Lecture 4

ECON 4910, Environmental Economics

Spring 2011

This lecture

- Policy instruments, cont.
  - Consumer subsidies
  - Green certificates
  - Tradable permits
  - Readings: Perman et al. 2003, Ch.7 (cont.)
- Policy instruments under uncertainty
  - Prices vs quantities
  - Readings: Perman et al. 2003, Ch. 8

Consumption: Taxes versus subsidies

- Three consumption goods
  - e^1: brown energy (e.g. coal), producer price q^1, tax $t \geq 0$
  - e^2: green energy (e.g. windpower), prod. price q^2, subsidy $s \geq 0$
  - c: non-energy consumption (e-books), producer price p
  - Consumer price = producer price + tax – subsidy.

Max $U = u(e^1, e^2, c, E)$ E considered exogenous by cons.

s.t. $(q^1+t)\, e^1 + (q^2-s)\, e^2 + pc = F$ F = ex. income

- First order conditions:

$(u'_{e1}/u'_{e2}) = (q^1+t)/(q^2-s)$ Same rel.price e^1 vs e^2: through t or s

$(u'_{e1}/u'_c) = (q^1+t)/p$ Tax: Relative energy price +

$(u'_{e2}/u'_c) = (q^2-s)/p$ Subsidy: relative energy price -

Subsidising green consumption

- Brown energy tax can decrease total energy use
  - and more of that energy use is green
- Green energy subsidy can increase total energy use
  - but more of that energy use is green
- Green energy: environment-friendly, or just less damaging, than brown?
- Rule of thumb: subsidize the good, tax the bad
  - the less bad: tax less

Combinations of tax and subsidy

- Deposit – refund (pant)
  - Ex.: Bottles and cans, cars
  - Tax at purchase, subsidy at return
  - If no environmental damage is caused, tax is returned
- Green certificates
  - Tax on electricity use & subsidy on green energy production

Green electricity certificates

- Producer of green electricity gets one certificate for each kwh produced
- Users of electricity must buy α *(< 1)* certificates for each kwh used
  - equivalent to subsidizing renewable electricity production with revenue obtained from tax on electricity use
- Implies that a share α of total electricity will be green
  - *Portfolio standard*: prod./use of good A must be proportional to prod./use of good B
  - Another example of portfolio standard: Biofuel in transportation fuels
- Note: Green share α can be reached with no decrease in brown consumption

Green certificates, cont.

- The tax part: Reduces electricity demand
- The subsidy part: Increases electricity supply
- Net effects on electricity use: Ambiguous
- Net effects on the environment:
  - Brown electricity decreases
  - Green electricity increases
  - If ONLY brown damages the environment: Environmental improvement!
  - If BOTH damage to some exent: Ambiguous
- (Goal: Technological development?
  - If so: subsidize technological development)

Tradable permits

- Total emission cap for society: M^{max}
- Initial allocation (initial emission cap) for each firm k: m_k^0, such that $\sum m_k^0 = M^{max}$
  - for the moment: consider # of firms fixed
- Firms can buy or sell permits
- If firms' abatment cost differ after initial permit allocation,
  - i.e. $f'_k(m_k^0) < f'_l(m_l^0)$ for some k, l

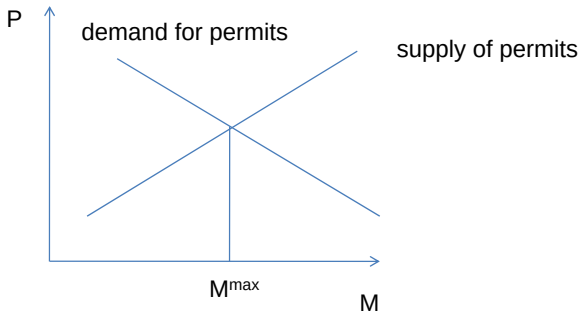
  there is room for "bargaining" between firms:
  - Firm k can abate cheaper than firm l -> k sells a permit to l, l pays a price P such that $f'_k(m_k^0) < P < f'_l(m_l^0)$ -> Both benefits
- A market for permits will arise
  - Demanders vs suppliers: determined by initial allocation and marginal costs
  - Trade occurs until every firm has the same abatement cost
  - In equilibrium, M^{max} is reached at least possible cost

