

Environmental Economics – Lecture 3

Emission control: Instruments

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Perman et al (2011) ch 6



Review last lecture

1. Benefits and damages from emissions

- ▶ The emission target should be set such that the aggregate marginal benefit from emission equals the aggregate marginal damage from emission.

2. The efficient level of emissions

- ▶ Equivalently, the marginal abatement costs should equal the total willingness to pay for a marginal improvement of environmental quality



Preview this lecture

1. Criteria for choosing emission control instruments
2. Voluntary approaches
3. Command-and-control measures
4. Incentive-based instruments



Criteria for choosing emission control instruments

Table 6.1 Criteria for selection of pollution control instruments

Criterion	Brief description
Cost-effectiveness	Does the instrument attain the target at least cost?
Long-run effects	Does the influence of the instrument strengthen, weaken or remain constant over time?
Dynamic efficiency	Does the instrument create continual incentives to improve products or production processes in pollution-reducing ways?
Ancillary benefits	Does the use of the instrument allow for a 'double dividend' to be achieved?
Equity	What implications does the use of an instrument have for the distribution of income or wealth?
Dependability	To what extent can the instrument be relied upon to achieve the target?
Flexibility	Is the instrument capable of being adapted quickly and cheaply as new information arises, as conditions change, or as targets are altered?
Costs of use under uncertainty	How large are the efficiency losses when the instrument is used with incorrect information?
Information requirements	How much information does the instrument require that the control authority possess, and what are the costs of acquiring it?

Criteria for choosing emission control instruments

- ▶ The use of cost-effective instruments is a prerequisite for achieving an economically efficient allocation of resources.
- ▶ Least-cost theorem: a necessary condition for abatement at least cost is that the marginal cost of abatement is equalized over all polluting firms. (equimarginal principle)
- ▶ ...Math on blackboard, see Perman et al Appendix 6.1 (http://personal.strath.ac.uk/r.perman/Appendix_6_1.pdf)



Voluntary approaches

Bargaining

- ▶ Recall Coase (1960) on property rights and transaction costs
- ▶ Bargaining may lead to some abatement as every consumer is willing to pay up something to avoid emissions...
- ▶ ...but not enough to reach the social optimum → E is a public good → free-rider problem



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Liability [watch out, change of mindframe]

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Liability [watch out, change of mindframe]

- ▶ Both “strict-” and “negligence liability” incentivize the efficient level of precautionary behavior
- ▶ Problems:
 - ▶ Lead to moral hazard (from consumers)
 - ▶ Harm may be public
 - ▶ Expected value of harm may be unbounded
 - ▶ Firms may not be risk-neutral



Command-and-control measures

Instrument category	Description
<i>Command and control instruments</i>	
Input controls over quantity and/or mix of inputs	Requirements to use particular inputs, or prohibitions/restrictions on use of others
Technology controls	Requirements to use particular methods or standards
Output quotas or prohibitions	Non-transferable ceilings on product outputs
Emissions licences	Non-transferable ceilings on emission quantities
Location controls (zoning, planning controls, relocation)	Regulations relating to admissible location of activities

Figure: Excerpt of Table 6.2 from Perman



Command-and-control measures: Class exercise

Assume:

- ▶ No uncertainty, no asymmetric information.
- ▶ The number of firms in the market, K , is fixed.
- ▶ Firms differ in productivity and set-up cost (increasing in j).
- ▶ Regulator sets a cap \bar{m} on emissions

The firm's objective is to maximize profits:

$$\pi(m_j) = f_j(m_j) - b_j \quad \text{subject to } m_j \leq \bar{m}$$



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- ▶ *What is the achieved reduction in emissions?*
- ▶ *Will the instrument be cost-effective?*



Command-and-control measures

Emission cap \bar{m} will, in general, not be cost-effective (CE).

