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Location of Polluting Activities

in Models of International Trade and Factor Mobility

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Introduction

How does trade in goods and factors of production affect the location of polluting industries?

If the location of polluting industries is affected,

- will trade liberalisation lead still generate welfare gains?
- will there be incentives to undercut competitors' environmental standards?
- is there a need to restrict international trade?
- should environmental standards be harmonised internationally?

Organisation of the presentation

1. Types of trade-and-the-environment models
2. Heckscher-Ohlin trade theory applied to environmental issues
3. Non-competitive models of trade in goods and the environment
4. International capital movements and the environment
5. Carbon Leakage
6. International (environmental) agreements with trade restrictions
7. GATT/WTO and the environment

DATE: December 12, 1991
TO: Distribution
FR: Lawrence H. Summers
Subject: GEP

'Dirty' Industries: Just between you and me, shouldn't the World Bank be encouraging MORE migration of the dirty industries to the LDCs [Less Developed Countries]? I can think of three reasons:

1) The measurements of the costs of health impairing pollution depends on the foregone earnings from increased morbidity and mortality. From this point of view a given amount of health impairing pollution should be done in the country with the lowest cost, which will be the country with the lowest wages. I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that.

2) The costs of pollution are likely to be non-linear as the initial increments of pollution probably have very low cost. I've always thought that under-populated countries in Africa are vastly UNDER-polluted, their air quality is probably vastly inefficiently low compared to Los Angeles or Mexico City. (...)

3) The demand for a clean environment for aesthetic and health reasons is likely to have very high income elasticity. The concern over an agent that causes a one in a million change in the odds of prostrate cancer is obviously going to be much higher in a country where people survive to get prostrate cancer than in a country where under 5 mortality is 200 per thousand. (...)

(...)

taken from <http://www.whirledbank.org/ourwords/summers.html>

1 Types of trade-and-the-environment models

Trade in

- environmentally intensively produced goods
 - inter-industry trade
 - intra-industry trade
- polluting intermediate goods (fossil fuels)
- factors of production (capital, FDI)

Market structure

- perfectly competitive
- monopolistically competitive
- non-competitive

Pollution generated by

- production activities
- consumption activities

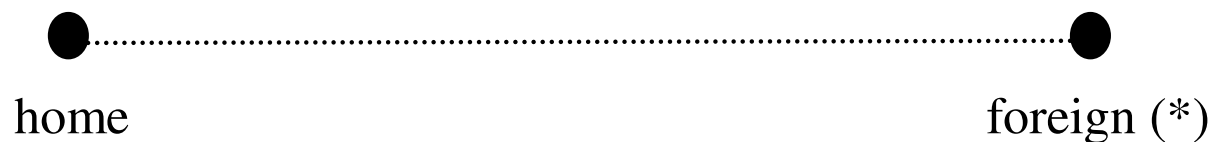
International dimension of pollution

- none
- transfrontier pollution

Environmental quality

- as a public consumption good
- as a public input into production

A remark on the spatial aspect of trade models



2 Heckscher-Ohlin-type models and the environment

Assumptions

- A $2 \times 2 \times 2$ world (results weakly generalise to a $l \times m \times n$ world)
- fixed factor endowments
- constant returns to scale
- perfectly competitive markets
- technologies are identical across countries, but differ across sectors
- identical homothetic preferences (necessary for some, but not all results)

The theorem:

A country relatively well endowed with a factor exports the commodity that relatively intensively uses this factor in its production.

Applied to environmental issues:

A country relatively well endowed with environmental resources exports the relatively environmentally intensively produced commodity.

Let's introduce some notation:

- Countries: home and foreign (*)
- Goods: 1 and 2
- Goods prices: p_1 and p_2
- Factors: capital (K) and emissions (E)
- Factor prices: r and t

What determines the endowment with environmental resources?

