Lecture 5

ECON 4910, Environmental Economics
Spring 2009

Instrument choice under uncertainty (Perman Ch.8)
Enforcement (Heyes 1998)
Voluntary contributions: Firms
(Heyes 1998, Lyon and Maxwell 2008)

Voluntary term paper

- Go to web page for ECON4910 Spring 2008:

http://www.uio.no/studier/emner/sv/oekonomi/ECON4910/v08/

  - Choose "Term paper"
- **Your assignment: Problems 1 and 2** (not 3)
  - 2 f: not yet discussed in class; think for yourself & make a try
- Before leaving class *today*: find a partner
- Next lecture (March 1; no lecture in week 8):
  - Bring your paper to class
  - Exchange papers with your partner
  - After class: Correct your partner's paper (solution will be posted on the course's web page on March 1
- Lecture March 8:
  - Bring your partner's (corrected) paper

Instrument choice with uncertain B'(M)

- Regulator:
  - Goal: Max net benefits ⟺ B'(M) = D'(M)
  - Choose instrument: tax or tradable permits
- Firms:
  - Goal: Max profits ⟺ f' = τ (unit price of em.)
- Uncertainty:
  - Marginal abatement costs are uncertain
  - Uncertaintly realized after regulator acts, before firms act
- Asymmetric information:
  - Firms, but not the regulator, know the abatement cost functions
  - Firms act after the regulator

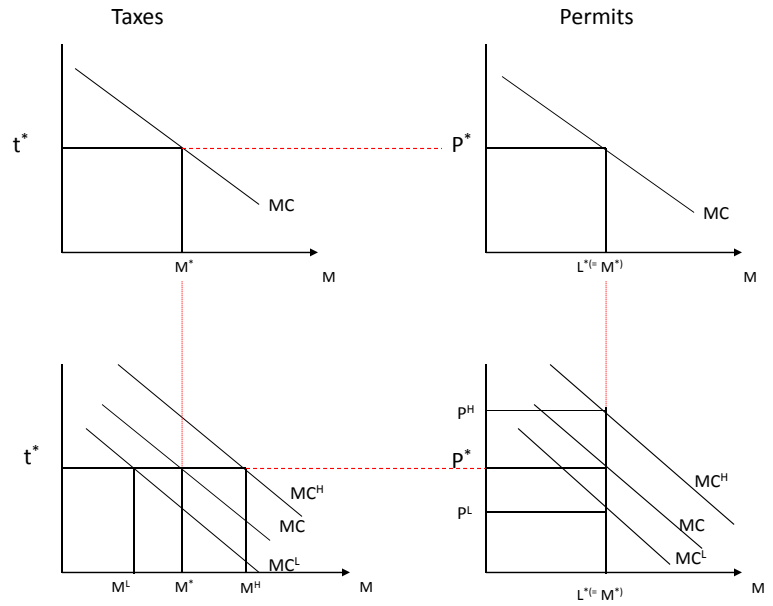
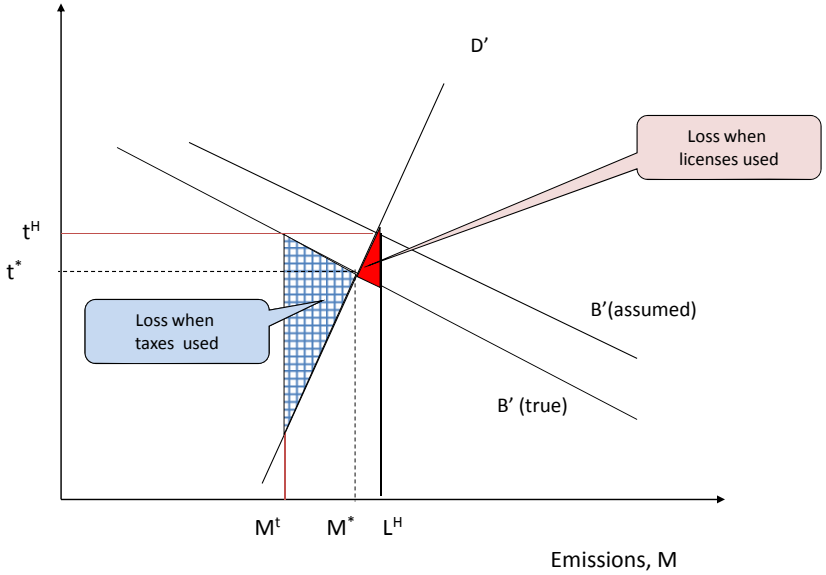


Figure 8.1 A comparison of emissions taxes and marketable emissions permits when abatement costs are uncertain.

Price or quantity instruments?

