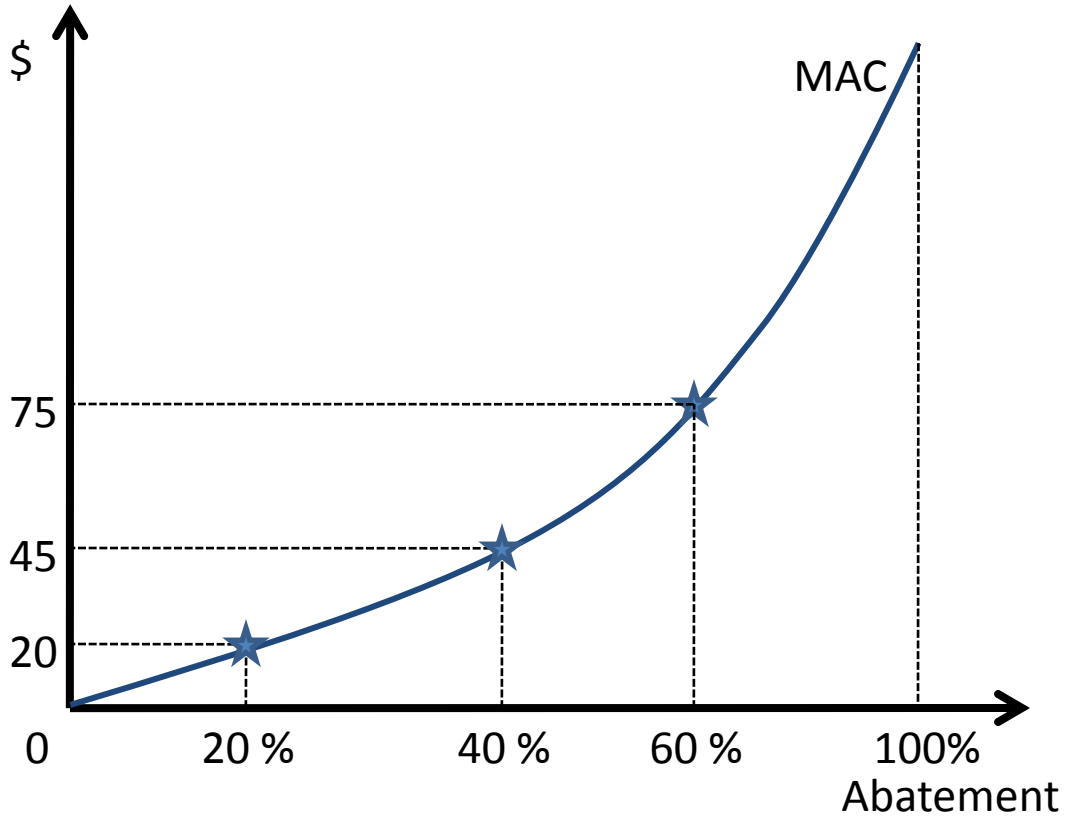
Cost-Effectiveness

- A policy is cost-effective if it achieves a given amount of environmental improvement at the least possible aggregate cost.
- This occurs when a policy is designed such that the *marginal cost of abatement* across sources are the same (known as the equimarginal principle).

Marginal Abatement Cost

- The marginal cost of abatement is the cost of reducing one additional unit of emissions (say 1 ton of CO_2).
- The marginal abatement cost curve shows the marginal cost of reducing (abating) each unit of CO_2 emissions.

Marginal Abatement Costs



Economic Efficiency of Policy Choices: An Example

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
8	0	0	0
7	1	10	20
6	2	20	60
5	3	30	80
4	4	40	100
3	5	50	140
2	6	60	200
1	7	80	250
0	8	100	310

A Standards Based Approach to Emission Reduction

- Standards can be defined in many ways, but two common approaches are technology standards and emission standards.
  - Technology standards define the technology that may be used.
  - Emission standards place a limit on emissions.

Economic Efficiency of Policy Choices: An Example

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- Let's take a look at the costs of an emission standard that calls for a 50% reduction in CO_2 Emissions from all sources.

