Lecture 4

ECON 4910, Environmental Economics

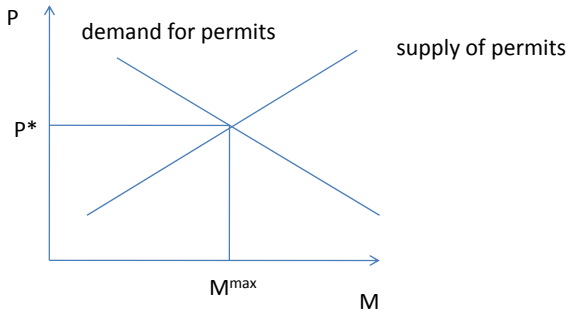
Spring 2008

This lecture

- Policy instrument, cont.
  - Permit markets: Initial allocation of permits
  - Asymmetric information: Prices vs quantities
  - (Incentive compatibility: See Perman 8.3.4)
- Enforcement
  - Will rules be obeyed by firms?
  - If not, what should the regulator do?

Permit market

- Suppliers: Firms with $f_k' < P$
- Demanders: Firms with $f_k' > P$



- If $M^{max} = M^*$ (Pareto optimal level, market produces equilibrium price $P^* = D' = t^*$ (Pigou tax)
- If # of firms fixed: Uniform tax, uniform subsidy, and permit marked (perfect competition) are equivalent

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 firms’ 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
  - This assumes that the # of firms is fixed
- 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
- 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

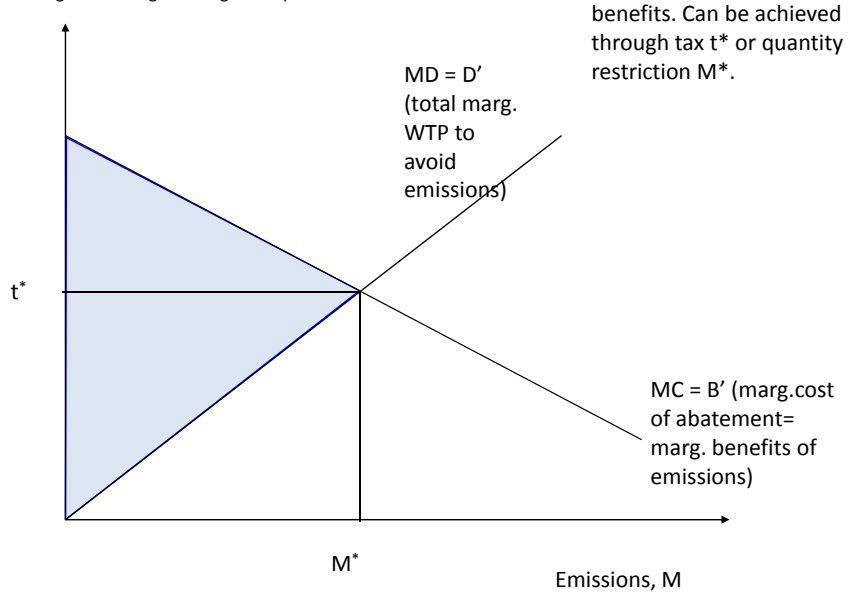
Combinations of tax and subsidy

- 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
  - Production of green energy gives right to issue green certificate
  - Production of brown energy requires purchase of green certificate
  - Tax on brown energy, subsidy to green energy

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.



