

Trade and the Environment

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Impact of Trade on Environment

- **general equilibrium: interaction between different sector & countries**
- **Countries with different standards: developed and developing countries as differences in standards reflects differences in income**
- **Composition effect: trade-induced specialization in world. Countries used to produce wide range of products to satisfy local demand now specialize in subset of product range and import others. Net effect on environment positive if expanding export sectors less polluting on avg. than contracting import competing sectors; negative if opposite**
- **International trade redistributes local pollution problems in world from countries with comparative advantage in less polluting industries to those with comparative advantage in more polluting one**

Comparative Advantage based on Environmental Standards

- **Copeland and Taylor (1994) presents a model with 2 countries (North, South) and a range of goods with different pollution intensities. Pollution local. govt. control pollution with pollution taxes, North higher tax because higher income**
- **As trade liberalized industrial composition changes. Polluting industries contract in North and expand in South because of different standards driven by different incomes. Composition effect mitigates pollution in North and magnifies in South**
- **Results based on critical assumption that comparative advantages in world determined by differences in environmental standards, in turn related to difference in per capita income where richer adopt stricter standards. Trade liberalization then reduces environmental degradation in North, increases in South, increases globally.**
- **Moral of story: trade liberalization must be accompanied by multilateral agreements to safeguard the global environment.**

Comparative Advantage: Environmental Standards

High Income

Low Income

Environmental Standards (emission tax)

No Environmental Standards

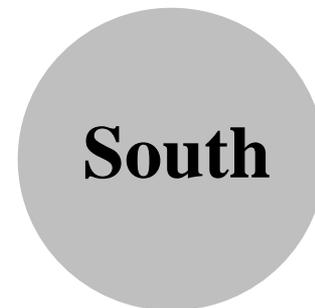
No trade:

Produce all goods

Produce all goods



North



South

Trade: Specialize

Specialize

Comparative Advantage?

Clean goods

Dirty goods
(lower cost: no emission tax)

Pollution? lower

higher

WORLD POLLUTION: HIGHER (dirty firms in South with no standards)

Trade and Environment with Classical Comparative Advantage

- **Classical comparative advantage: capital and labor. North more capital abundant so comparative advantage in capital, South in labor**
- **Most polluting industries are pulp and paper, non-ferrous metals, industrial and agricultural chemicals, iron and steel, petroleum refining. Among most capital-intensive so natural tendency to conglomerate in capital-abundant countries. So questionable if cost disadvantage of 1-2% because of higher pollution abatement costs in North will turn comparative advantage 180 degrees around**
- **If comparative advantage remains, results turn. Antweiler, Copeland, Taylor (1998) show that trade between developed and developing countries increase pollution in North (because of increased specialization in capital-intensive production), reduce pollution in South (specialization in labor-intensive), reduce pollution overall (large share of polluting production in North with stricter standards)**

Classical Comparative Advantage

High Income

Low Income

Capital Abundant

Labor Abundant

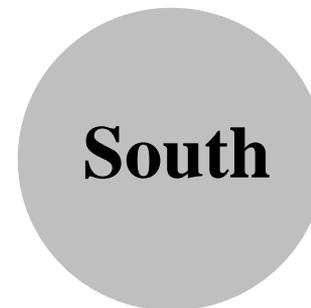
No trade:

Produce all goods

Produce all goods



North



South

Trade: Specialize

Specialize

Comparative Advantage?

Capital intensive goods (dirty)

Labor intensive goods (clean)

Pollution? higher

lower

WORLD POLLUTION: LOWER (dirty firms in North: Standards: Can't pollute)

The Dilemma of International Environmental Protection 1

**governments are players in the game, they choose between abate or pollute;
only one go, simultaneously**

- **outcomes: (abate,abate); (abate,pollute); (pollute,abate); (pollute,pollute)**
- **payoffs: left X, right Y. utility gain or monetary term, not important here**
- **self-interest dictates; each player prefers a larger payoff to a smaller one**
- **outcome most preferred by X (pollute,abate) is least preferred by Y**
- **X and Y both prefer (abate,abate) to (pollute,pollute)**

