Nonpoint Source Pollution Contracts - Emission Based Regulations Through Models

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Motivation and introduction

- The NPS problem: technically difficult and (too?) costly to monitor emissions from single farms or farm fields
- Currently used NPS regulations on inputs and agricultural practices
  - give incentives to change input use or agricultural practices
  - NOT directly to reduce emissions or improve ambient quality in receptors
- Potential gains to be made from an emission or ambient focus, provided information cost issues can be resolved?

Survey of ambient NPS pol.

- Segerson (JEEM 1988) seminal paper
  - ambient tax for the single farmer case where each polluter pays a charge depending on overall ambient levels
    - \+ correct marginal incentives for the last agent in the sequence
    - – unequal marginal incentives among agents
      e informationally demanding
    - – high monitoring costs
    - – excessive tax payments
      e incorrect entry/exit incentives

... survey of ambient NPS pol. (2)

- Cabe & Herriges (JEEM 1992)
  - ambient concentrations measured on selected sites using a Bayesian framework
    - \+ vis-a-vis Segerson: overall monitoring costs are reduced
- Hansen (ERE 1998), Horan *et al.* (JEEM 1998)
  - devise lump pay-back schemes for excessive tax collection of the Segerson approach
    - \+ vis-a-vis Segerson: less information demanding, more correct entry-exit incentives

... survey of ambient NPS pol. (3)

- Hansen and Romstad (*EcolEcon*. 2007)
  - informationally efficient self reporting mechanism that is robust regarding cooperation among agents
    - \+ correct entry-exit incentives
    - – information flow among agents
- Romstad (*EcolEcon*. 2003)
  - make polluters jointly responsible (teams) by measuring ambient levels up- and down-strea
    - \+ reduced monitoring costs
    - \+ opens for "trades" among agents
    - – conditions for the team to work restrictive?
    - – works only on small watersheds

Proposed mechanism

- Basic idea: Use models to assess agents' individual pollution and issue taxes/-payments on this basis based on self reported input use/ choice of agronomic practices
- Features:
  - Contract approach with sign-on fee
  - Agents given access to models to enable them to test profit impacts of various actions
  - Agents self report planned input use/chosen agronomic practices
  - agriculture: weather ⇒ plans don't work out
    e additional reports on actual actions

... proposed mechanism (2)

- Mechanism design difficulties:
  - Model results challenged in courts
    e costly litigation
  - ➡ "Solution": contract framework where agents waive their rights to sue
  - Variability between years ⇒ variable profits
  - ➡ "Solution": not forgiving, but NPS models also used to wash model emissions for clearly non-man made effects
  - False self-reports (planned or actual)
  - ➡ "Solution": random monitoring of practices, penalty for false reports

Model framework (1)

- Condition for signing a contract:

contract non-contract

$$U_c(\pi_c, l_c, \boldsymbol{x}_c) \geq U_n(\pi_n, l_n, \boldsymbol{x}_n) \qquad [1]$$

profits | labor | inputs

- Difficulty with [1]:
  complex modeling wise
  + utility may vary strongly among agents

$$\frac{\partial U_c}{\partial \pi_c} \geq 0 \qquad \frac{\partial U_n}{\partial \pi_n} \geq 0 \qquad [2]$$

... model framework (2)

- Correlation between yield revenues and environmental payments ⇒ risk correction

Contract:

env.paym. costs

$$\hat{\pi}_c = \hat{p}\hat{y}_c + t\hat{z} + \varphi - c_c(\hat{y}_c, \hat{z}) - r\left[cov(\hat{p}\hat{y}_c, t_z\hat{z})\right]$$

price x quantity | contr. comp. | risk correction

Non-contract:

$$\hat{\pi}_n = \hat{p}\hat{y}_n - c_n(\hat{y}_n)$$

... model framework (3)

- Important determinants for environmental impacts:
  - human actions: l' (labor) and $\boldsymbol{x}'$ (input use)
  - natural factors: Ω'
- ... not fully observable by principal, and hence replaced by observable (reported) items
  - human actions: l (labor) and $\boldsymbol{x}$ (input use)
- estimated natural factors: Ω