- objective characteristics of the country
- preferences, willingness to pay (and ability to pay)
- the political process

Implication

no harmonisation of environmental policy

Effects of trade liberalisation in the HO model

- specialisation according to comparative advantage
- no effect on the environment due to $E_1 + E_2 = E = \text{constant}$
- price of emission permits affected according to Stolper-Samuelson theorem

More realistic versions of the model:

- given emission tax rate
- given emission standards such that E_i/Q_i are constant

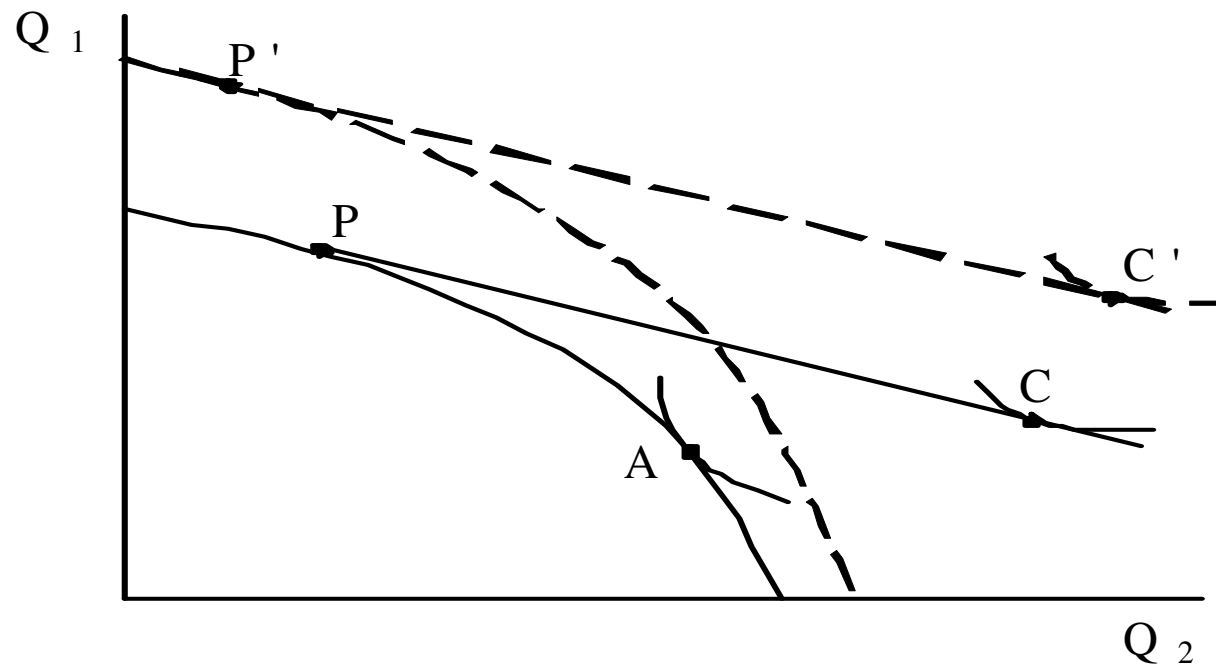
Stolper-Samuelson effect in the "dirty" country:

- willingness to pay for pollution permits rises
- exceeds t
- E rises

Implication:

Pollute your neighbour via trade

Welfare effects of trade liberalisation



$A \rightarrow C$	HO trade liberalisation effect	+
$C \rightarrow C'$	production expansion effect	+
	environmental degradation effect	-

Theory of second best: removal of restrictions may be harmful

Trade partner may suffer from increased transfrontier pollution

Incentives to change environmental policy for trade reasons

improve the terms of trade

increase the relative scarcity of the factor you are well-endowed with

- "dirty" country should tighten environmental standards
- "clean" country should relax environmental standards

lobbying by capitalists

increase the relative scarcity of your own factor

- erosion of environmental standards

lobbying by environmentalists

- tighten environmental standards

3 Trade models without perfect competition

3.1 The intra-industry trade model à la Krugman (1979,1980)

Assume

- Two identical countries with identical endowments
- A continuum of goods that are good substitutes ($\sigma > 1$)
- Love-of-variety preferences
- Fixed costs in production
- Free entry of producers

This implies monopolistic competition with limited variety (n and n^*).

Larger markets generate more variety.

Trade is advantageous.

In the standard Krugman model, nothing happens on the supply side as σ is constant.

Alternatively:

Assume σ increases in the number of varieties.

Tradeoff low prices vs. variety changes.

