Efficient Institutions for Encouraging Private Sector Cooperation in Preventing Unintended Imports of Invasive Species in Agricultural Commodities

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Disclaimer: Not necessarily EPA's opinion.

Invasive Species Problem

- Unintentional hitchhiker pest in shipment of a traded good
- The pest may be a soil born insect on plants for planting goods or on woodpackaging material the traded good is shipped in
- Exporters can undertake effort to abate risk
- Risk varies by exporter

Model

- Extends McAusland & Costello (2005), Merel & Carter (2008)
- Innovations:
  - Asymmetric Information
    - exporter risk abatement (hidden action)
    - exporter abatement cost (hidden characteristic)
  - More instruments-
    - technical assistance
    - Mechanism design contract to overcome information asymmetry, pollution externality

Technical Assistance Motivated by

- World Trade Organization's Article 9 of SPS Suggests more trade through importer technology transfer to exporter for invasive species control
- NAPPO sponsors technical assistance for rest of world such as woodpackaging treatment technology to prevent invasive species
- APHIS-Miami provides ornamental plant pest control for Costa Rican Dracaena exporters
- May be highly specialized or not (outside value for export) that is accounted for in model

Model Components

- Shipments
  - Standard downward-sloping demand curve in importing country.
  - ‘Clean’ or ‘Infected’
  - ‘Infected’ shipment causes (constant) marginal damage δ.

Model Components

- Risk neutral importer (e.g., NAPPO) chooses
  - Inspection intensity I at cost k
    - $r(I)$ is the probability of discovering infection conditional on shipment being infected
  - "Tariff" τ (pre-clearance, fast lane ...)
  - Penalty t (fumigation rqmts, destroy cargo)
  - Technical assistance ϕ, added to effort
    - non-fungible
    - fungible (outside value)

Model Components

- Regulator's Objective: Maximize expected domestic social welfare not knowing if exporters' hidden action, risk

  – cost of inspection, technical assistance
  – value of good to domestic consumers
  – expected damage from invasive species
  – net payments to exporters can vary by type.

Model Components

- Risk neutral exporters:
  - Unit supply of good.
  - Baseline risk of infection $\overline{q}$.
  - Can undertake abatement effort e.
  - Abatement reduces risk to $q(e+\phi)$.
  - Heterogeneous abatement cost (private info).
    - θ: $0<\theta<1$, distributed $G(\theta)$.
    - regulator's cost of technical assistance is average of exporters.

Model
(non-fungible assistance)

- Stackelberg game
  - Regulator chooses inspections & technical assistance, offers contracts to exporters $\langle t(\theta), \tau(\theta) \rangle$ to maximize

$$\max_{t(\theta),\phi,I,\tau(\theta)} \int_0^M P(z)\mathrm{d}z - \int_0^1 \Big\{P - rq(e(\theta)+\phi)[P+t(\theta)] - \tau(\theta) + q(e(\theta)+\phi)[1-r]\delta\Big\}\mathrm{d}G(\theta)$$
$$-kI - \bar{\theta}\phi,$$

  - Exporters choose contract and abatement effort to maximize profit:

$$\pi(\theta) = P - rq\Big(e(\theta)+\phi\Big)[P+t(\theta)] - \tau(\theta) - \theta e(\theta)$$

  - Participation constraint and Incentive compatibility constraint.

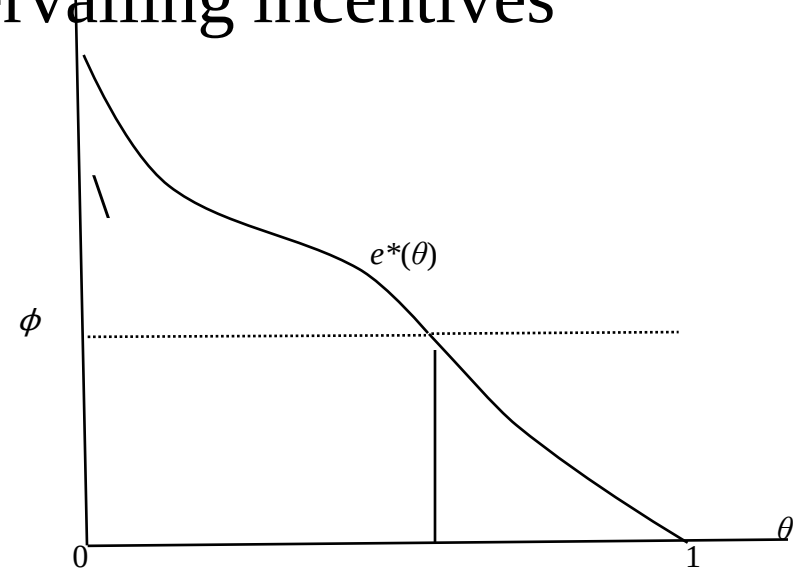
Model

- Symmetric Information Baseline (without technical assistance)
  - Regulator can observe θ, set tariff for each exporter to reduce profit to zero.
  - optimal penalty equal for all exporters (effort non-increasing in cost)
    - each exporter chooses effort so that marginal cost equals marginal benefit of reduced penalty (fees)
    - penalty chosen such that this marginal cost is equal to the regulator's marginal benefit of reduced damage (Merel &Carter 2008):

$$r(I)t = [1 - r(I)]\delta$$

Model (fungible assistance)