... model framework (4)

- Environmental model:

$$z = g(l, \boldsymbol{x}, \Omega) \qquad [5]$$

- When agents decide (contract or no contract) their estimated profits depend on their expectations, i.e.,

$$\hat{z} = g(\hat{l}, \hat{\boldsymbol{x}}, \hat{\Omega}) \qquad [6]$$

- The principal's assed payment is based on the observed state of nature, and report on labor (practices) and input use

$$\hat{z}^r = g(\tilde{l}, \tilde{x}, \Omega) \qquad [7]$$

Critical issue

- The regulator's calculated losses for each agent is given by [7]

$$\hat{z}^r = g(\tilde{l}, \tilde{x}, \Omega)$$

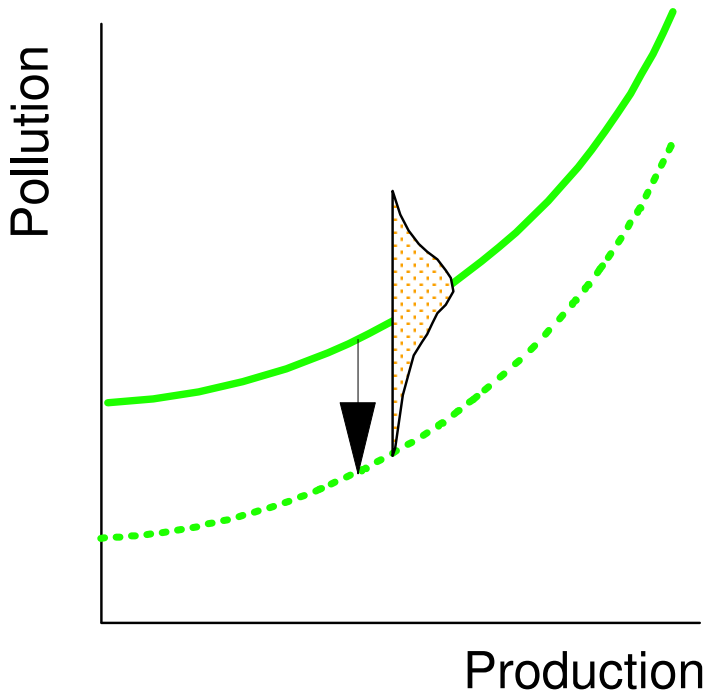
- This opens up for individual agents playing "games" with $\tilde{l}$ and $\tilde{x}$ by reporting values for these that minimize the environmental penalties paid, while doing something else
- What are
  - principal's possibilites of detecting false reports?
  - costs of detecting false reports?

What is to be gained?

- Closer to equal marginal abatement costs among agents **e** potential for cost savings
  - heterogeneous settings, the larger the savings
- Flexible system that captures agent hetero-geneity wo "excessive regulatory detail"
  - conventional NPS regulations become extremely complex
  - targeted, tractable, transparent
- Agents given incentives to seek new solutions to reduce their emissions
  - agents learn/frontier considerations

... what is to be gained?

- Differences in pollution loads among agents with similar per unit (hectare, animal) production levels
  - cfr. diversity parameters in ordinary adverse selection models
- Policies directed at production or input use - limited incentives for the primary objective - reduce pollution the least costly way



Preliminary results

- (using EcEcMod 2.0 simulations, i.e., no actual testing of agent responses)
- cost savings realized
  - larger the more heterogeneous settings/-agents
- models used to remove non-man made variations in emissions
  - reduces needed contract sign-on fee
    e reduced public expenditures
- size of contract fee influence share of agents accepting the contract (separating equilibrium)

The road ahead ...

- Eutropia modeling suite under development
  - enables testing of testing of acceptance criteria
  - → model reliability
  - → size of contract sign-on fee
  - provides easy self-reporting on planned activities
  - → difficulty: monitoring of actual actions
- A start regarding the use of models onto "other NPS problems": ex. biodiversity
- Low cost experimental economics?