Chapter 14 Lecture - Economics of Pollution Control: An Overview

Econ 275 – Environmental Economics

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Pollution Control

Identifying Major Air Pollutants

- **Criteria pollutants** are substances known to be hazardous to health and welfare, characterized as harmful by criteria documents. They are particulate matter (often referred to as particle pollution), ground-level ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead.
- **Hazardous air pollutants** are noncriteria pollutants that may cause or contribute to irreversible illness or increased mortality. Examples of HAPs include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Other examples are dioxins, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.
- **Greenhouse gas (GHG) pollutants** are those collectively responsible for the absorption process that naturally warms the earth

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A Pollutant Taxonomy

- The ability of the environment to absorb pollutants is called its **absorptive capacity**.
- **Stock pollutants** are pollutants for which the environment has little or no absorptive capacity. Examples of stock pollutants include non-biodegradable bottles tossed by the roadside; heavy metals, such as lead, that accumulate in the soils near the emissions source.
- **Fund pollutants** are pollutants for which the environment has some absorptive capacity. An example is carbon dioxide.
- **Local pollutants** cause damage near the source of emissions while regional pollutants cause damage at greater distances. Particulate matter (PM10 and PM2.5) and nitrogen dioxide (NO_2) are the most important components of local air pollution.

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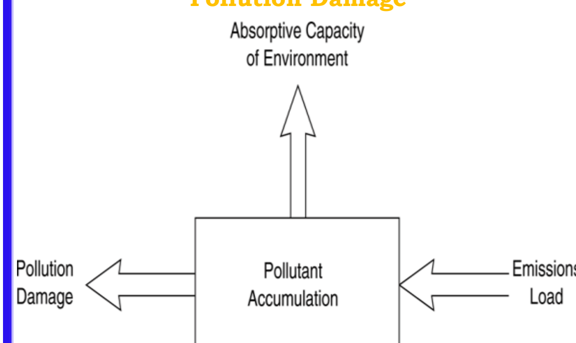
Relationship Between Emissions and Pollution Damage



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A Pollutant Taxonomy

- **Local and regional pollutants make up the horizontal dimension of damage or horizontal zone of influence.**
- **The vertical zone of damage refers to whether the pollution damages are mostly at ground level or if they accumulate in the upper atmosphere.**
- **Surface pollutants (water pollution) cause damage near the earth's surface, while global pollutants (carbon dioxide and chlorofluorocarbons) cause damage in the upper atmosphere.**

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Defining the Efficient Allocation of Pollution

Stock Pollutants

- **Damage rises as the pollutant accumulates.**
  - **Damage can take many forms.**
- **The optimal allocation of a stock pollutant is the one that maximizes the present value of benefits from consuming the good whose production causes the pollution minus the cost of damage to the environment caused by the pollutant.**
- **Stock pollutants create burdens for future generations.**

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Defining the Efficient Allocation of Pollution

Fund Pollutants

- **Pollution control is most easily analyzed from the perspective of minimizing cost.**
  - **Damage costs**
  - **Pollution control or avoidance costs.**
- **Marginal damage costs generally increase with the amount of pollution.**
- **Marginal control costs typically increase with the amount of pollution that is *controlled* or abated.**
- **The cost-minimizing solution is found by equating marginal damage costs to marginal control costs (see next slide).**

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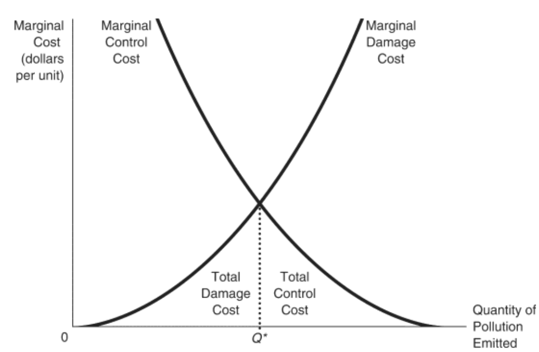
Efficient Allocation of a Fund Pollutant



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Market Allocation of Pollution

- Damage costs are externalities.
- Control costs are not externalities.
- Therefore what is cheapest for the firm is not always what is cheapest for society as a whole.
- Firms that attempt to control pollution unilaterally are placed at a competitive disadvantage.
- The market fails to generate the efficient level of pollution control *and* penalizes firms that attempt to control pollution.

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Efficient Policy Responses

- Efficiency is achieved when the marginal cost of control is equal to the marginal damage caused by the pollution for each emitter.
- One policy option for achieving efficiency would be to impose a legal limit on the amount of pollution allowed by each emitter.
- Another approach would be to internalize the marginal damage caused by each unit of emissions by means of a tax or charge per unit of emissions.
- Knowing the level of pollution at which these two curves cross is the difficulty.

