Environmental Policy and International Trade when Governments and Producers Act Strategically

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Introduction

- In the absence of trade policy, governments may relax their environmental policies to give their domestic producers an advantage
- Competitive markets, not transboundary pollution $\Longrightarrow$ No incentive to distort the Environmental Policies
- Reasons for setting too lax environmental policies may be small:
  - Welfare Cost
  - Compete using prices

Model

- Both Producers and Governments act strategically.
- Single Industry, 2 Producers (located in different countries) and a homogeneous good.
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- They sell their good in a Third Market (No *local* Consumers)
- Total Revenue: $R(x, y) = x(A - x - y)$
- Total Cost Function: $C(x, \phi) = \phi \frac{x^2}{4}$
- If the Producer does not act strategically: $\min_{\phi} C(x, \phi) + \frac{1}{\phi}$
  - $\phi = \frac{2}{x}$ and unrestricted total cost function $K(x) = x$ [Efficient choice of R&D]

Model

- Emission of the Pollutant: $e \equiv x - a$
- Abatement costs: $\frac{a^2}{2}$
- Total damage costs: $\frac{de^2}{2}$
- Two instruments: *emission standard*, e, and *emission tax*, t.
- Assume that both governments enact the same instrument
- Government's welfare:
  $W = R(x, y) - [C(x, \phi) + \frac{1}{\phi}] - \frac{a^2}{2} - \frac{de^2}{2}$
- Notation (other country):
  - y levels of production, ψ R&D
  - ε emission standard and τ emission tax

Move Structure

- When both governments and producers **act strategically** (three-stage game, SPNE):

1. Two governments set their (e, ε) or (t, τ) [Simultaneously]
2. Two producers choose their levels of R&D (ϕ, ψ) [Simultaneously]
3. Two producers choose (x, y) non-cooperatively

- Only Governments act strategically (one stage game):
  - Two producers choose (x, y) and (ϕ, ψ)

- Only Producers act strategically : Governments ignore the impact of their environmental policy

- When neither act strategically (Two Stage Game):
  - First Best equilibrium (governments and producers act non-cooperatively)

- First Stage: Government chooses standard
- Second Stage: Producers choose output level and use the efficient choice of R&D $\phi = \frac{2}{x}$

- $\max_x (A - x - y)x - x - 0.5(x - e)^2$
- Reaction Function $x = (A - 1 + e - y)/3$

- output level at the 2nd stage:
  - $x = \frac{(2A-2+3e-\varepsilon)}{8}$
  - $y = \frac{(2A-2+3\varepsilon-e)}{8}$
  - note that: $\frac{\partial x}{\partial e} = \frac{3}{8} > 0$ and $\frac{\partial x}{\partial \varepsilon} = -\frac{1}{8} < 0$

- Government take as given ε and y
- $\max_e (A - x - y)x - x - 0.5(x - e)^2 - 0.5de^2$

- F.O.C $\{(A - 1 - y + e - 3x)\}\frac{\partial x}{\partial e} - x - e - de = 0$
- $x - e = de$ or $e = \frac{x}{(1+d)}$

- Symmetric equilibrium: $e = \varepsilon$
  - $x^* = \frac{(A-1)(1+d)}{(3+4d)}$
  - $e^* = \frac{(A-1)}{(3+4d)}$

- Producers: $\max_{x,a}(A-x-y)x-x-t(x-a)-0.5a^2$
  - Reaction Function $x=(A-1-t-y)/2$ and $a=t$
  - standards $\frac{\partial x}{\partial y}=-\frac{1}{3}$ and taxes $\frac{\partial x}{\partial y}=-\frac{1}{2}$

- output level at the 2nd stage:
  - $x=\frac{(A-1+\tau-2t)}{3}$
  - $y=\frac{(A-1+t-2\tau)}{3}$
  - note that: $\frac{\partial x}{\partial t}=-\frac{2}{3}<0$ and $\frac{\partial x}{\partial \tau}=\frac{1}{3}>0$

- Governments $\max_{t}(A-x-y)x-x-0.5t^2-0.5d(x-t)^2$
  - F.O.C $\{(A-1-y-2x-d(x-t))\}\frac{\partial x}{\partial t}-t+d(x-t)=0$ and $t=\frac{dx}{1+d}$

- The second stage game set out above continue to apply, but in the first stage governments recognize that the output of the rival firm depends on the policy instrument
- F.O.C $\{(A-1-y+e-3x)\}\frac{\partial x}{\partial e} - x\frac{\partial y}{\partial e} + x - e - de = 0$
- $e(1+d) = x - x\frac{\partial y}{\partial e}$ or $e = \frac{9x}{8(1+d)}$

- Comparison: $e = \frac{9x}{8(1+d)} > e = \frac{x}{(1+d)}$
- Higher outcome and higher emissions when government acts strategically.

- F.O.C
  $\{(A-1-y-2x-d(x-t))\}\frac{\partial x}{\partial t} - x\frac{\partial y}{\partial t} - t + d(x-t) = 0$
- $t(1+d) - dx = \frac{x\frac{\partial y}{\partial t}}{\frac{\partial x}{\partial t}-1}$ or $t = \frac{(d-0.2)x}{(1+d)}$

- Comparison: $t = \frac{(d-0.2)x}{(1+d)} < t = \frac{dx}{(1+d)}$
- Higher outcome and higher emissions when government acts strategically.

- If governments act strategically this always increases the incentives for producers to overinvest in R& D;
- If producers act strategically, this always reduces, but does not reverse, the incentive for governments to relax their environmental policies.
- When both governments and producers act strategically, distortions to both environmental policy and R& D are larger when governments use emission taxes than when they use emission standards.
- Welfare is lower when both governments and producers act strategically than when only one party acts strategically