

Lecture 4

ECON 4910, Environmental
Economics
Spring 2010

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
- Enforcement (Heyes 1998)
 - 5th lecture!

Effects of an abatement subsidy

- Existing firms pollute less
- But: The industry is now more profitable than before
 - Number of firms may increase
- Which effect dominates?

Subsidies versus taxes

- Fixed # of firms:
 - Emission tax/abatement subsidy: equivalent, except profits
 - Pure transfer, does not affect efficiency
- Tax, endogenous # of firms:
 - Tax makes industry *less* profitable
 - Tax reduces pollution from existing firms, and may decrease number of firms -> reduced total emissions
- Subsidy, endogenous # of firms:
 - Subsidy makes industry *more* profitable
 - Subsidy reduces pollution from existing firms, and may increase number of firms -> total emissions: +/-?
- Subsidy: **More emissions** than with tax
 - More emissions than with no regulation??

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 extent: Ambiguous
- (Goal: Technological development?
 - If so: subsidize technological development)

Tradable permits

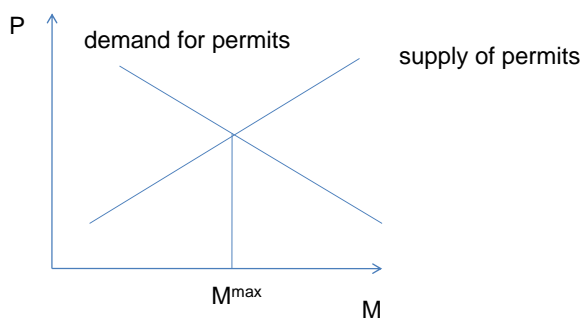
- Total emission cap for society: M^{max}
- Initial allocation (initial emission cap) for each firm k : m_k^0 , such that $\sum m_k^0 = M^{max}$
 - for the moment: consider # of firms fixed
- Firms can buy or sell permits
- If firms' abatement cost differ after initial permit allocation,
 - i.e. $f'_k(m_k^0)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

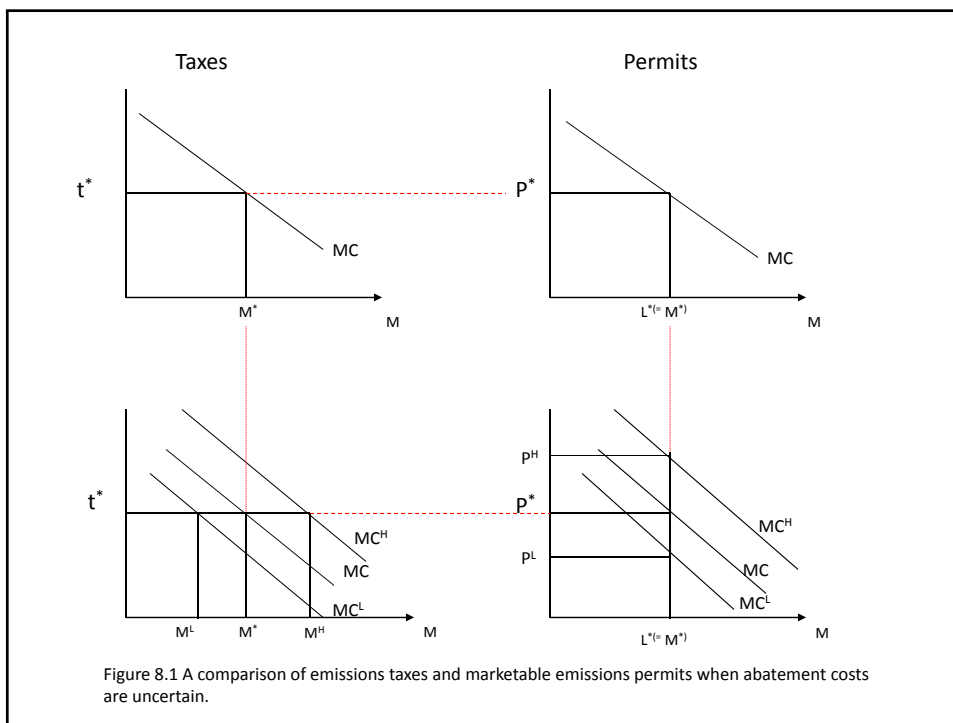
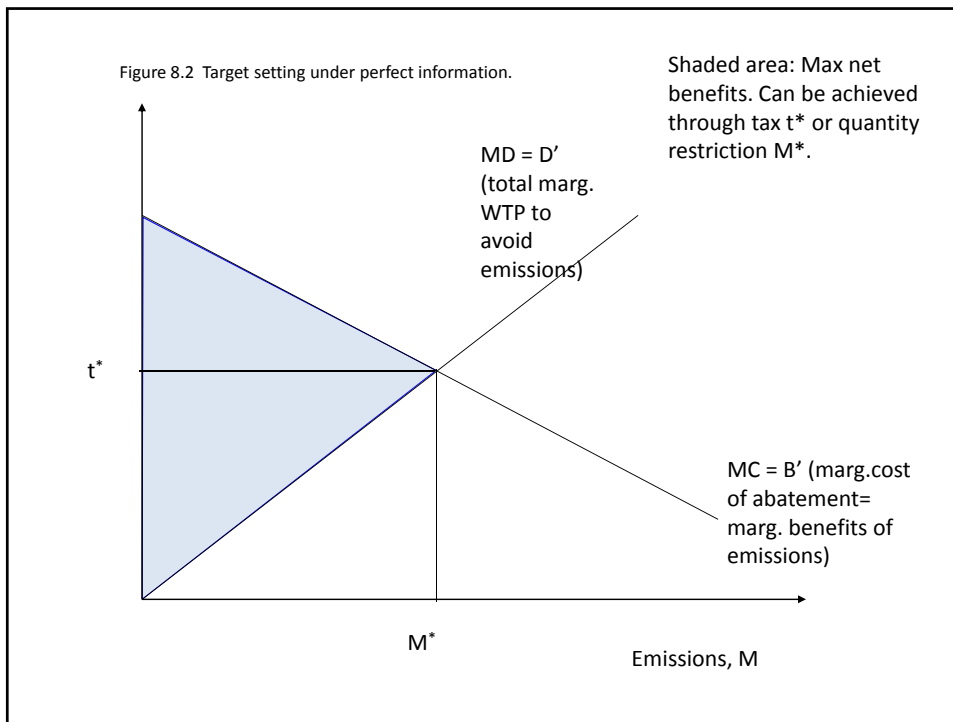
- Assume that firms:
 - expect regulator to use tradable permits
 - expect M^{max} to be set such that the regulator thinks $D'=B'$
 - expect regulator to decide M^{max} *after* information is collected
- Will firms report marginal abatement cost truthfully?
 - Report high f' : Regulator thinks B' are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