X: considers how the payoff it receives depends on Y's choice: Y plays abate, then X receives 1 by abate and 2 by pollute. Given Y's choice, X can do no better than to play pollute. If Y plays pollute, X gets -1 with abate and 0 with pollute. Again given Y plays pollute, X can do no better than pollute

The Dilemma of International Environmental Protection 2

**X's best strategy to play pollute no matter what Y does: dominant strategy; situation is entirely symmetric for Y. also pollute whatever X does
→ (pollute,pollute) is an equilibrium as neither can do better by deviating unilaterally and unique as at least one would deviate unilaterally starting from any of the other three feasible solutions**

prisoner's dilemma: both play pollute even though both would be better off if they both played abate. The equilibrium is therefore inefficient.

Transparency won't change outcome. If X moves before Y, then whatever X does, Y pollutes. Knowing that, best for X is to pollute. So (pollute,pollute).

The Dilemma of International Environmental Protection

		y	
		abate	pollute
x	abate	1 , 1	-1 , 2
	pollute	2 , -1	0 , 0

Self-Enforcing Agreements 1

Recognizing that it is in the joint interests of players to play abate, we might suppose that each state's own interests compel it to play abate.

Pay off of X and Y from (abate,abate) exactly one unit greater than (pollute,pollute). Measured in \$, if X transfers \$1 to Y, X's pay off falls by 1 and Y's rises by 1

Agreement: any country that plays pollute must pay the other a fine of \$2

If Y plays abate and X plays pollute, X receives a payoff of 2 minus a fine of 2 which equals 0 and Y receives -1 plus a fine of 2 which equals 1. payoffs reversed if X abates and Y pollutes.

if both abate or pollute payoffs unchanged

equilibrium is again unique. But very different. X now plays abate no matter what Y does and Y likewise abates whatever X does.

Self Enforcing Agreements 2

Playing abate is a dominant strategy. dilemma removed.

- only fixes things if contract is binding on both countries, otherwise nothing but communication (communication can not alter equilibrium of the game)**
- third party must be able to enforce the contract**
- easy for most domestic conflicts. But there does not exist a world government that can enforce agreements between countries (WTO?)**

the norms that govern relations between states requires international agreements to be self-enforcing; agreement to impose a fine as a means of removing dilemma not self-enforcing. Knowing that it could not be forced to pay the fine, X's best strategy is to play pollute so is Y's. The only self-enforcing outcome in the game would then be (pollute, pollute)

Self Enforcing Agreements

		y	
		abate	pollute
X	abate	1 , 1	-1+2 , 2-2 1 , 0
	pollute	2-2 , -1+2 0 , 1	0 , 0

Full Cooperation and Side Payments 1

- **Suppose no self-enforcing constraint**
- **Though outcome (abate,abate) strictly preferred by both to Nash equilibrium (pollute,pollute), outcomes (abate, pollute) and (pollute, abate) are also Pareto efficient. Which would they choose?**
- **allow countries that gain to compensate losers “side payments” (i.e. money)**
- **- each player can identify an amount of money such that it would be indifferent between having this outcome and having this amount of money**
 - money could be redistributed such that what appears as a gain for one party appears as a loss for the other, with the aggregate amount of money constant**
 - if \$1 transferred from X to Y, X loses \$1 worth of X-utility and Y gains \$1 worth of Y utility measured in dollars.**