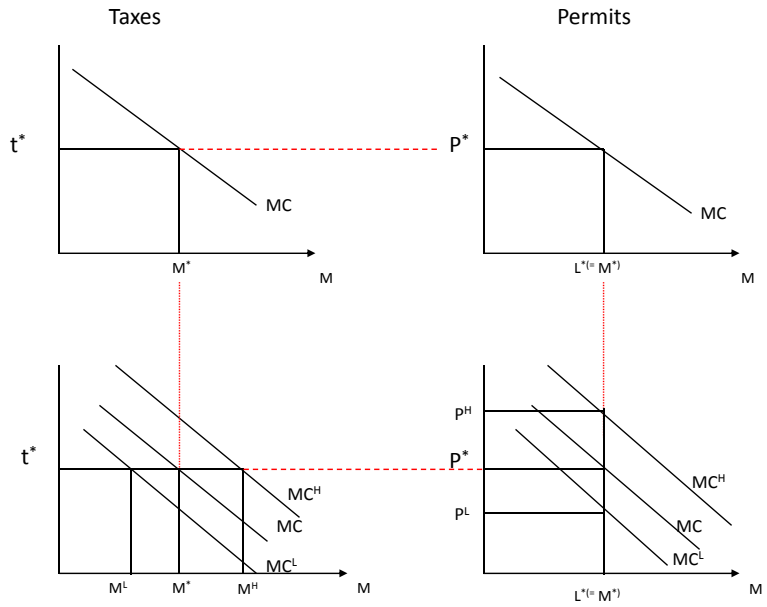
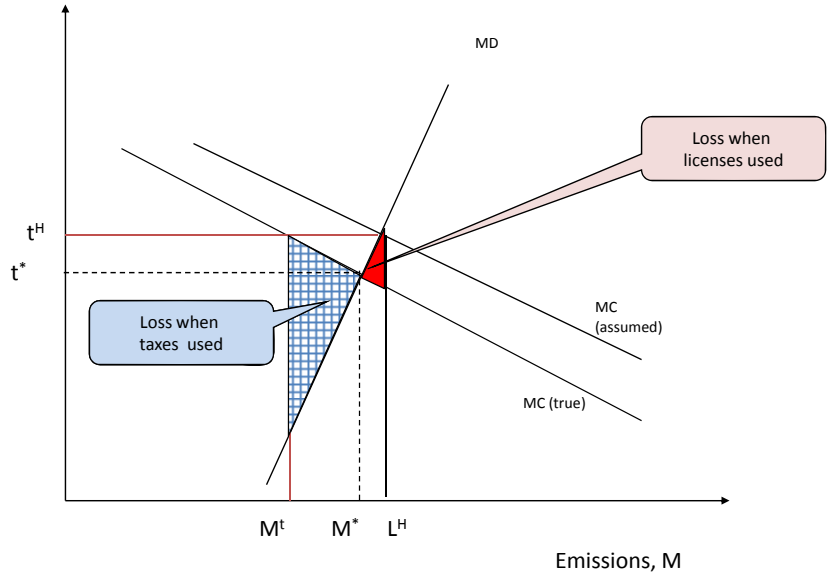


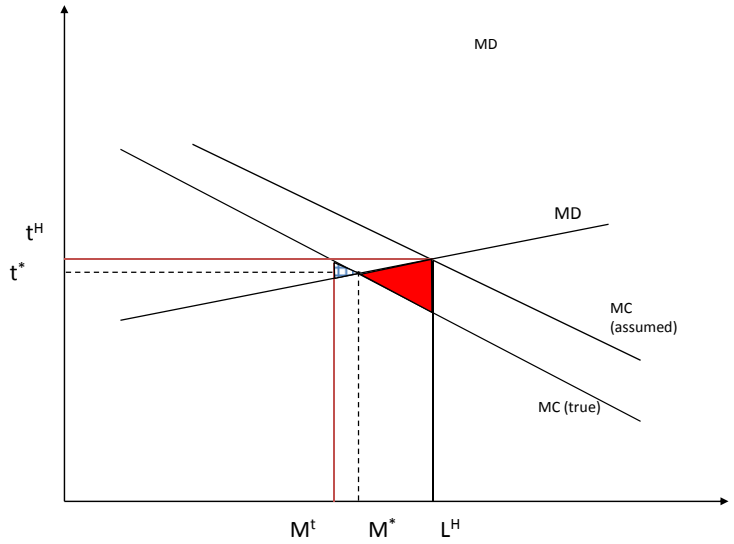
Figure 8.1 A comparison of emissions taxes and marketable emissions permits when abatement costs are uncertain.

Figure 8.3 Uncertainty about abatement costs – costs overestimated.



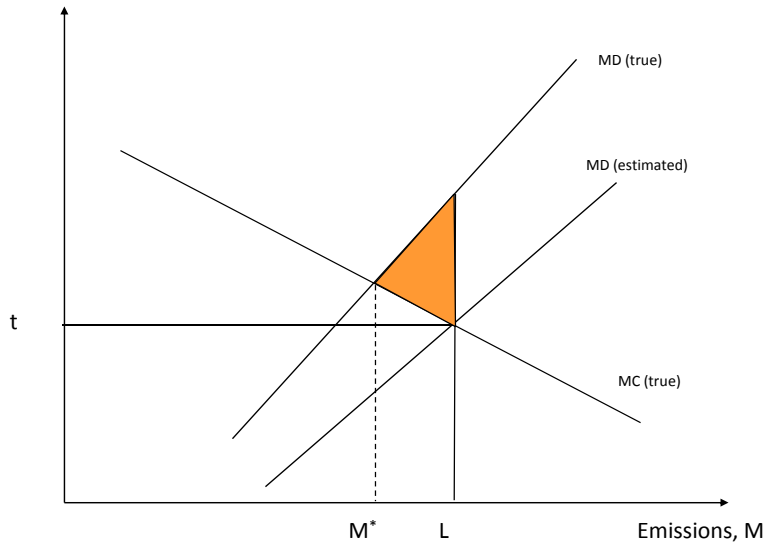
Target mistake: Costs of setting the ”wrong” target is *larger* with tax than permits