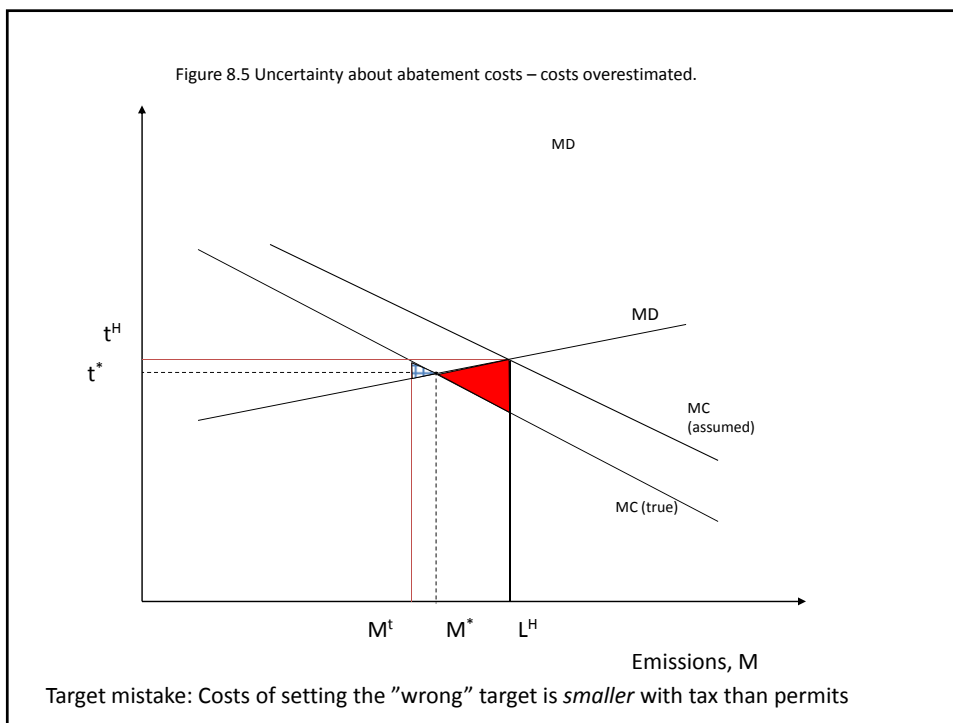
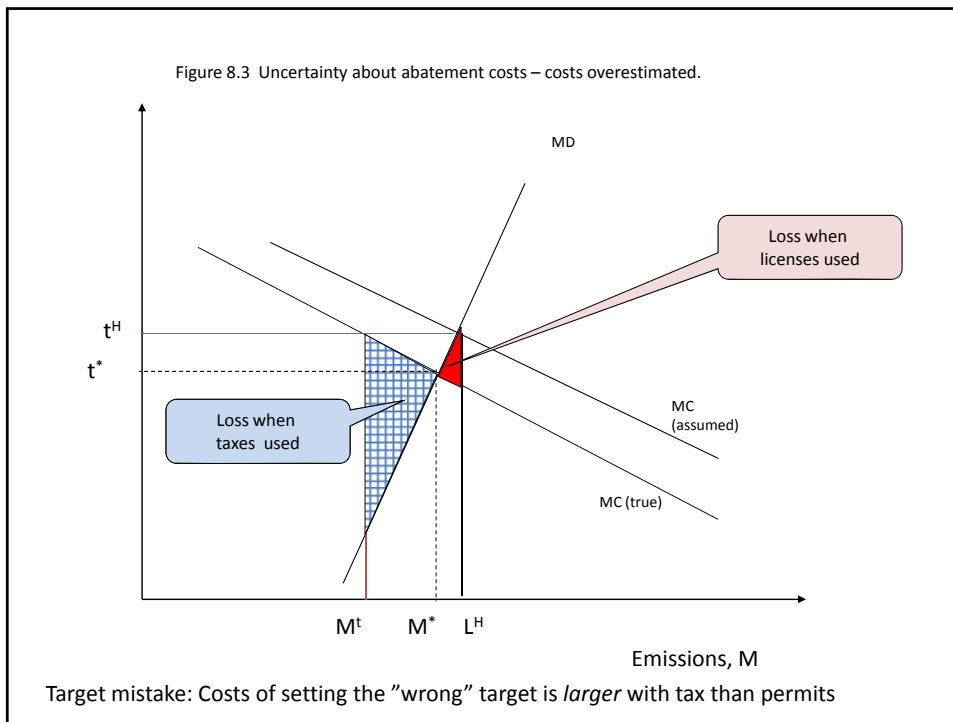
Firms expect a tax regime