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Cost-Effective Policies for Uniformly Mixed Fund Pollutants

Defining a Cost-Effective Allocation

- The cost-effective allocation is found by equating the marginal control costs of the two sources.
-
- Since total cost is the area under the marginal control cost curve, total costs across the two firms is minimized by minimizing the two areas and is found by equating the two marginal costs.
- Any other allocation would result in higher total cost.

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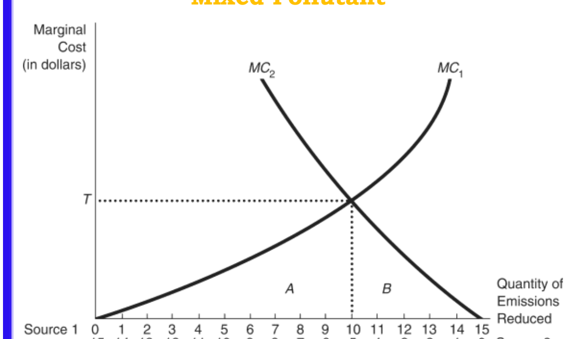
Cost-Effective Allocation of a Uniformly Mixed Pollutant



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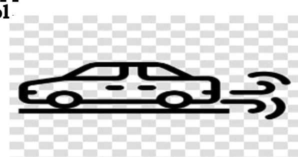
Cost-Effective Policies for Uniformly Mixed Fund Pollutants

- **Cost-Effective Pollution Control Policies**
  - **Emissions Standards**
    - **An emission standard is a legal limit on the amount of the pollutant an individual source is allowed to emit.**
    - **This approach is referred to as command-and-control**



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Cost-Effective Policies for Uniformly Mixed Fund Pollutants

Emissions Charges

- **An emission charge is a per-unit of pollutant fee, collected by the government.**
- **Charges are economic incentives.**
- **Each firm will independently reduce emissions until its marginal control cost equals the emission charge.**
- **This yields a cost-effective allocation.**
- **A difficulty with this approach is determining how high the charge should be set in order to ensure that the resulting emission reduction is at the desired level.**

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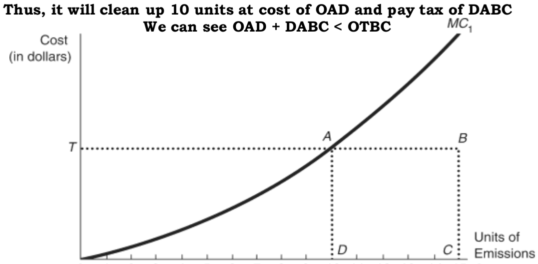
Cost-Minimizing Control of Pollution with an Emissions Charge

T = Emission charge per unit
OTBC = amount firm would pay with uncontrolled emissions

If company decides to control emissions it would do so if MC<T
Thus, it will clean up 10 units at cost of OAD and pay tax of DABC
We can see OAD + DABC < OTBC



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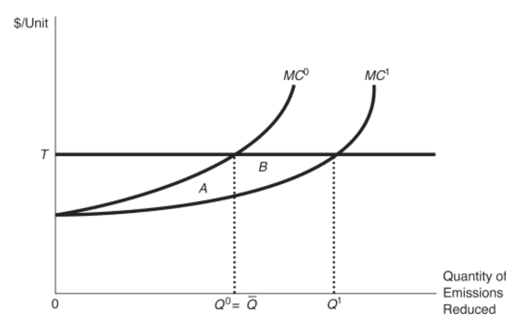
Cost Savings from Technological Change: Charges versus Standards (MC_0 to MC_1)



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Cost-Effective Policies for Uniformly Mixed Fund Pollutants

Cap-and-Trade

- **All sources are allocated allowances to emit either on the basis of some criterion or by auctioning. The allowances are freely transferable.**
- **The equilibrium price will be the price at which the marginal control costs are equal for both (or across all) firms.**
- **The market equilibrium for an emission allowance system is the cost-effective allocation, but it is easier said than done.**

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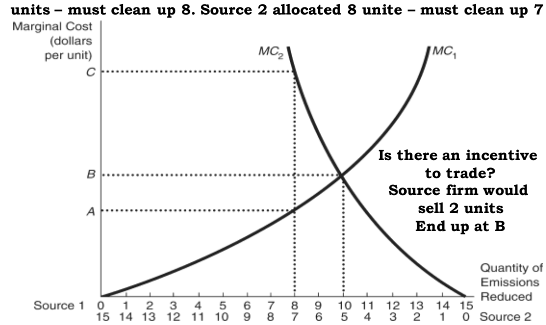
Cost-Effectiveness and Emission Trading

Total units of pollution allocated is 15 units. Source 1 allocated 7 units – must clean up 8. Source 2 allocated 8 unite – must clean up 7