Two effects

- concentration $N < n + n^*$
- output per firm rises
- total output rises
- emissions rise

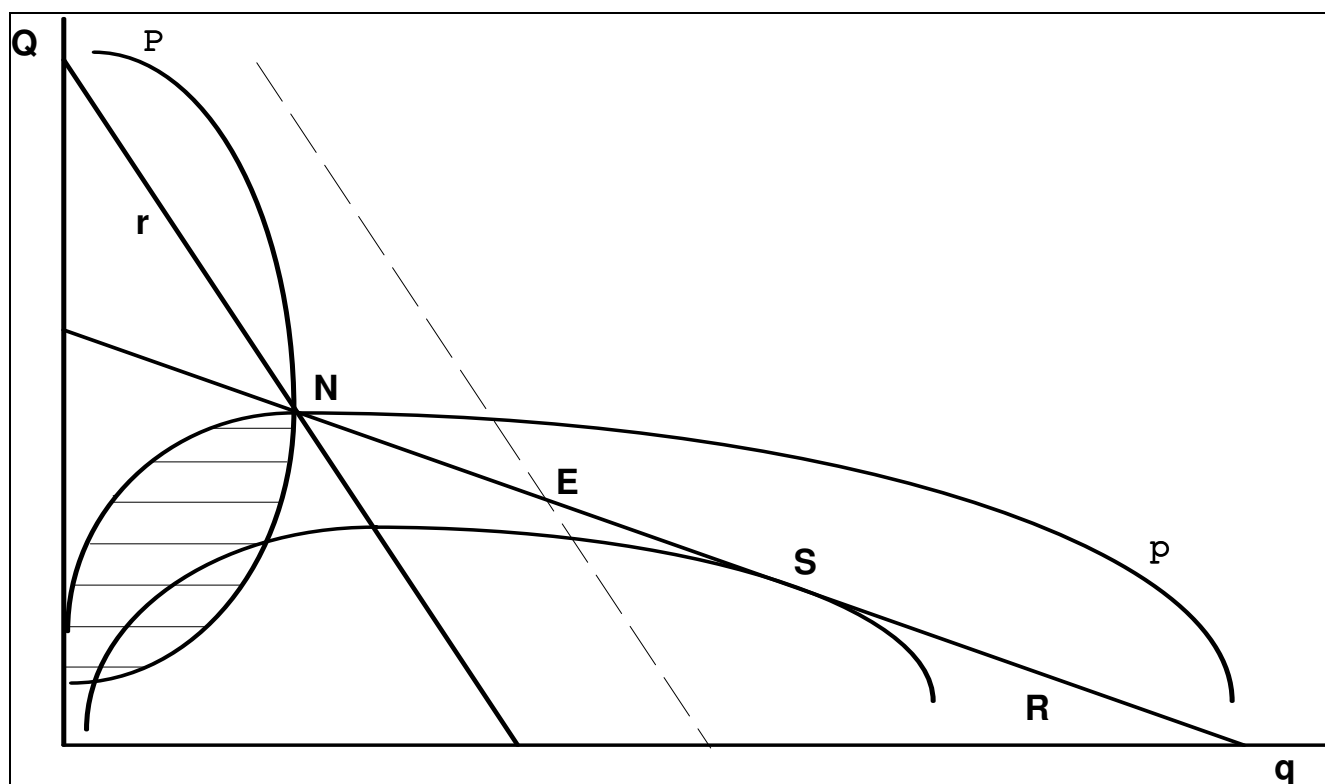
Using environmental policies to affect trade

- Tighter policies improve the terms of trade

3.2 International oligopoly and strategic trade policy

Trade liberalisation effects not to be addressed.

Profit-shifting motive



Strategic Environmental Policy in the Cournot Model

4 International capital movements and the environment

Assume only one good

Perfect competition

Production technology

$F(K, E)$ with decreasing returns and $F^*(K^*, E^*)$

4.1 Trade liberalisation

The country with laxer environmental policy will ceteris paribus attract capital

$$F_{KE}(K, E) > 0$$

Assume that there are constant emission tax rates, t and t^* .

Then

$$F_E(K, E) = t$$

and

- capital-importing country has increased emissions
- capital-exporting country has reduced emissions

Welfare effects for the capital-importing country

- trade liberalisation effect +
- production expansion effect +
- environmental degradation effect –

This is again a second-best result.

4.2 Are there incentives for a race to the bottom?

Extension and calibration of the model

$$Q = F(K, E, L, B_0) = (\alpha K^\rho + \beta E^\rho + \gamma L^\rho + \delta B_0^\rho)^{1/\rho}.$$

with parameters such that

$$\phi_L \equiv \frac{LF_L}{F} = 0.60, \quad \phi_K \equiv \frac{KF_K}{F} = 0.30, \quad \phi_E \equiv \frac{EF_E}{F} = 0.05,$$

$$\eta_{Ep} \equiv \frac{p}{E} \frac{dE}{dp} = \frac{1 - \phi_K}{(\rho - 1)(1 - \phi_E - \phi_K)} = -0.40.$$

4.2.1 The terms-of-trade argument

Each country wants to improve its factor-terms of trade

- Capital-exporting country likes large r
→ lax standards
- Capital-importing country likes small r
→ tight standards

Convergence !