Profit max with tradable permits

- Permit purchase: $m_k - m_k^0$
- Permit sale: $m_k^0 - m_k$ = negative purchase
- Assume perfect competition in the permit market, i.e. each firm considers the permit price P fixed
- Assume each firm considers m_k^0 exogenously fixed
- Max $\pi_k = f(m_k) - b_k - P(m_k - m_k^0)$ wrt m_k
- Differentiate, get first order condition for interior max: $f_k' = P$
- Market price for permits P: Similar to a uniform tax (or subsidy)
- Note: Holds for permit sellers and buyers. Reason: Alternative value of permits

Permit market

- Suppliers: Firms with $f_k'(m_k^0) < P$
- Demanders: Firms with $f_k'(m_k^0) > P$



- At M^{max}, all firms have $f_k'(m_k) = P$ -> cost efficiency
- If goals are set such that M^{max} = M* (PO level), then the market will produce the equilibrium price P=D'= t* (Pigou tax)

Initial allocation of permits

- Allocation mechanisms (see Perman 7.4.2):
  - The regulator sells permits to firms: Fixed price or auction
  - The regulator gives permits to firms for free (e.g. ”grandfathering”: allocations based on previous emissions)
- M^{max} is reached cost efficiently, regardless of
  - which firms get (most of) the initial allocations
  - whether firms must pay for initial allocations or not
  - Assumes: Permits allocated unconditional on production
- Recall the Coase theorem:
  - Bargaining (here: trade) gives efficiency, independent of who has the property rights.
  - Permits: Pollution rights
- Initial allocation does affect income distribution

Industry size & composition

- What if number and composition of firms are not fixed?
- Free initial permits:
  - Higher profits (than with paid initial permits)
  - Size of industry higher (than with paid initial permits)
  - Recall: subsidies vs. taxes
- But: **M^{max} is fixed!**
  - **industry size may affect P, but not M**
- If only some firms get free permits
  - Cost advantage
  - composition of industry may be affected
  - Ex.: Grandfathering -> old firms get cost advantage over new firms; firms that did not abate before gets cost advantage over those who did

Asking for information

- Optimal policy: must know B'(M) and D'(M)
  - B'(M) = D'(M) (∑MWTP, abatement costs)
  - How to get this knowledge: Ask?
  - Ask consumers?
  - If they expect to pay their MWTP: Incentive to underreport
  - If they do not expect to pay, but want more E: Incentive to overreport
  - Ex post redistribution: who are the losers?

    To make it a Pareto improvement: Must know every MWTP; incentive to underreport
- *Incentive-compatible* instrument: Incentives faced by the regulated coincide with those of the regulator
  - including: no incentive to lie!
- Hard to find fully incentive-compatible instruments (but for one example: see Perman 8.3.4).

Firms expect a permit regime

- Assume that firms:
  - expect regulator to use tradable permits
  - expect M^{max} to be set such that the regulator thinks D'=B'
  - expect regulator to decide M^{max} *after* information is collected
- Will firms report marginal abatement cost truthfully?
  - Report high f': Regulator thinks B' is high rel. to D'
  - That justifies a high aggregate permit level
- In firms' interest to exaggerate marginal abatement costs