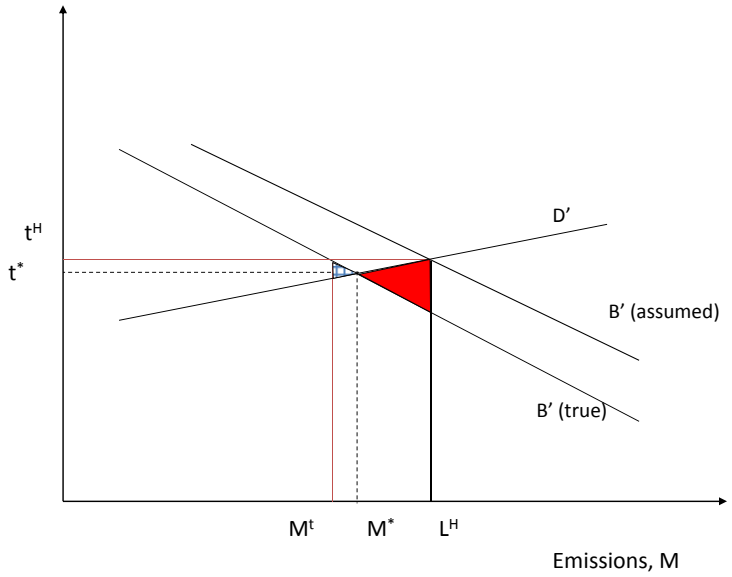
- What is worst:
  - That we end up with too high (or low) emission levels?
  - That we end up with too high (or low) price (marginal abatement cost) levels?

Figure 8.3 Uncertainty about abatement costs – costs overestimated.



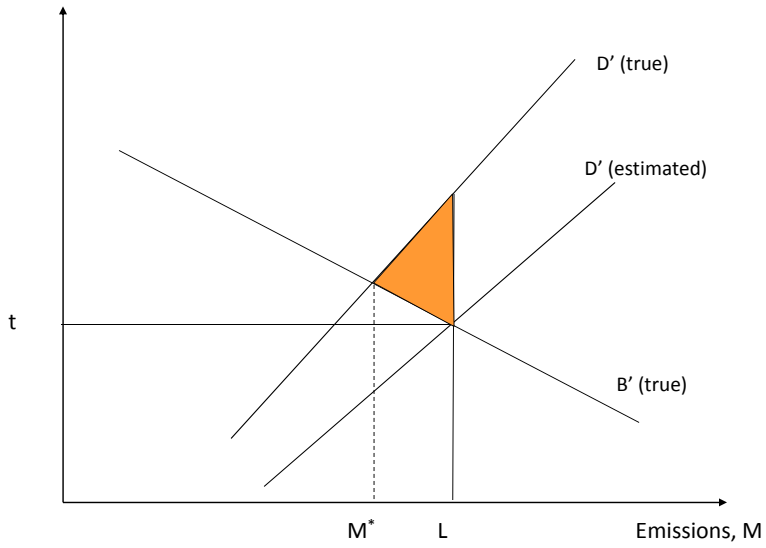
Target mistake: Costs of setting the "wrong" target is *larger* with tax than permits

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 B' is steep
  - Preferred when marginal abatement costs change faster than marginal damages
  - **B' curve steeper** (absolute slope is greater) **than D' curve**
- **Permits** (quantities): Good when D' is steep
  - Preferred when marginal abatement costs change slower than the marginal damages
  - **B' curve is flatter** (absolute slope is lower) **than D' curve**
- Intuition:
  - Marg. **abatement costs** vary a lot: wrong tax has large consequences for firms' costs
  - Marg. **damages** vary a lot: wrong emissions have large consequences for the environment
- Assumption: Uncertainty about level, not slope
- Damage uncertainty does not matter for instrument choice

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
- Question 1: 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
- Question 2: What should the regulator do about it?

Firms' compliance choice

- "Binding" emission cap: $m^{max} < \hat{m}$
  - disregard difference between firms
- Violate? If yes: How much?
- Assume risk neutral firms: Maximize expected profits
- Assume perfect monitoring
  - *If* inspected, violations are revealed with certainty
- Enforcement policy (known by firm):
  - Fixed monitoring probability *q*
  - Penalty P if inspected (note notation):
    If $m \leq m^{max}$: P = P(m) = 0
    If $m > m^{max}$: P = P(m) ≥ 0, P' ≥ 0
- E(P(m)) = qP(m)