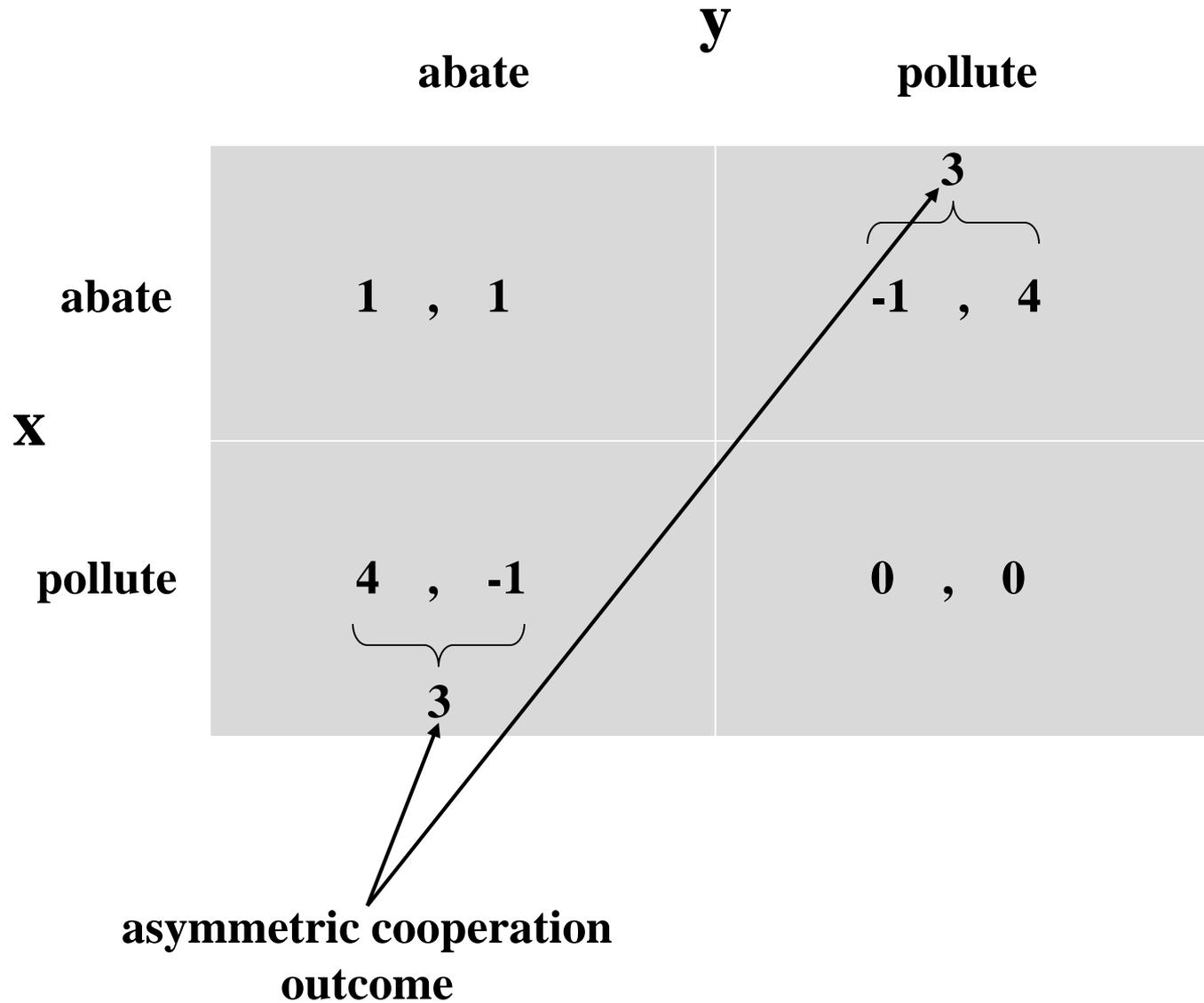
Full Cooperation and Side Payments 2

- **If countries cooperate fully and if side payments are allowed, reasonable to assume countries will maximize their joint payoffs (in the prisoner's dilemma game of first figure) & choose full cooperative outcome over every other feasible outcome (abate,abate)**
- **in this case side payments would not actually be paid, because full cooperative outcome is symmetric and so are the two players.**
- **Now two full cooperative outcomes (pollute, abate) and (abate,pollute) asymmetric (see joint profits in third figure) and choice of either would give the player required to play abate a lower payoff than it could guarantee for itself by playing pollute (-1 compared to 0). Here side payments needed to ensure that full cooperative outcome acceptable to the two countries. It can help sustain cooperation when the underlying game is asymmetric.**