Economic Efficiency of Policy Choices: An Example

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4	4	40	100
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2	6	60	200
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0	8	100	310

Source A reduces CO_2 emissions from 8 tons/wk to the set standard of 4 tons/wk.

The cost of achieving the 50% reduction for Source A is 10 + 20 + 30 + 40 = $100.

Economic Efficiency of Policy Choices: An Example

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
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7	1	10	20
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5	3	30	80
4	4	40	100
3	5	50	140
2	6	60	200
1	7	80	250
0	8	100	310

Source B reduces CO_2 emissions from 8 tons/wk to the set standard of 4 tons/wk.

The cost of achieving the 50% reduction for Source B is 20 + 60 + 80 + 100 = $260.

Economic Efficiency of Policy Choices: An Example

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
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7	1	10	20
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5	3	30	80
4	4	40	100
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0	8	100	310

- What is the total cost of achieving a 50% reduction in CO_2 emissions?
- $100 + $260 = $360 per week
- Note that the marginal abatement costs are different for Source A and B.

A $C0_2$ Emission Tax (carbon tax)

- A carbon emission tax places a tax on a unit of carbon emissions… effectively placing a price on pollution.
- For example, if an emissions tax of $50 were placed on each ton of $C0_2$ emissions and a power plant emitted 40 tons per month…they would have a tax bill (cost) of $2000 per month.
- Firms and individuals seek to reduce costs to increase profit.
- The emission tax (if correctly priced) gives polluting sources an incentive to reduce emissions.
- Let's take a look…consider a $65 emission tax in our previous example.

Economic Efficiency of Policy Choices: An Example

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What are *total costs* for Source A and Source B if they continue to emit 8 tons/wk?

Source A = \$0 + \$65*8 = \$520

Source B = \$0 + \$65*8 = \$520

Economic Efficiency of Policy Choices: An Example

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- Do Source A and Source B have an incentive to reduce costs by reducing their CO_2 emissions?

Economic Efficiency of Policy Choices: An Example

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-65

Potential marginal tax savings per ton

Economic Efficiency of Policy Choices: An Example

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Potential marginal tax savings per ton

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5	3	-65	+30	80
4	4	-65	+40	100
3	5	-65	+50	140
2	6	-65	+60	200
1	7		80	250
0	8	↑	100	310

Potential marginal tax savings per ton

Source A reduces CO_2 emissions from 8 tons/wk to 2 tons/wk when there is a $65/ton carbon tax.

The abatement cost of achieving the reduction for Source A is 10 + 20 + 30 + 40 +50 + 60 = $210, and their tax bill is $65*2 = $130. For total costs of $100 +$130 = $340.

Economic Efficiency of Policy Choices: An Example

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
8	0	0	0
7	1	10	20
6	2	20	60
5	3	30	80
4	4	40	100
3	5	50	140
2	6	60	200
1	7	80	250
0	8	100	310

- Does Source B have an incentive to reduce costs by reducing their CO_2 emissions?

Economic Efficiency of Policy Choices: An Example

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7	1	10	20
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Potential marginal tax savings per ton

Economic Efficiency of Policy Choices: An Example

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Potential marginal tax savings per ton

Economic Efficiency of Policy Choices: An Example

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4	4	40		100
3	5	50		140
2	6	60		200
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Potential marginal tax savings per ton

Source B reduces CO_2 emissions from 8 tons/wk to 6 tons/wk when there is a $65/ton carbon tax.

The abatement cost of achieving the reduction for Source B is 20 + 60 = $80, and their tax bill is $65*6 = $390. For total costs of $80 +$390 = $470.

Economic Efficiency of Policy Choices: An Example

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Has a $65/ton carbon tax lead to a 50% reduction in CO_2 emissions/wk?

Yes!

Total abatement costs are 10 + 20 + 30 + 40 + 50 + 60 = $210 from Source A and $20 + $60 = $80 for Source B, for a total of $290/wk.