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)

- Cost uncertainty matters for instrument choice – damage uncertainty does not
- **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, extra abatement is costly
  - if marg. damages increase quickly, extra pollution creates a lot of damage
- Implicit assumption: Uncertainty about levels rather than slopes

Enforcement

- Readings: Heyes (1998), Perman et al. 8.4
  - classical paper: Becker (1968): Crime and Punishment: An Economic Approach, *J.Pol.Econ*. 76
- Enforcement:
  - Monitoring/detection: Are firms violating?
  - Sanctioning: Punishment of confirmed violators
- Will firms comply?
  - For simplicity: Consider the case of emission cap
  - Profit max. firm complies only if expected penalty of violating exceeds the firm's compliance cost
- What should the regulator do about it?
  - Sufficiently strict enforcement to ensure no violation?
  - Accept that some violation will occur?

Firms' compliance choice

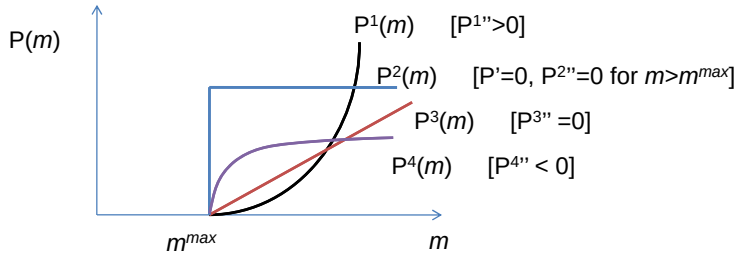
- "Binding" emission cap: $m^{max} < m^{\wedge}$
  - What happens if rule is broken?
  - disregard difference between firms – skip subscript *k*
- Discrete / continuous choice?
- Risk neutral firms: Maximize expected profits
- Perfect monitoring
  - if inspected, firm's compliance is revealed without error
- Enforcement policy:
  - Fixed monitoring probability *q*
  - Only inspected firms can be sanctioned
  - Penalty P (inspected firms) (unlucky notation: P is NOT permit price!):
    If $m \leq m^{max}$: P = P(m) = 0
    If $m > m^{max}$: P = P(m) ≥ 0, P' ≥ 0
  - Firm knows P(m) and *q*

Profit maximizing compliance levels

- Rather than taking the constraint $m \leq m^{max}$ as given, the firm maximizes expected profits, given that there may be costs associated both with abatement and violation:
- Max E(π) $= f(m) - b - E(P)$
  $= f(m) - b - q P(m)$ with respect to m
- First order condition for interior solution:
  $\partial E\pi / \partial m = f' - qP' = 0$ $\rightarrow f' = qP'$
- The firm will pollute until the marginal abatement cost equals the *marginal expected penalty*.
- Note: equivalent to Heyes, just slightly different notation and formalization
  - abatement costs vs. income from pollution; cost minimization vs. profit max., penalty as a function of emissions or violations

The penalty function

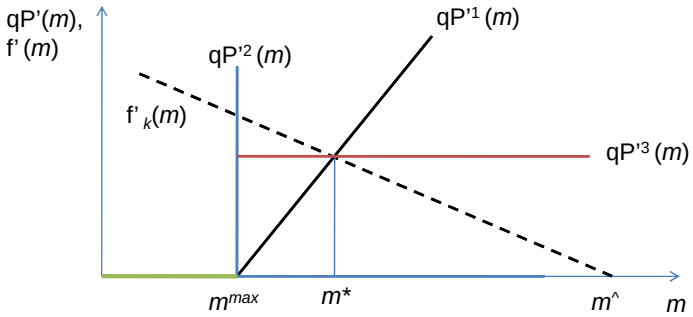
- Is the marginal penalty increasing in the degree of violation?
- All of these P functions impose a penalty for violations
  - but their effect on emissions are very different:



- *F.o.c.:* $f' = qP'$
  - f' decreasing in m (because f is concave)
  - If qP' is increasing in m, there will be an interior solution: The firm pollutes until marginal expected penalty becomes higher than f'
  - If qP' is *not* increasing in m : May get corner solutions

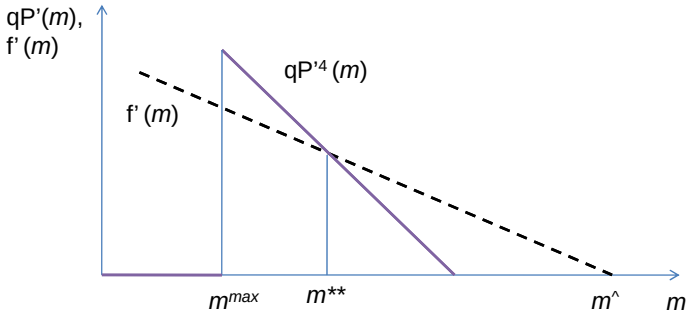
The importance of marginal penalties

- Increasing or fixed marginal penalties ($P^1(m)$, $P^3(m)$):
  - Profit max. emissions m^*
- High absolute, but zero marginal penalties ($P^2(m)$):
  - Corner solution: either m^{max} or $m^{\wedge}$



The importance of marginal penalties, cont.

