Lecture 8:
Monitoring and enforcement

- Purpose
  - demonstrate why monitoring and enforcement (M&E) generally is necessary
  - understand the objective of M&E: to create desired compliance at least social costs
  - understand the impact of stochastic emissions
  - increase insights through some models of M&E

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Outline

- why is M&E important
  - for (emission) taxes to work
  - for tradable (emission) permits to work
- purpose of M&E
- stochastic emissons
- the penalty function
- basic model of ME
- reputation based ME schemes
- deviations reported and actual performance

The importance of M&E

- Taxes
  - without M&E, firms may emit more than they should
    - optimal emission levels are exceeded
- Tradable permits
  - without M&E, firms may emit more than they should
    - optimal emission levels are exceeded
    - the prices (the info. extracting device of TPs) do not correspond to firms' $MAC_i(z_i)$

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The purpose of M&E

- Deliver the desired level of compliance at the least social costs
- Why desired compliance level rarely is 100:
  - the expected gains of M&E should equal the expected costs
- Why least cost is important:
  - if this does not hold, society spends more resources on M&E than it should
  - least costs implies that the optimal comliance level increases (why?)

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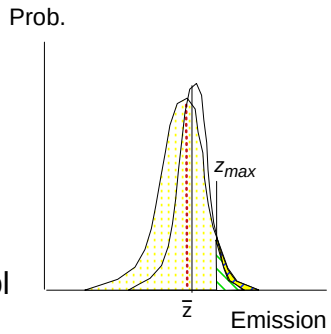
Stocastic emissions

- Emissions are generally not fixed, but stochasic
- Sources of stochasticity
  - measurement errors
  - natural processes are random (wheather!)
  - insufficient process control
- Stochastic emissions
  - agents must have some safety intervall
  - increased process control reduces size of "needed" safety intervall, and allows agents to increase mean emissions



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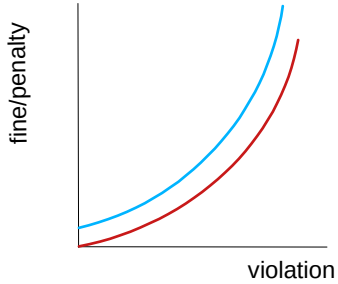
The penalty function

- From welfare perspective
  - large violations of allowed emissions worse than small violations
  - ➡ increase penalty in size of violation
- Penalty
  - grows at an increasing rate in terms of the size of the violation
- Extra cost of (admini-strating) a violation justifies a fixed term in the penalty function



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Basic model of M&E (1)

- Intuition:
  - expected payoff of being in compliance must exceed expected payoff of not complying
  - U_c = state dependent payoff of compliance
  - U_n = state dependent payof of noncompliance

$$U_c \geq p(U_n - S) + (1-p)U_n$$

$$\Downarrow$$

$$U_c \geq pU_n - pS + U_n - pU_n = U_n - pS$$

$$\Downarrow$$

$$p \geq \frac{U_n - U_c}{S}$$

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... basic model of M&E (2)

- Addition of stochastic emissions
  - allow som grace region, like k, which allows extra emissions over the limit for compliance

$$p = \frac{U_n - (U_c)}{S(z-k)}$$

- Principal's problem
  - make k sufficiently large to avoid that overcompliance is not too large
  - to adjust (reduce) k over time as agents increase their precision

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Reputation based M&E

- Intuition: making monitoring probabilities and penalties depend on past performance creates a compliance rent that reduces the monitoring prob. needed for incentive compatibility to hold
- Basic setup:
  - firms in group 3 (habitual non compliers) have to pay monitoring costs themselves and must comply inrepeated periods before being moved to group 2
  - firms in group 2 have lower monitoring prob. than group 3 firms, and must comply to get to group 1
  - firms in group 1 (habitual compliers) have the lowest monitoring prob and do not pay monit.costs

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... reputation based M&E (2)

- Monitoring probabilities:
  1. habitual compliers (monitoring prob = p_1)
  2. in the "purgatory" (monitoring prog = p_2)
  3. "habitual" cheaters (monitoring prob = p_3)

  - $p_1 < p_2 < p_3 \leq 1$

- Monitoring costs:
  - group 3 firms pay monitoring costs themselves
  - group 1 and 2 firms do not pay monitoring costs