That's right, we've achieved a 50% reduction in CO_2 emissions at 20% lower cost compared to the uniform standard (recall that the cost there was $340/wk).

Implications of the Carbon Emission Tax

- *If* the emission tax is set correctly, the carbon emission tax can achieve the target reduction in a cost-effective manner.
- Sources with low abatement costs will do more of the abating and pay less in taxes. Sources with high abatement costs will do less abating but pay higher taxes.
- The emission tax creates an incentive for those that are most effective (least cost) at reducing emissions to do more of the abating.
- Reduces emissions and generates tax revenues that can be used for other things (so called “double dividend”).
  - Covering regulatory budgets.
  - Subsidizing consumers.
  - Returned to firms in other ways (technology subsidies, etc.)

Tradable Emission Permits (Cap & Trade)

- Tradable Emission Permit programs create a ‘market’ for pollution by allocating permits that can be traded amongst polluters.
- Regulators set the CO_2 emission target and allocate (or auction) the permits to polluters.
- Suppose a polluter is allocated 8 permits (1 ton of CO_2 equivalent) per month.
- Polluter has three options:
  1. Pollute 8 tons of CO_2
  2. Pollute less than 8 tons and sell the extra permits
  3. Buy more permits and pollute greater than 8 tons

Economic Efficiency of Policy Choices: An Example

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- Is there a price at which Source A and Source B could agree to trade a permit and make themselves better off?
- Yes! Any price between $40 and $100 can make both firms better off.
- Let's say they agree to a price of $65.

Economic Efficiency of Policy Choices: An Example

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- Source A increases abatement by 1 ton, thereby increasing abatement costs by $50.
- But they can sell that permit they freed up for $65…a net gain of $15.

Economic Efficiency of Policy Choices: An Example

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- What about Source B? They purchase a permit for $65 from Source A (so that they now hold 5 permits), which allows them to avoid $100 of abatement costs.
- They pay $65 for a permit and save $100 in costs…a net gain of $35.

Economic Efficiency of Policy Choices: An Example

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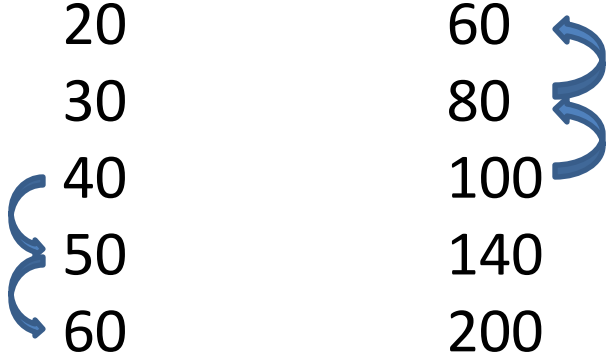

- Should they trade another permit?
- Source A could frees up another permit for $60 and sells for $65…a net gain of $5.
- Source B purchases a permit for $65 and reduces costs by $80…net gain=$15

Economic Efficiency of Policy Choices: An Example

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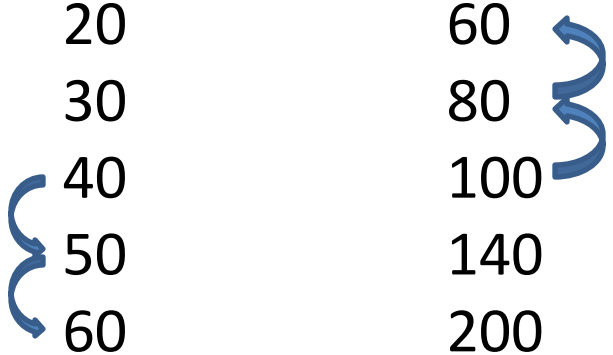

- Should they trade another permit?
- No. Source A would take a loss ($65-$80 = -$15) and Source B would take a loss ($60-$65=-$5).
- RESULT: 2 permits are traded at $65 apiece.