- Decreasing marginal penalties ($P^4(m)$):
  - at m^{**}, f.o.c is fulfilled
  - But: If emissions increase marginally, revenue will increase more than expected penalty
  - Corner solution: either m^{max} or $m^{\wedge}$

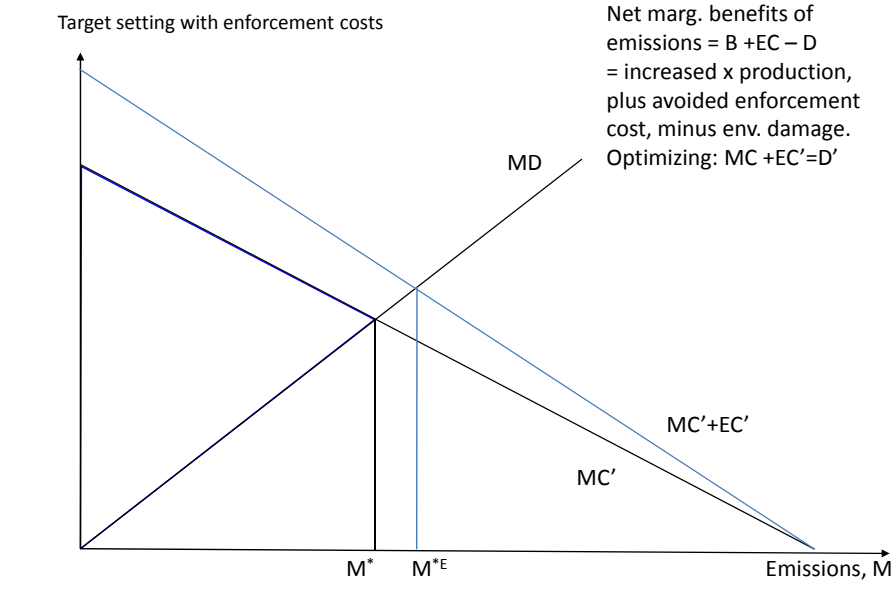


Firms' compliance

- Profit maximizing firms: Violate as long as the cost of compliance exceeds expected penalty
- The degree of violation depends on the *marginal* expected penalty (and marg. abatement cost)
  - decreasing marginal penalties may encourage full violation
- Note: If violation is profitable for the firm, and *q* and *P* are independent of compliance history, the firm will violate "forever" (even after it is caught).
  - Ex: q = 1, P''>0, $f'(m^{max}) > P'(m^{max})$
  - In this case, regulator knows that firm is violating, the firm is sanctioned, but still violates.

Regulator's response

- Sufficiently high penalties and/or monitoring probabilities can ensure full compliance
  - e.g.: q=1, P'(m^{max})> f'(m^{max}), and P''≥0
  - Credible threats of sufficiently harsh punishment can eradicate crime
- In practice: Expected penalty is limited
  - If monitoring is costly (inspection costs etc): Limited regulatory budget gives q<0
  - If sanctioning is costly (legal procedures etc): Limited reg. budget may limit the level of practically feasible penalties
  - If monitoring is imperfect: Type I and II errors, fairness
  - Fairness concerns, more generally: Reasonable/politically acceptable?



M^{*E} = Pareto efficient emission level, taking real enforcement costs into account

Regulator's response – general remarks

- Enforcement costs are real economic costs
  - Some goals may not be worth it, given the enforcement costs
  - Example of transaction costs
  - Arise (partly) because of information asymmetries and strategic incentives (private information on e.g. costs, emissions)
- Enforcement costs are not independent of the goal
  - Easy measurement/verification -> lower enforcement cost
- Relevant for all policy instruments
  - e.g.: collection of emission taxes requires knowledge of emission levels
- Enforcement and regulation must be considered jointly
- The regulator may have to take into account: Regulation will not be perfectly obeyed
  - Full compliance usually too expensive
  - Some taxes will be evaded; some illegal emissions will take place.

Next time: Project assessment and valuation

- Normative vs positive welfare economics
  - Distributional concerns
- Cost-benefit analysis
  - Theoretical underpinnings and ethical foundation
  - The use of CBA in practice
  - CBA and politics: How to handle the controversies in practice?
- Monetary valuation of environmental goods
  - Different valuation methods
  - Alternatives to monetary valuation