Profit maximizing compliance levels

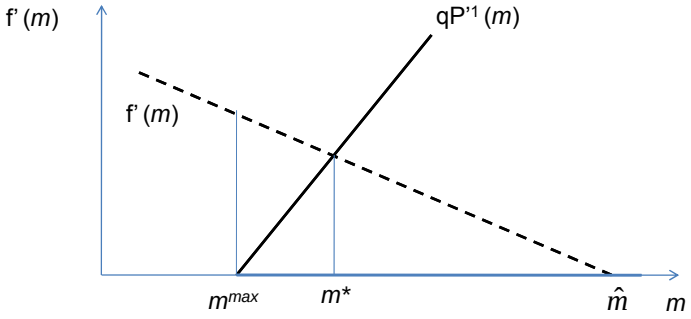
- Before: assumed that firms took $m \leq m^{max}$ as given
- Now: Firms decide m by maximizing expected profits
- Max E(π) = $f(m) - b$ – E(P(m)) (with respect to m)
  = $f(m) - b - q$P(m)
- First order condition for interior solution:
  ∂Eπ /∂m = $f' - qP' = 0$ -> $f' = qP'$
- The firm pollutes until marginal abatement cost equals *marginal expected penalty*
  - interior solution
- Corner solutions:
  - No violation if $f'(m^{max}) < qP'(m^{max})$
  - Full violation (no abatement) if $f'(\hat{m}) < qP'(\hat{m})$

Equivalent to Heyes (1998), but notation & formalization slightly different:

- abatement costs vs. income from pollution
- cost minimization vs. profit max
- penalty as a function of emissions or violations

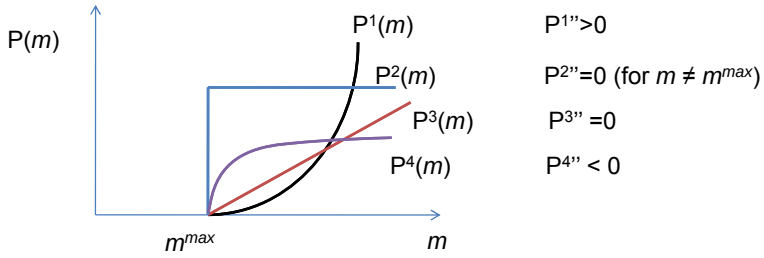
The importance of marginal penalties

- F.o.c.: $f' = qP'$
- f' decreasing in m (because f is concave)
- Increasing marginal penalties ($P'^{1}(m)$ increasing):
  - Profit max. emissions m^*



The penalty function

- Is the marginal penalty increasing in the degree of violation?
- All of these P functions impose a penalty for violations:

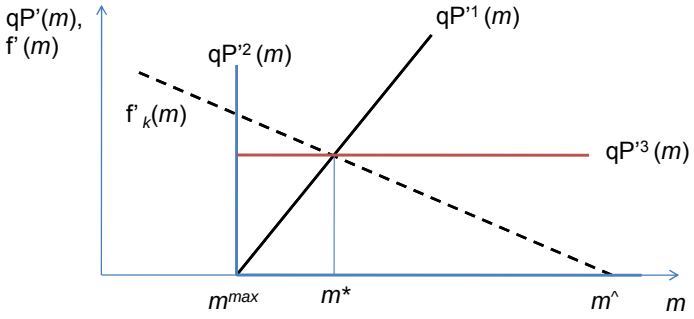


- but their effect on emissions are very different!

- *F.o.c.:* $f'(m) = qP'(m)$
- If qP' is *not* increasing in m : May get corner solutions

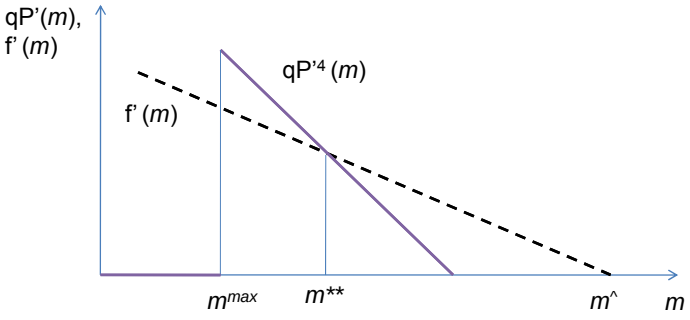
The importance of marginal penalties

- F.o.c.: $f' = qP'$
  - f' decreasing in m (because f is concave)
- Increasing or fixed marginal penalties ($P^1(m)$, $P^3(m)$):
  - Interior solution: m^*
- High absolute, but zero marginal penalties ($P^2(m)$):
  - Corner solution: either m^{max} or $\hat{m}$



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 $m^{\wedge}$
  - Area below f': Gain of violating; area below qP': Exp. cost of violating