Tradable Emission Permits

- Tradable emission permits create a private property right for emissions.
- Low cost CO_2 abaters will increase abatement and sell permits for a profit.
- High cost CO_2 abaters will abate less by purchasing permits that cost less than their abatement costs.
- Result: Those sources with the low abatement costs do most of the CO2 abatement.
- Policymakers control the level of emissions through the issuance of permits!

Carbon Tax or Tradable Permits?

- In the previous examples, the carbon tax and the tradable permits approach are equally effective at achieving the target goal of a 50% reduction in CO_2 emissions in a cost-effective manner.
- From a policymaker or regulator's standpoint however this requires perfect information about each sources marginal abatement cost structure.
- Let's take a look at a world where the policymakers *do not* have perfect information about the marginal abatement costs of firms (countries)…

Carbon Tax or Tradable Permits?

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- With perfect information a cost effective reduction of 50% can be achieved with a $65 carbon tax or allocating 8 permits (the market price will clear at $65).
- As a policy maker, you are indifferent from a cost-effectiveness perspective.

Carbon Tax or Tradable Permits?

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- But what if you don't know the true marginal abatement costs of the sources?

Carbon Tax or Tradable Permits w/imperfect information?

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
8	0		
7	1		
6	2		
5	3		
4	4		
3	5		
2	6		
1	7		
0	8		

- But what if you don't know the true marginal abatement costs of the sources?
- Are carbon taxes and tradable permits equally efficient in the face of uncertainty for the policymaker?

Carbon Tax or Tradable Permits w/imperfect information?

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
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7	1		
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2	6		
1	7		
0	8		

- Let's begin with the carbon tax. Suppose that the policymaker made a best guess at a carbon tax of $65.

Carbon Tax or Tradable Permits w/imperfect information?

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3	5	70	160
2	6	80	220
1	7	100	270
0	8	120	330

- Let's begin with the carbon tax. Suppose that the policymaker made a best guess at a carbon tax of $65.
- But the true marginal abatement costs of the Sources were above.

Carbon Tax or Tradable Permits w/imperfect information?

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- Source A will abate 4 tons…abate as long as *MAC < tax*.
- Source B will abate 1 ton… as long as *MAC < tax.*
- END RESULT: We're short of the 50% reduction target (5 tons abated, rather than 8)!

Carbon Tax or Tradable Permits w/imperfect information?

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- Are things different with a carbon trading program?

Carbon Tax or Tradable Permits w/imperfect information?

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- Are things different with a carbon trading program?
- Suppose each firm gets allocated 4 permits. Will they trade?
- Yes. Any price between $60 and $120 can make them both better off.

Carbon Tax or Tradable Permits w/imperfect information?

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1	7	100	270
0	8	120	330

- Suppose the market clears in the middle at $90 per permit.
- Source A will increase abatement and sell permits to Source B as long as the permit price > MAC.
- Source A increases abatement by 2 tons, freeing up 2 permits to sell.

Carbon Tax or Tradable Permits w/imperfect information?

CO_2 Emissions (tons/wk)	Tons Abated	Marginal Abatement Costs($) Source A	Source B
8	0	0	0
7	1	30	40
6	2	40	80
5	3	50	100
4	4	60	120
3	5	70	160
2	6	80	220
1	7	100	270
0	8	120	330

- Source B will purchase permits as long as purchase price < MAC.
- Source B will decrease abatement and purchase 2 permits.
- END RESULT: 50% reduction has been achieved, but permit price is higher.

Carbon Tax or Tradable Permits?

- Under the Carbon Tax, the policymaker sets the price and the quantity of abatement is determined by the market.
- Under the Tradable Permits program, the policymaker sets the quantity of abatement (by controlling how many permits they allow) and the market determines the price.

Carbon Tax or Tradable Permits?

Pros for tax

- No price volatility
- Revenue allows for “double-dividend”
- Can be applied at source (fewer monitoring sites. Relevant for developing countries)

Pros for cap-&-trade

- Emissions certainty
- Can raise revenues through auctioning
- Political feasibility in countries that are “taxation-averse” (e.g. U.S.)
- Non-producing participants have a “voice” by buying and retiring permits.