- ▶ If the cap is not binding, no change of firm emissions
- ▶ If firms have different $f_i(m)$ but face the same cap \bar{m} , equimarginal principle will not hold
- ▶ If regulator has full knowledge of each $f_i(m)$ and $D'(M)$, firm-specific cap \bar{m}_i can be set: CE and Pareto-optimality (PO)
- ▶ If regulator has full knowledge of each $f_i(m)$ but does not know $D'(M)$, firm-specific cap can be set: CE but not PO



Incentive-based instruments

- ▶ Suppose a total emission quota \bar{M} is set by the regulator, and each firm is allocated a part of it. When firms have the right to buy or sell their permit, their problem is to maximize:

$$\pi(m) = f(m) - b + p(\bar{m} - m)$$

- ▶ The corresponding FOC is $f'(m) = p$ which can be interpreted as the firm's demand function. p reveals info about $f'(m)$.
- ▶ By setting $\bar{M} = M^*$, the regulator achieves PO and CE.
- ▶ Although the initial allocation of \bar{m} does not matter for efficiency, it does have distributional consequences.
- ▶ Further problems are thin markets and emission leakage.
- ▶ Which tax level has the same effect as setting the optimal quota?



Undifferentiated vs differentiated taxes and permits

- ▶ When emissions are uniformly mixing, but different tax levels for different firms, regulation will not be cost-effective
- ▶ When emissions are not uniformly mixing, but cause different damages at different places, a uniform tax will not be optimal.
- ▶ Differentiated (source-specific) taxes will solve the problem but require the same amount of information as a tailored command-and-control instrument (marginal abatement cost and transfer coefficients)
- ▶ What about marketable permits?



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- ▶ What about marketable permits? Not cost-effective if undifferentiated, effective if differentiated (receptor specific). Requires less info (only transfer coefficients)



Taxes and subsidies

- ▶ Instead of taxing emissions, the regulator may choose to subsidize abatement
- ▶ The two instruments are equivalent in terms of achieved emission reduction when $s = \tau$
- ▶ Both instruments are CE, and PO if $s = \tau = \sum_i z'(M) \sum_i \frac{u'_E}{u'_y_i}$
- ▶ Recall Coase (and all the caveats): It does not matter for efficiency who has the initial property right
- ▶ But clearly the choice between tax and subsidy has an impact on the firm's balance sheet (and the political feasibility of regulation)



Taxes and subsidies: Class exercise II

Assume:

- ▶ No uncertainty, no asymmetric information.
- ▶ The number of firms in the market, K , is endogenous and adjusts within a year
- ▶ Firms differ in productivity and set-up cost (increasing in j).
- ▶ Regulator either sets a tax τ on emissions or subsidizes emission reductions

The firm's objective is to maximize profits:

$$\pi(m_j) = f_j(m_j) - b_j - \tau m_j + s(\hat{m}_j - m_j)$$



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- ▶ *What is the achieved reduction in emissions on impact and after a year for each instrument?*



Taxes and subsidies

- ▶ With fixed # of firms:
 - ▶ difference subsidy/tax: pure transfer, no real cost
 - ▶ may matter for distribution, not for efficiency
- ▶ Tax with endogenous # of firms:
 - ▶ Makes the industry less profitable
 - ▶ Tax reduces pollution from existing firms, and can decrease number of firms → unambiguous reduction!
- ▶ Subsidy with endogenous # of firms:
 - ▶ even if each pre-existing firm abates just as much with each instrument, there are more firms with the subsidy
 - ▶ total emissions are higher with subsidy than with tax; may be higher than with no regulation!



Review this lecture

1. Criteria for choosing emission control instruments
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4. Incentive-based instruments
 - ▶ Undifferentiated vs differentiated taxes
 - ▶ Taxes and subsidies



Preview next lecture

Regulation under imperfect information Weitzman (1974)

Perman et al ch7,

1. Regulator does not know the firm's "type"
 - ▶ Prices vs. Quantities
 - ▶ Revealing private control cost information
2. Regulator does not know the firm's action
 - ▶ Midnight dumping and deposit-refunds
 - ▶ Audits and Enforcement
 - ▶ Dynamics and Commitment