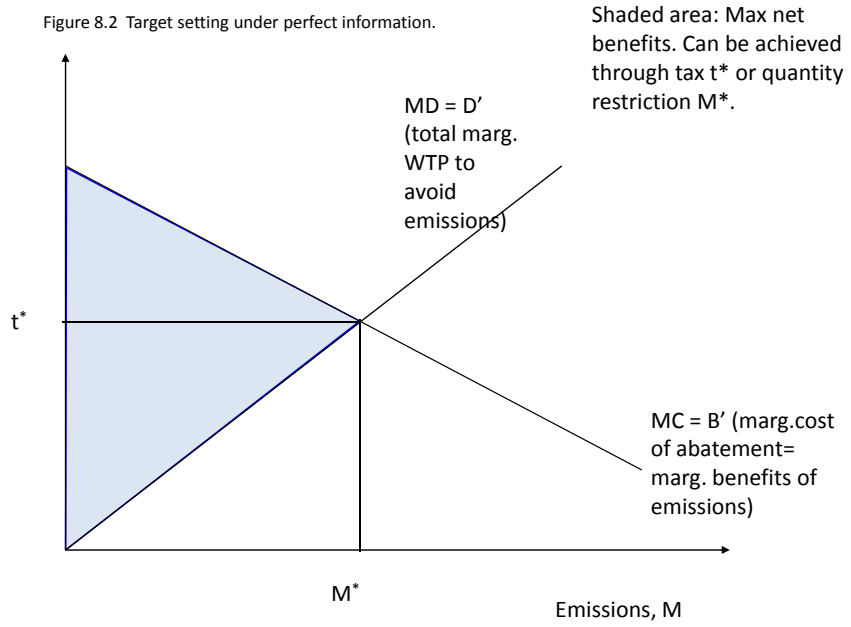
Firms expect a tax regime

- Assume that firms:
  - expect regulator to use emission taxes
  - expect *t* to be set such that the regulator thinks D'=B'
  - expect regulator to decide *t after* information is collected
- Will firms report marginal abatement cost truthfully?
  - Report high f': Regulator thinks B' is high rel. to D'
  - That justifies a high tax
- In firms' interest to underreport marginal abatement costs

Instrument choice under uncertainty

- Assume: Regulator's goal = Pareto efficiency
- Assume: Aggregate marginal damages are known
- If aggregate abatement cost function is known
  - tax and tradable permits are equivalent
  - Both can achieve PO: Total quantity M*, marginal abatement cost t*
- What if aggregate abatement costs are uncertain?
  - Genuinely uncertain; but realized *after* regulator moves, *before* firm moves
  - Not known by regulator (firms' private information)

Figure 8.2 Target setting under perfect information.



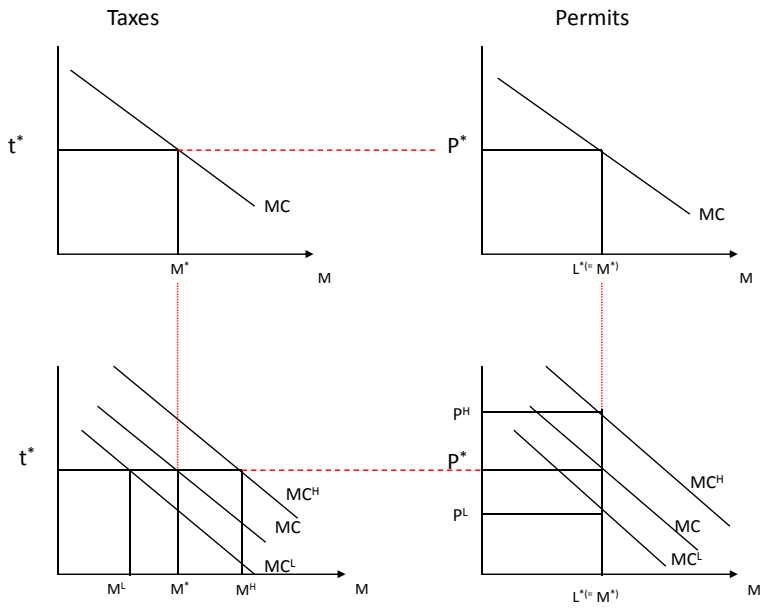
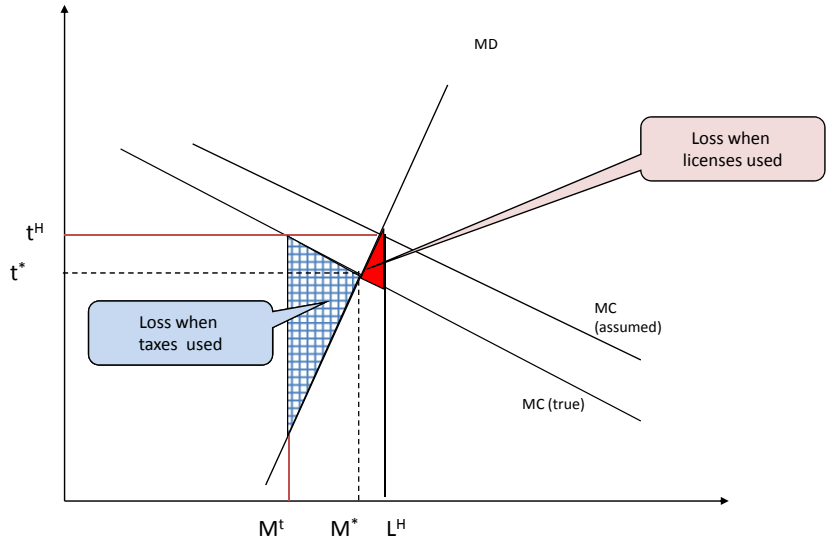