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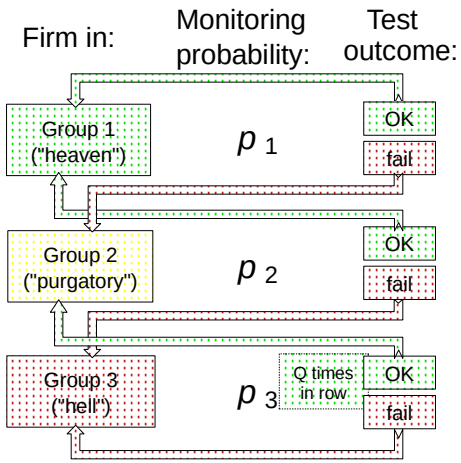
... reputation based M&E (3)

Structure:

implementation
(before firms have established a repuation): depends on firm mobility

fully operational

- existing firms moved to group matching reputation
- entrant firms start in group 3 (or group 2)



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... reputation based M&E (4)

- Intuition behind the scheme
  - there exists a compliance rent that lowers the necessary monitoring probabilities in all groups as firms' reputation influence
    - ➡ monitoring probability (habit of noncompliance ⇒ p_i ↑
    - ➡ stronger incentive for compliance than under uniform monitoring
  - to lower overall effort spent on monitoring by the regulator, and hence social costs of monitoring
  - to meet the participation constraint for complying firms (better off than under uniform monitoring)

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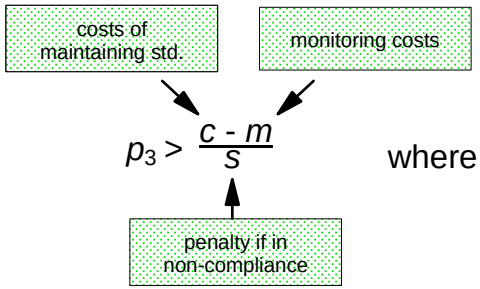
... reputation based M&E (5)

- Group 3 firms pay monitoring costs, *m*
  - can be justified as they have ended up in group 3 due to their own failure to comply
  - reduces monitoring probability in group 3 - necessary monitoring prob in group 3 to comply



$$p_3 > \frac{c - m}{s}$$

where $c = U_n - U_c$

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... reputation based M&E (6)

Net present value of compliance costs in group 2:

group 2 OK where $c = U_n - U_c$

$$\sum_{t=0}^{T_2+1+QT_3} b^t (p_2 s - c) <$$

$$\sum_{t=0}^{T_2} b_{T_2} s + \sum_{t=T_2+1}^{T_2+1+QT_3} b^t (p_3 s - c + p_3 m)$$

group 2 not OK

caught in group 2

group 3 OK

T_i is expected time in group i

b is the discount factor $(1+r)^{-1}$

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... reputation based M&E (7)

Net present value of compliance costs in group 1:

group 1 OK where $c = U_n - U_c$

$$\sum_{t=0}^{T_1+1+T_2} b^t (p_1 s - c) <$$

$$\sum_{t=0}^{T_1} b^{T_1} s + \sum_{t=T_1+1}^{T_1+1+T_1} b^t (p_2 s - c)$$

group 1 not OK — caught in group 1

group 2 OK

T_i is expected time in group i

b is the discount factor $(1+r)^{-1}$

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Deviation: reports and actions (1)

- Starting point:
  - firms self-report, and regulator performs checks
  - single sectors/firms are informed that next year their behavior/actions will be heavily monitored
- Intutive results:
  - firms that reported truthfully: no change in behavior/actions
  - firms that reported false (doomed if you do, doomed if you don't):
    - adjust behavior, but deviations from prev. years' reports ⇒ signal to regulator something wrong
    - do not adjust: one is caught:

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... deviation: reports and actions (2)

- Implemented (in a systematic sense)
  - UK : tax audits for independent small firms (plumbers, carpenters, etc.)
  - no academic papers yet (as I know), but a promising approach
- Possible advantages
  - most firms self report (also on env. issues)
    ⇒ no additional costs onto firms
  - reduces M&E costs (as in reputation base M&E) through targeting
  - can be implemented immediately as past self reports exists

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Summary

- Objective of monitoring and enforcement:
  create desired compliance at the least social costs
- Stochastic emission: "grace intervall" (k)
  - = extra incetives for firms to increase precision
    (reduce future k to avoid excessive mean emissions)
- Basic idea behind monitoring and enforcement:
  make the expected payoff of compliance larger than the expected payoff of noncompliance
  - basic model for M&E :: $p \geq (U_n - U_c)/S$
  - extension 1: reputation based models
  - extension 2: deviation reports - actions

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