However, the bias in the tax rate is less than 1€/tCO₂

4.2.2 Tax competition

Countries are symmetric

Countries finance expenditure with source tax on mobile capital

$$t = MED - \theta \frac{dK}{dE} .$$

Parameterise

$$t = MED - \frac{\theta}{F_K} \frac{55,71\text{€}}{\text{tCO}_2} .$$

4.2.3 Labour-market problems

$$t = MED - (w - v') \eta_{LE}^i \frac{L}{E}, \quad (v' \text{ is marg. disutility of labour})$$

Assume $(w - v') = 1\text{€}/\text{h}$

then

$$t = MED - 8.30\text{€}/\text{tCO}_2 \text{ in the closed economy}$$

$$t = MED - 33\text{€}/\text{tCO}_2 \text{ in the closed economy}$$

4.2.4 Not in my backyard

Markusen, Morey, Olewiler (1995), Rauscher (1995), Hoel (1997)

5 Carbon leakage

What is carbon leakage?

Why is it bad?

In competitive models, there are three channels

- relocation of energy-intensive industries via specialisation
- relocation of energy-intensive industries via FDI
- shifts of energy demand via changes in energy prices

The model neglects second channel.

Utility

$$\omega(c, x) = u(c) + x - d(E + E^*)$$

Demand for final goods

$$u'(c) = p + \theta$$

Domestic energy demand and final-goods supply

$$(p + \theta) F(E) = p^E + \theta^E + t^E,$$

Domestic energy supply:

$$g'(S) = p^E + t^E$$

The same conditions hold in the foreign country. ,

Market equilibrium:

$$c + c^* = F(E) + F(E^*), \quad)$$

$$E + E^* = E + E^*$$

$F(E)$ and $u(c)$ specified such that elasticities have realistic values.

Results dE^*/dE :

- Leakage via goods markets is 3-4%
- Leakage via energy market is ca. 20%.
- The latter effect is decreasing in country size.

Other models:

- | | |
|--|------------|
| • Effects through FDI | 3-4% |
| • Partial equilibrium energy-intensive goods | up to 20% |
| • Oligopolies | up to 100% |
| • Intra-industry trade | < 0% |

Explanation of the last effect:

- Tighter standards at home
- Higher production cost
- Reduction of product variety
- σ is reduced
- Number of varieties abroad is increased
- Total production abroad is reduced

6 Border-tax adjustments

second-best taxation to avoid negative welfare effects after specialisation

border-tax adjustments to avoid carbon leakage

- tax final-goods imports
- subsidise final goods exports
- tax fossil-fuel exports
- subsidise fossil fuel imports
or: tax domestic production of fossil fuels

tax rate = leakage rate * domestic tax on use of fossil fuels

6. International (environmental) agreements with trade restrictions

Montreal protocol

- no trade in CFCs
- no trade in products that contain CFCs
- possibility to ban trade in products that do not contain CFCs, but have been produced using CFCs

Convention on Trade in Endangered Species

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

North American Free Trade Agreement

- ARTICLE 904. Each Party may in accordance with this Agreement, adopt, maintain or apply any standards-related measure, including any such measure relating to safety, the protection of human, animal or plant life or health, the environment or consumers, and any measure to ensure its enforcement or implementation. Such measures include those to prohibit the importation of a good of another Party (.....) that fails to comply with the applicable requirement of those measures (...).
- ARTICLE 1114. The Parties recognize that it is inappropriate to encourage investment by relaxing domestic health, safety or environmental measures. ... If a Party considers that another party has offered such an encouragement, it may request consultations with the other Party and the two Parties shall consult with a view of avoiding such an encouragement.

EU: principle of subsidiarity – country-of-origin principle

- Cassis de Dijon 1979
- German beer purity law of 1516
- Italian pasta purity law
- Danish bottle case

9 GATT/WTO and the environment

ARTICLE XX. Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures:

(b) necessary to protect human, animal or plant life or health;....

(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption;

1993 Tuna-dolphin case (USA – Mexico)

- *Achim Körber* Why everybody loves Flipper: the political-economy of the U.S. dolphin-safe laws, *European Journal of Political Economy*, 1998, 14, 475-509

1998 Shrimp-turtle case (USA – India, Malaysia, Pakistan, and Thailand)

Conclusion

The field is very interesting,

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but well-researched