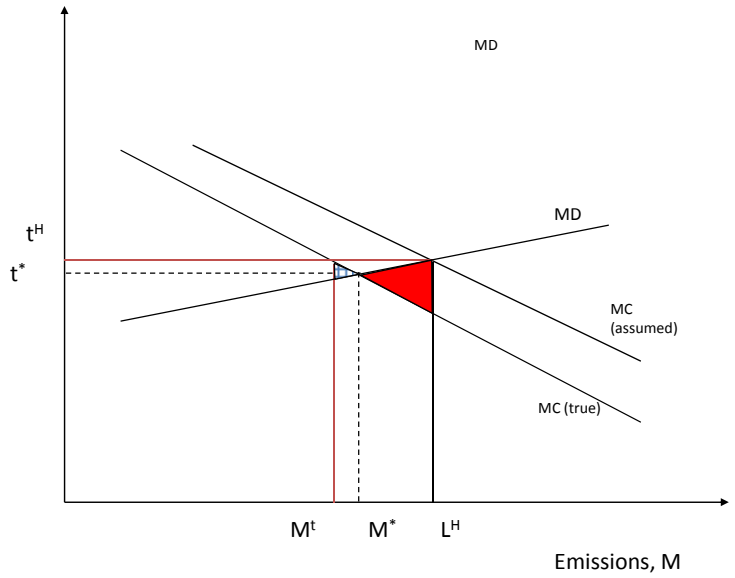
Figure 8.1 A comparison of emissions taxes and marketable emissions permits when abatement costs are uncertain.

Figure 8.3 Uncertainty about abatement costs – costs overestimated.



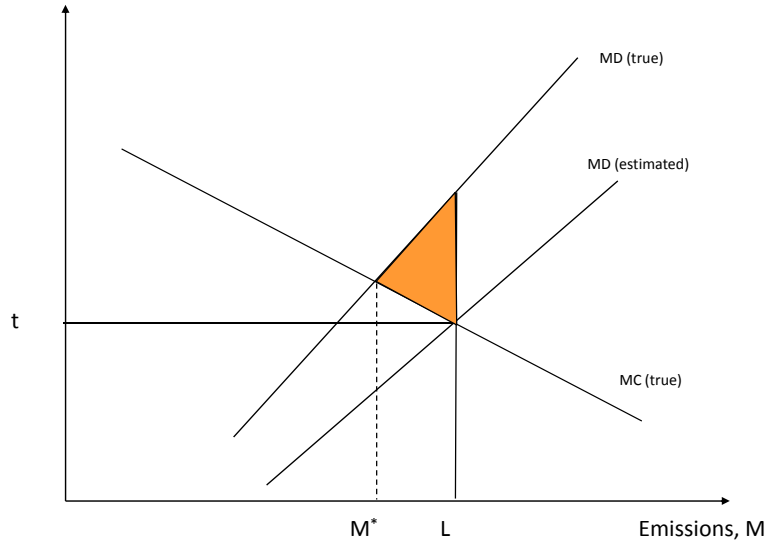
Target mistake: Costs of setting the ”wrong” target is *larger* with tax than permits

Figure 8.5 Uncertainty about abatement costs – costs overestimated.



Target mistake: Costs of setting the ”wrong” target is *smaller* with tax than permits

Figure 8.7 Uncertainty about damage costs – damages underestimated.



Damage uncertainty does not matter!

Reason: Only firms act; firms relate to MC curve, not MD curve

Prices versus quantities

Weitzman (1974)

- **Taxes** (prices): Good when MC is steep
  - Preferred when the marginal abatement cost curve (MC=B') is steeper (absolute slope is greater) than the marginal damage curve (MD=D')
- **Permits** (quantities): Good when MD is steep
  - Preferred when the marginal abatement cost curve (MC=B') is flatter (absolute slope is lower) than the marginal damage curve (MD=D')
- Intuition:
  - if marg. abatement costs increase quickly, too much abatement is costly
  - if marg. env. damages increase quickly, too much pollution creates a lot of damage
- Implicit assumption: Uncertainty about levels rather than slopes
- Cost uncertainty matters for instrument choice – damage uncertainty does not

Next time

- Enforcement
  - Will firms break the law?
  - If not: what to do?
- Readings: Heyes 1998