- Countervailing incentives



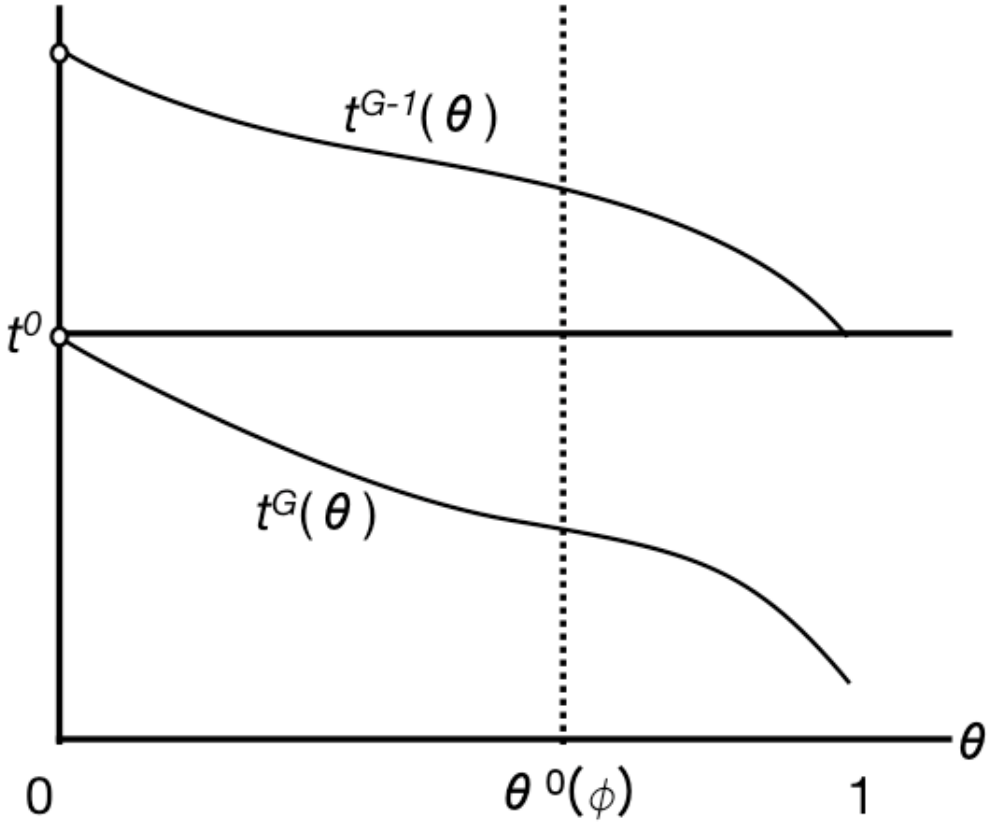
- over-state for low types, understate for high.
- central type left with no profit
- pooling equilibrium
  - penalty constant in type (like symmetric info case)
  - tariff same for everyone
- strictly positive technical assistance is optimal
- Inspections distorted from asymmetric information.

- Two Penalty Paths:

$$-q'(e(\theta))[rP + [1-r]\delta] - \theta = \frac{G(\theta)}{g(\theta)}$$

$$-q'(e(\theta))[rP + [1-r]\delta] - \theta = \frac{G(\theta) - 1}{g(\theta)}$$

- Pooling equilibrium:



Model (fungible assistance)

- Asymmetric Information Contracts:
  - pooling equilibrium
    - penalty constant in type (like benchmark)
    - tariff same for everyone
  - strictly positive technical assistance
  - Inspections directly distorted.
    - which direction depends on distribution of types
    - affects effort, which affects the (central) type that receives zero surplus, and distribution of surplus.

Conclusions

- Allowing for asymmetric information gives model power to explain real-world policy decisions, esp. prevalence of technical assistance and establishes economic rationale for the policy

- Fungibility of technical assistance has important qualitative implications for optimal policy characteristics
  - Non-fungible = complex contracts vary by type
  - Fungible = simple pooling

Validation

- The WTO's Article 9 and technical assistance has economic rationale for trading stakeholders
- NAPPO continues in its coordination of invasive species prevention for North America (and the rest of the world)
- APHIS has lead role in an optimal balance of policies at and before the border (inspection, preclearance, technical assistance, systems approach to invasive species prevention).