# Policy Instruments for Prevention of Invasive Species in Strategic International Trade Relationships

Mexican fruit flies
laying eggs in a grapefruit
ARS, USDA

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# Background

- International trade provides pathways for invasive species introductions

- Invasive pest species affect domestic producer and consumer welfare
  - production technology
  - costs of production
  - export markets
  - product quality and demand

- Preventive trade policy raises cost of imported goods and affects domestic consumer and producer welfare

- Protective sanitary and phytosanitary (SPS) measures allowed under Article 2 of WTO Agreement
  - import bans
  - best practice standards
  - product, processing and packaging standards
  - inspection
  - treatment (fumigation, cold or heat treatment)

- SPS measures must not restrict trade more than necessary

# Policy Questions

- What kind of trade policy should a country adopt toward invasive species?
  - Extent and type of SPS measures

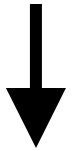
- When are SPS measures a credible threat capable of inducing voluntary cooperation by exporters?

- Role of harmonization in securing efficient actions and resolving coordination problems among multiple trading nations.

# Pest prevention in traded goods

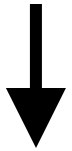
Foreign producers

Prevention at source/inspection of pest free zones



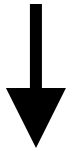
Packing

Inspection/treatment in exporting country



Shipping

Treatment in transit



Port of entry

Inspection/treatment in importing country

Potential benefits of pest prevention in exporting countries:

- lower cost for exporting producers
  - alternative markets for rejected produce
  - economies in treatment/inspection
- welfare benefits for domestic consumers

Pest prevention in exporting countries requires coordination and cooperation between countries

- training
- inspection/certification/preclearance
- harmonization of international standards

The Plant Protection Act, Sec. 431(a) authorizes APHIS to cooperate with foreign governments and producer associations to prevent the spread of plant pests and diseases.

Preclearance Programs – Minimize pest risk in exporting country

- best agricultural practices
- treatment
- inspection (by USDA inspectors)

Costs borne by exporting producers

Exporting producers and foreign agricultural ministry must request to establish a preclearance program

Application is either approved or denied

Both countries must find it advantageous to enter into a cooperative agreement

Agreement should be self enforcing – neither country should have an incentive to renege

# Basic Framework – Strategic Trade Policy

- Static and repeated games between domestic (importing) country and foreign (exporting) agricultural ministry + producers
- No import competing industry (no incentive for protectionist trade policy – can be relaxed)
- cooperative vs. noncooperative outcomes

- Preventive trade policy
  - raises marginal cost of imported goods, increasing their price
  - effect on marginal cost depends on implementation (domestic enforcement vs. preclearance)

- Domestic welfare depends on
  - consumer surplus
  - costs of invasive species introduced via trade

- Domestic country chooses trade policy to maximize welfare

- Foreign producers profits depend on:
  - export demand
  - cost of production
  - opportunity cost of rejected product

- Preclearance programs
  - change production technology
  - change cost of production
  - reduce opportunity cost of rejected product

# A Stylized Model

t = technology used to produce good (including pest mitigation measures)

$\tau$ = trade policy regime

q = quantity produced by foreign firms and imported domestically

P(q) = inverse demand, p = price

$\alpha$ = probability each unit of the good is contaminated with invasive species

d = per unit damage associated with invasive species introductions

$\int_0^q P(x)dx - pq - d\alpha q$ = domestic social welfare

$C(q,\alpha,t,\tau)$ = marginal cost of producing q with associated invasive species risk, α, when technology is t and trade policy is τ

Foreign firms maximize profit

$$\pi(p,\alpha,t,\tau) = \underset{q}{Max}\ pq - \int_0^q C(x,\alpha,t,\tau)dx$$

=> $p - C(q,\alpha,t,\tau) = 0$

$q = Q(p,\alpha,t,\tau)$

Foreign govt. requests preclearance if it yields higher industry profit

$$\pi(p,\alpha(t_p,\tau),t_p,\tau) > \pi(p,\alpha(t_n,\tau),t_n,\tau)$$

For each trade/technology regime, the equilibrium price and quantity depend on α and can be written P*(α,t,τ) and Q*(α,t,τ).

In each regime the domestic government chooses α to maximize welfare, with full understanding of the equilibrium response of price and quantity to its policies.

$$W(t,\tau) = \underset{\alpha}{Max} \int_0^{Q^*(\alpha,t,\tau)} P(x)dx - P^*(\alpha,t,\tau)Q^*(\alpha,t,\tau) - d\alpha Q^*(\alpha,t,\tau)$$

$$\Rightarrow \quad \left[\frac{\eta}{\varepsilon}\right] + \frac{\alpha d}{P^*}\left[\eta + 1\right] = 0$$

where ε = price elasticity of demand

η = elasticity of Q* with respect to α

Given the domestic policy toward invasive species risk, $\alpha(t,\tau)$, the foreign industry's profit is $\Pi(t,\tau)$.

Choice of trade regime/technology results in 2x2 game

| Foreign Ag. Ministry \ Domestic Govt. | No preclearance | Preclearance |
|---|---|---|
| No preclearance | $\Pi(t_n,\tau_n), W(t_n,\tau_n)$ | $\Pi(t_n,\tau_p), W(t_n,\tau_p)$ |
| Preclearance | $\Pi(t_p,\tau_n), W(t_p,\tau_n)$ | $\Pi(t_p,\tau_p), W(t_p,\tau_p)$ |

Equilibrium depends on payoff structure

Ex: If payoffs have structure of prisoner's dilemma then preclearance is the cooperative outcome, but no preclearance is the non-cooperative outcome

Solution can be characterized analytically for some cases (linear demand and supply) and numerically for others.

Characterize non-cooperative and cooperative static equilibrium (when preclearance emerges as a cooperative outcome, but not as an equilibrium to the non-cooperative game).

Folk theorem implies that if both parties are sufficiently patient, preclearance can be sustained as an equilibrium to a non-cooperative repeated game where the domestic government threatens to revert to a no-preclearance regime if preclearance conditions are violated.

Current work:

Theoretical analysis of more general models
- nonlinear supply and demand
- qualitative analysis of determinants of self-enforcing cooperative agreements (pest risk, damages, elasticity of demand, costs of production + pest mitigation)

Analysis of case studies:
- Table Grapes

Several bilateral agreements exist

U.S. ↔ Chile
U.S. ↔ S. Africa
U.S. ↔ Australia
U.S. ← Korea
U.S. → New Zealand, China
Australia ← Chile

Compare pre-agreement with post-agreement

USDA, ARS

Other applications:

U.S. – Chile preclearance program

- One of the largest and oldest programs
- 98 commodities (protocol varies by commodity)
- USDA personnel in Chile since 1980
- 4 APHIS approved inspection sites
- Annual cost of inspection program = $2.5 million
- Producers register annually with Chile's NPPO
- Pest-free production areas

Cross section of commodities