Nonpoint source pollution contracts – Emission based regulations through models

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Motivation and background

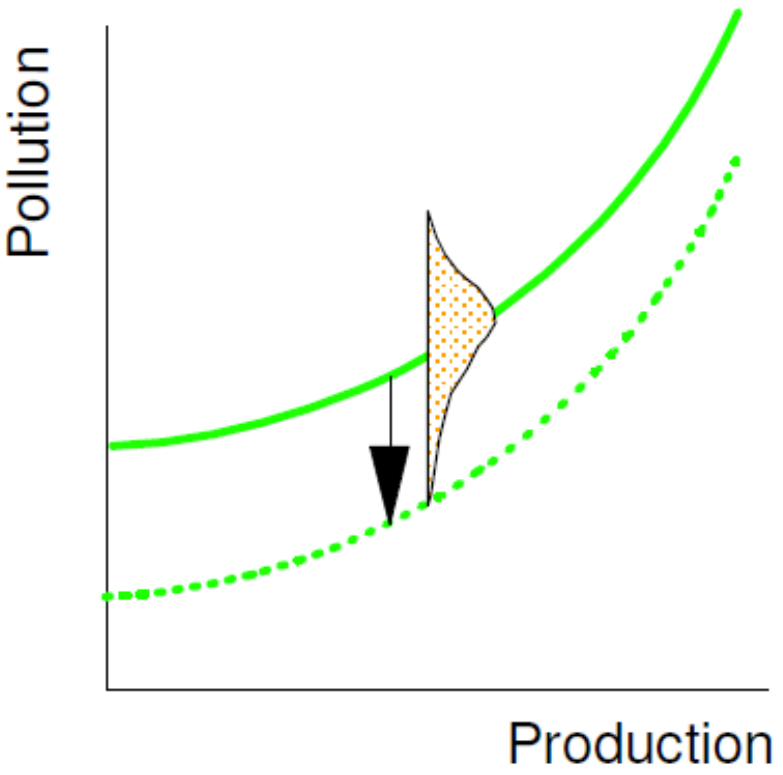
- Monitoring NPS single farm/field emissions
  - Technically difficult
  - (Too?) costly
- Current NPS regulations: input use/ management practices → agents seek
  - To be within regulations at least agent cost → adjust input use/management practices
  - Not directly on how to reduce emissions or improve ambient quality in receptors
- Gains from emissions/ambient focus if info. cost issues can be solved?

This paper

- Starting point: Modern farm level and runoff models have become quite sophisticated
  - What about using models to assess NPS from reported input use and agricultural practices? (some of this info. available in farm accounts)
- Voluntary contracts on who “accepts” model based env.quality and are taxed accordingly
  - Self selection – low level polluters more likely to sign than high level polluters
  - → signal to regulator: whom to monitor (more closely)

Potential gains

- Regulating production or input use moves focus from emissions
  - Large variation in pollution loads
- Reward env. more "friendly" production – focus env. quality
  - Identify producers with less poll.load
  - Learning effects



Literature ambient NPS policies (1)

- Segerson (JEEM 1988) seminal paper
  - Ambient tax single farmer case, each polluter pays a charge depending on overall ambient quality
    - + Correct marginal incentives for the last agent in the sequence
    - − Unequal marginal incentives among agents
      → informationally demanding
      → manipulation (farmer sequence)
    - − High monitoring costs
    - − Excessive tax payments → incorrect entry/exit incentives

… ambient NPS policies (2)

- Cabe & Herriges (JEEM 1992)
  - Ambient concentrations measured on selected sites using a Bayesian framework
    - + Reduced monitoring costs (comp. Segerson)
- Hansen (ERE 1998), Horan *et al.* (JEEM 1998)
  - Lump sum pay-back schemes for exessive tax collection compared to Segerson
    - + Less information demanding
    - + More correct entry-exit incetives

… ambient NPS policies (3)

- Hansen & Romstad (EcolEcon 2007)
  - Informationally efficient self reporting mecha-nism that is robust on coop. among agents
    - \+ Correct entry-exit mechanism
    - − Information flow among agents
- Romstad (EcolEcon 2003) – teams
  - Polluters jointly responsible for changes in ambient quality/pollution up- and down-stream
    - \+ Reduced monitoring costs + “benefits of trade”
    - − Restrictive conditions for the team to work?
    - − Small watersheds only

Proposed mechanism (1)

- Use models to assess agents' individual pollution, and issue taxes/payments from self-reported input use/agronomic practices
- Features
  - Contract where agents receive a sign-on fee
  - Agent access to models: test profit and env. implications of various actions (agent learning)
  - Agents self-report planned input use/agronomic practices
  - Agriculture: weather → plans don't always work out → corrective reports on actual actions

… proposed mechanism (2)

- Mechanism design difficulties:
  - Model findings challenged in courts → litigation
    - "Solution": contract framework where agents waive rights to sue under max env. penalty
  - Variation between years → variable profits
    - "Solution": contract framework where agents waive rights to sue under max env. penalty
  - False self-reports (planned or actual)
    - "Solution": random monitoring of practices, penalties for false reports

Model framework (1)

- Condition for signing contract

contract no contract

$$U_c(\pi_c, L_c, z_c) \geq U_n(\pi_n, L_n, z_n) \qquad [1]$$

profits labor env.quality

- Difficulties with [1]
  - Utility (preferences) vary among agents, but "more preferred to less" $\frac{\partial U_c}{\partial \pi_c} > 0 \quad \frac{\partial U_n}{\partial \pi_n} > 0$
  - Detailed modeling needed to capture central aspects of agent choices

… model framework (2)

- Correlation between yield revenues and environmental payments → risk correction

Contract – expected profits agent perspective

price x quantity prod.costs

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

emission tax sign-on paym correlation term

No contract – expected profits agent perspective

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

… model framework (3)

- Determinants for environmental impacts:
  - Human actions: *L'* (labor), and ***x'*** (input use)
  - Natural factors: **Ω'**
- … human actions not fully observable by principal → replace by reported values
  - Input use from enterprise accounts
  - Labor and timing of applications (self reports)
- Natural factors estimated
  - Weather
  - Soil nutrient contents

… model framework (4)

- Environmental model:

$$z = g(L, \boldsymbol{X}, \boldsymbol{\Omega})$$

- Agent expected perspective of env. model:

$$\hat{z} = g(\hat{L}, \hat{\boldsymbol{X}}, \hat{\boldsymbol{\Omega}})$$

- Principal's assessed penalty for an agent
  - Self reports on labor and input use/timing
  - State of the nature (ex post = actual weather)

$$\hat{z^R} = g(L^R, \hat{\boldsymbol{X}}^{\boldsymbol{R}}, \Omega)$$

Critical issues

- Regulator's calculated env.quality for each agent given by:

$$\hat{z}^R = g\left(L^R, \hat{\boldsymbol{X}}^{\boldsymbol{R}}, \Omega\right)$$

- Agent manipulation
  - Agents report labor and input use that minimize environmental penalties paid
  - … but do something else?
- Principal's possibilities and costs detecting false reports
  - Consistency with tax data and farm accounts

Preliminary results + road ahead

- EcEcMod 2.0 simulations:
  - No testing of contract part
  - Similar pollution performance
  - Cost savings on test models – 3-5 EUR per kg reduced N-leaching per hectare (20-35 %)
- Make user front end so farmers can test practices
- Test contract design

Take home points

- moves focus to emissions (where it should be)
- cost savings
- learning by doing
- promising prelim. results, much work remains