Firms' compliance

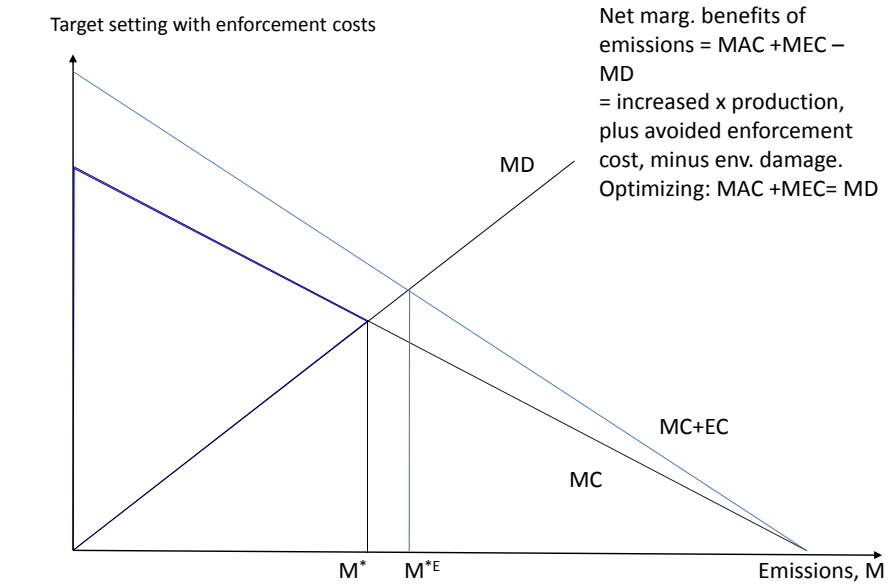
- Profit maximizing firms:
  - **Violate** when cost of compliance exceeds expected penalty
  - **Degree of violation:** depends on *marginal* expected penalty (and marg. abatement cost)
  - Decreasing marginal penalty may encourage full violation!
- Note:
  - If violation is profitable, and q and P independent of compliance history, firm will violate "forever" (even after it is caught).
  - Ex: q = 1, P = $P^1(m)$, $f'(m^{max}) > P^{1\prime}(m^{max})$
  - In this case, regulator knows firm is violating; firm is sanctioned; firm keeps violating: Prefers sanctions to abatement cost!

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
  - Costly monitoring (inspection costs etc): May limit q
  - Costly sanctioning (legal procedures etc): May limit P(m)
  - Imperfect monitoring: May limit P(m)
    (type I & II errors, fairness concerns)
  - Fairness, more generally: May limit P(m)
    (Reasonable/political acceptable)

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.



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

Voluntary approaches: Firms

- Firms violate less than predicted (?)
  - The ”Harrington paradox” (see Heyes)
- Firms abate more than predicted
  - Corporate social responsibility
- Voluntary regulation/self-regulation
  - voluntary/negotiated agreements

The Harrington paradox

- Harrington (1988):
  - For most sources, monitoring frequence is low
  - Even when violations are discovered, fines or other penalties are rarely imposed
  - Sources are, nonetheless, thought to be in compliance a large part of the time.

Theoretical prediction: $f'(e) = qP'(e)$

  - Firm pollutes until marginal abatement cost equals marginal expected penalty.
  - q low, P' close to zero: violations even with low f'
- Widely cited – poorly documented
  - Nyborg and Telle 2006: Low $qP'(e)$ well documented; high compliance largely undocumented

Voluntary agreements

- Negotiations industry/firm vs. regulator
- Agreement:
  - Firm/industry commits to abatement goal (e.g.: reduce non-recycled packaging waste by 60 per cent by 200x)
  - Regulator abstains from taxes/CAC measures
- Gains:
  - Firms: No tax/CAC regulation
  - Regulator: More efficient abatement? Better cooperation?
- Problems:
  - Legal committment limitations, regulator
  - Openness / democratic control
- Public voluntary programs (US)
  - Government initiated, no credible regulatory threat

Corporate social responsibility

- ”A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis" (EU Commission 2002)
- Exxon, Chiquita, McDonald’s, Coca-Cola, Ford...
  - ”Corporate citizenship is a critical part of our business now and in the future. Our focus has expanded from philanthropy and community involvement to a broader look at how we use our resources to create sustainable growth and a better world.” (From Ford Motor Company’s homepage)
  - Only nice words?
- Business/industry organizations
  - NHO, HSH, EBL

CSR and markets

- Conventional wisdom:
  - Firms with extra costs are wiped out by competition
  - A perfectly competitive market does not allow for CSR
- But green production and CSR do exist
- Explanations suggested in the literature:
  1. Pre-emption of taxes or regulations
  2. Market power: Vertical differentiation
  3. Ethical customers: Extra WTP for green/”ethical” products
  4. Ethical investors
  5. Ethical workers: recruitment, motivation
- 3-5: Inconsistent w. standard model?

Next time

- Voluntary approaches, cont.
  - Read: **Nyborg and Rege**; Lyon and Maxwell
- Monetary valuation
  - Read: Perman Ch. 12

Voluntary term paper:
Find a partner before leaving today's lecture!