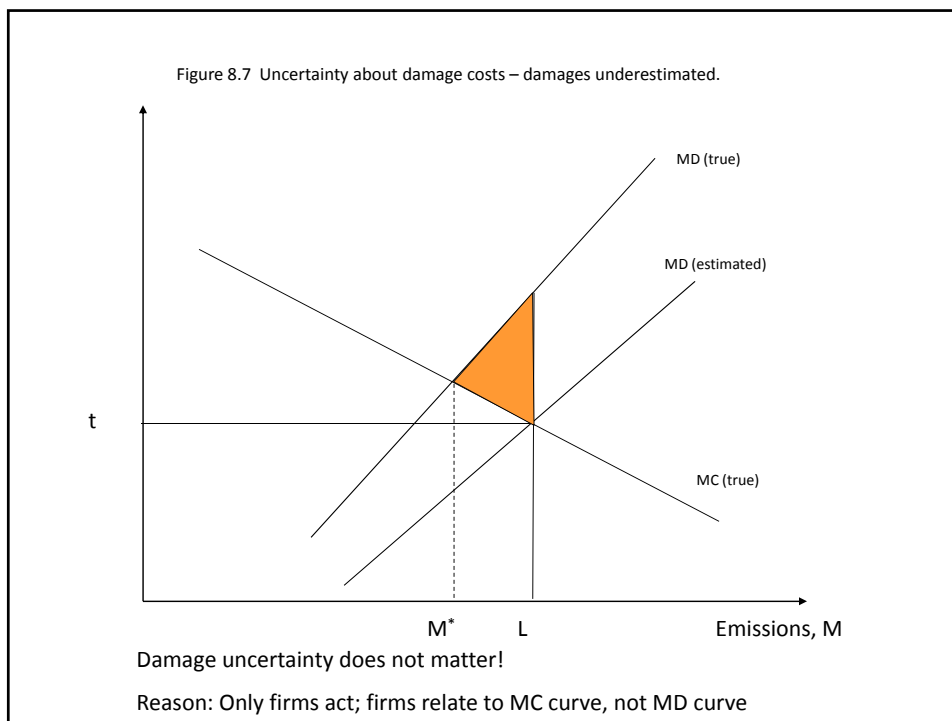
- Assume that firms:
 - expect regulator to use emission taxes
 - expect t to be set such that the regulator thinks $D'=B'$
 - expect regulator to decide t *after* information is collected
- Will firms report marginal abatement cost truthfully?
 - Report high f' : Regulator thinks B' are high rel. to 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)







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?
- Voluntary contributions to the environment
 - Firms: Voluntary agreements, CSR
 - Consumers: Altruism, social and moral norms