Full Cooperation and Side Payments 3

- **Only limited in promoting cooperation. Real challenge to international cooperation is not ensuring that everyone gains from the agreement. Real challenge is deterring free-riding**
- **full-cooperation is just one of the two attractors other being free-riding. Free-riding usually stronger of the two.**

Full Cooperation and Side Payments



Chicken 1

- **Given X plays pollute, player Y can do no better than play abate. However, if X were to play abate, Y would play pollute.**
- **Two equilibria: (pollute,abate) and (abate,pollute). Neither Pareto-dominated**
- **Starting from either equilibria, a move to (abate,abate) makes one worse off**
- **At the same time aggregate payoff highest when both play abate**

Chicken 2

- **If played sequentially equilibrium unique. but equilibrium would depend on who moves first. If X goes first it would play pollute as it could see that if it played pollute then Y would play abate. X has “1st-mover-advantage”; if Y moves 1st same (pollutes).**
- **(i.e. lady with a child stroller at intersection) → Equilibrium reached depends on the order of play unlike prisoner’s dilemma**
- **Since players can gain by moving first, may try to pre-empt the other and say it really will play pollute, no matter what the other player does. no effect with complete information, but if X’s payoff not known with certainty by Y, X takes actions to make Y believe that X really pollutes no matter what Y does**

Chicken 3

- **Negotiation games involve parties making threats with intention of forcing other to back down. (US & EU in Tokyo protocol hoping other relents 1st: US didn't play regardless of flexible or not, then EU made big concessions to secure participation of Russia, Japan, Canada)**
- **Chicken creates incentives for parties to behave strategically. Make irreversible investment in a preliminary round for purpose of changing its payoffs in the chicken game making pollute a dominant strategy**

Chicken

		y	
		abate	pollute
X	abate	2 , 2	0 , 3
	pollute	3 , 0	-1 , -1

Pure Coordination 1

- **Though, chicken game model of confrontation or deterrence (Cuban missile crisis) here it is not whether to play abate or pollute, but whether to be a signatory or a non-signatory to a treaty that requires all parties to abate**
- **Depends on number of other countries or which countries participate whether one participates or not. i.e.**
 - a. **abatement by Scandinavian countries necessitated by weak abatement by upwind countries.**
 - b. **US rejection to Kyoto changed behavior of others: EU more keen on making it succeed, some less enthusiastic to ratify due to US non-participation**
- **Sometimes 1 efficient and 1 inefficient outcome, both can be self-enforcing**

Pure Coordination 2

- **pure coordination games: one country's interest to play abate only if other plays abate; if other plays pollute then can do no better than pollute**
- **Unlike the dilemma game, outcome (abate,abate) self-enforcing, so is (pollute-pollute) → two equilibria**
- **As with chicken, if pure coordination game played sequentially, a unique self-enforcing outcome: (abate, abate).**
- **Unlike chicken, does not depend on order of moves. If X moves first and pollutes, Y pollutes. But if X played abate, Y abates. Latter preferable to X (as well as Y) so X plays abate and so would Y if roles reversed. Unique equilibrium would then be (abate,abate)**

Pure Coordination 3

- **if players make choice simultaneously (imperfect information) then outcome (abate,abate) at least likely, given that it is the unique Pareto-efficient outcome. Sen's reasoning that individuals will pay attention to their collective interest & not just individual interests compelling. Both might play abate, recognizing that to do so is better for respective goal & is equilibrium.**
- **If unsure how other behaves, still rational to pollute, can guarantee a higher payoff for self by playing pollute than abate. If X played pollute, it could not get lower payoff than 0, by abate however it may get payoff of -1.**
- **assurance needed that other abates, communication not enough, treaty helps**

Pure Coordination

		y	
		abate	pollute
X	abate	2 , 2	-1 , 1
	pollute	1 , -1	0 , 0

Pure Coordination vs. Chicken and Prisoner's Dilemma

- **assurance needed that other abates, communication not enough, treaty helps**
- **Could players also sign agreement to play abate in prisoner's dilemma or chicken? no as here if a state is a party to an agreement requiring that participants play abate, the other wants to join, not true in the other 2 games**