Lecture 7:
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 M&E
- reputation based M&E schemes
- deviations reported and actual performance

The importance of M&E

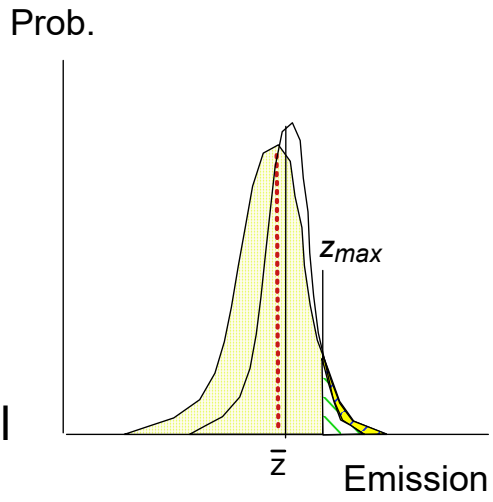
- Taxes
  - without M&E, firms may emit more than they should
    - optimal emission levels are exceeded
- Tradable permits
  - without M&E, firms may emit more than they should
    - optimal emission levels are exceeded
    - the prices (the info. extracting device of TPs) do not correspond to firms'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

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:
  - does not hold: society spends more resources on M&E than it should
  - least costs implies that the optimal comliance level increases (why?)

Stocastic emissions

- Emissions generally not fixed, but stochasic
- Sources of stochasticity
  - measurement errors
  - natural processes are random (wheather!)
  - insufficient process control
- Stochastic emissions
  - agents: safety intervall (measurement error also triggers justification for safety intervall
  - increased process control ⇒ size of "needed" safety intervall ↓ ⇒ agents 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 + grace = fixed term in the penalty function

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Basic model of M&E (1)

- Intuition:
  - expected payoff of compliance $\geq$ expected payoff of not complying
  - π_C = state dependent payoff of compliance
  - π_N = state dependent payof of non-compliance
  - S = penalty if found in non-compliance

$$\rho\pi_C+(1-\rho)\pi_C\geq\rho(\pi_N-S)+(1-\rho)\pi_N$$

$$\pi_C\geq\rho\pi_N-\rho S+\pi_N-\rho\pi_N$$

$$\rho\geq\frac{\pi_N-\pi_C}{S}$$

... 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

$$\rho\geq\frac{\pi_N-\pi_C}{S(z-k)}$$

- 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

Reputation based M&E

- Intuition: 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:
  - group 3 (habitual non compliers): pay monitoring costs themselves and must comply inrepeated periods before being moved to group 2
  - group 2: lower monitoring prob. than group 3 firms, and must comply to get to group 1
  - group 1 (habitual compliers) have the lowest monitoring prob and do not pay monit.costs

... 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

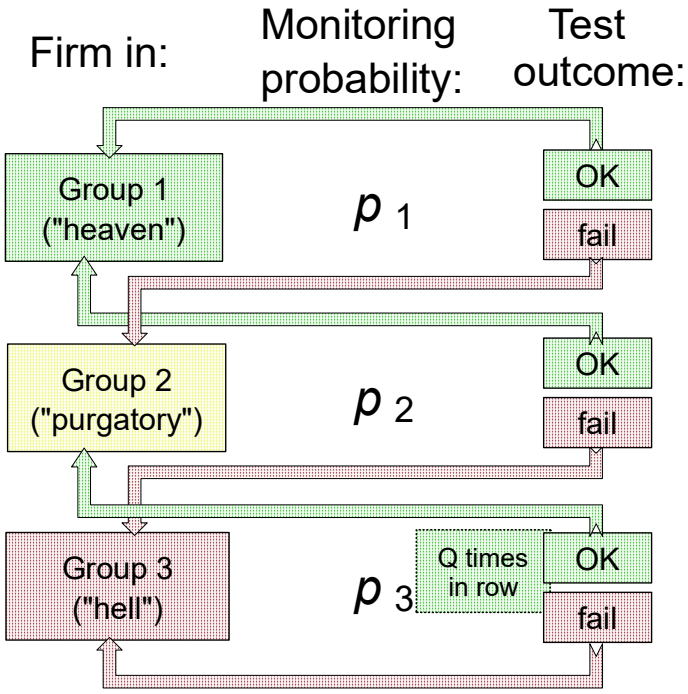
... reputation based M&E (3)

Structure:

implementation
(before firms have esta-blished a repuation): de-pends 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
  - *compliance rent* (= extra rents-/profits ⇐ from past compliance) ⇒
    - lower monitoring probability (habit of compliance ⇒ $p_i \downarrow$)
    - stronger incentive for compliance than under uniform monitoring
  - lower overall effort spent on monitoring by the regulator ⇒ lower social costs of monitoring
  - participation constraint OK for complying firms (firm at least as well off in reputation model than in 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 profits in group 3 by $\rho_3 M$
  - creates an extra incentive to avoid group2 and 3 ==> lowers monitoring probs. for group 1 and 2

- Group 3 monitoring probability equal to basic equation monitoring probability:

$$\rho_3 = \frac{\pi_N - \pi_C}{S}$$

- We get: $\rho_1 < \rho_2 < \rho_3$

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... reputation based M&E (6)

Net present value of compliance costs in group 2:

group 2 OK where $c = \pi_N - \pi_C$

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

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

group 2 not OK

caught in group 2

group 3 OK

T_i is expected time in group i

β 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 $c = \pi_N - \pi_C$

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

$$\sum_{t=0}^{T_1} \beta^{T_1} s \; + \; \sum_{t=T_1+1}^{T_1+1+T_2} \beta^t (p_2 s - c)$$

group 1 not OK — caught in group 1

group 2 OK

T_i is expected time in group i

β 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 :: $p \geq (\pi_N - \pi_C)/S$
  - extension 1: reputation based models
  - extension 2: deviation reports - actions

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