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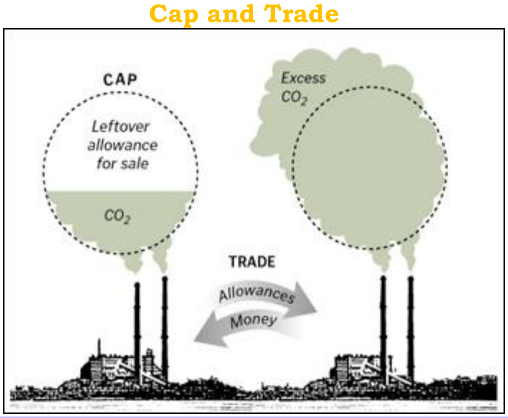
Cap and Trade



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Carbon Tax

Pros	Cons
1. Makes polluters pay external cost of carbon emissions.	1. Business claim higher tax can discourage investment and economic growth.
2. In theory, enables greater social efficiency, as we pay full social cost.	2. May encourage tax evasion – firms polluting in secret to avoid tax.
3. Raises revenue which can be spent on mitigating effects of pollution.	3. It can be difficult to measure external costs – and how much tax should actually be.
4. Encourages firms and consumers to look for alternatives, e.g. solar power.	4. Administration costs in measuring pollution and collecting tax.
5. Reduces environmental costs associated with excess carbon pollution.	5. Firms may shift production to countries without a carbon tax

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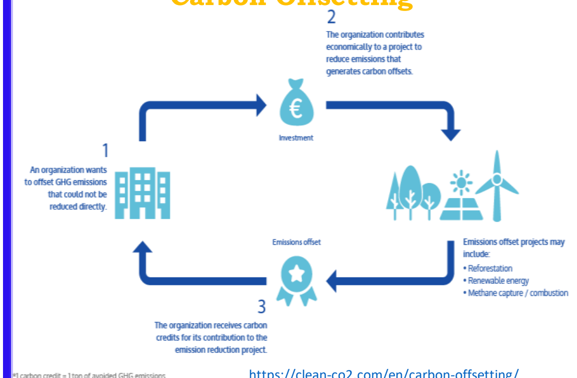
Carbon Offsetting



https://clean-co2.com/en/carbon-offsetting/

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The Swedish Nitrogen Charge

One of the dilemmas facing those who wish to use charges to control pollution is that the amounts of revenue extracted from those subject to the tax can be considerable and that additional expense can produce a lot of political resistance to the policy. This resistance can be lowered if the revenue is rebated to those who pay it, but if all firms know they are getting their money back, the economic incentive to limit emissions is lost. Is it possible to design a system of rebates that will promote political feasibility without undermining abatement incentives?

The Swedish nitrogen charge was designed specifically to resolve this dilemma. Sweden's nitrogen oxide emissions charge was first imposed in 1992 on large energy sources. Some 120 heating plants and industrial facilities with about 180 boilers were subject to the tax.

It was intended from the beginning to have a significant incentive effect, not to raise revenue. Although the charge rate is high by international standards (thereby producing an effective economic incentive), the revenue from this tax is not retained by the government, but rather is rebated to the emitting sources (thereby lowering resistance to the policy by the regulated sources). It is the form of this rebate that makes this an interesting scheme. While the tax is collected on the basis of *emissions*, it is rebated on the basis of *energy production*. In effect, this system rewards plants that emit little per unit of energy and penalizes plants that emit more per unit of energy, thereby providing incentives to reduce emissions per unit of energy produced.

As expected, emissions per unit of energy produced fell rather dramatically. The Swedish Ministry of the Environment and Natural Resources has estimated that the benefits exceeded the costs by a factor of more than 3 to 1. Note, however, that rebating the revenue means that this tax cannot produce a double dividend and it provides no incentives to reduce energy consumption.

Sources: Anderson, R., & Lohof, A. (1997). Foreign Experience with Incentive Systems. Section 11 in *The United States Experience with Economic Incentives in Environmental Pollution Control Policy*. Washington, DC: Environmental Law Institute; Sterner, T. (2003). *Policy Instruments for Environmental and Natural Resource Management*. Washington, DC: Resources for the Future, 286–288.

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Other Policy Dimensions

Responses to Changes in the Regulatory Environment

- **With charges, an increase in emitters will raise total levels of pollution.**
- **With an emission allowances system, the total level of pollution is fixed.**
- **Inflation will affect the price of the permit and result in higher permit prices.**
- **Technological progress in pollution control equipment would result in lower permit prices and lower abatement costs, but the same level of control.**

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Other Policy Dimensions

- **Price volatility**
  - **Volatility does not affect emission charges, but it affects allowances.**
- **Instrument Choice under Uncertainty**
  - **Determining the best policy option usually depends on whether certainty about emissions or certainty about control costs is more important.**
- **Product Charges: An Indirect Form of Environmental Taxation**
  - **One strategy is to tax the commodity that is most directly responsible for the emissions, rather than the emissions themselves.**
  - **It is efficient when all purchased units cause exactly the same marginal damage.**

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