

# Empirics and the Pollution Haven Hypothesis (PHH)

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# Empirical questions related to PHH

- Do investment flows respond to differences in environmental standards?
- Has trade liberalization increased pollution intensity in developing countries?
- Have tighter standards in developed countries led to loss in pollution-intensive industries?
- We do *not* attempt to determine whether countries use environmental policies that are too weak, in order to attract investment or increase market share of dirty goods.

# What is a statistical model?

- We are interested in relation between net exports and pollution control costs.
- We know that net exports depend on other variables (e.g. supply of factors – remember the HOS model and Rybczynski theorem)
- If we have data on these variables we can estimate a relation between exports and pollution control costs, while “controlling” for other variables (e.g. supply of factors).
- We are (usually) interested in sign and magnitude of coefficient on pollution control costs, and on whether the coefficient is statistically significant.

# The empirical evidence

- Early studies use US data to categorize industries into dirty and clean sectors (based on emissions per \$ of output, or per employee, or on abatement costs)
- The statistical exercise looks for link between dirty and clean good trends in production or export (share) and country characteristics such as income, income growth, and openness.
- Are developing countries “moving toward” dirty industries?
- This type of exercise ignores possible changes in technique -- it assumes that changes in composition translate directly into changes in pollution. Also ignores other explanatory values, such as factor endowments.

## Early evidence

- Early research found that a rise in environmental control costs in North was positively correlated with increases in dirty good share of exports from developing countries, and decreases in dirty good share of exports from rich countries.
- The Lucas and Wheeler study found that toxic releases per unit of output (measured by GNP) fell as countries became richer, due to changes in composition. Poorer countries had the largest increases in toxic intensity.
- Birdsall and Wheeler found that pollution intensity increased most rapidly in Latin American countries after OECD pollution regulation became stricter.

## Interpretation of these results

- These findings are consistent with PHH, and with model of changes in factor endowments (capital accumulation).
- Evidence for the importance of capital accumulation:
  - (i) Over 90% of dirty good production in 1988 was in OECD countries, suggesting that location of dirty good production reflects more than weak environmental regulation.
  - (ii) If stricter environmental policies in rich countries were responsible for reallocation of dirty good production (as in PHH) then we would see an increase in the relative price of dirty goods; if capital accumulation in South caused the reallocation, the relative price would fall. Data does not show a clear upward or downward trend in relative price.
  - (iii) All studies show that poor countries alter their mix of production toward dirty goods, the more open countries have a cleaner mix. Pollution intensity grew most rapidly in the more closed economies.

## Early studies of trade effect of pollution control costs

- Tobey uses cross country data on exports of 5 dirty commodities and country-specific factor endowments and measures of environmental stringency.
- Few “degrees of freedom” (not much data). Coefficient on environmental stringency insignificant, but so are most of the coefficients on factor endowments.
- The statistical model does not explain much ...of anything.

## The relation between trade flows and measures of environmental stringency

- Link net exports (as share of value of industry production) to industry-specific measure of environmental stringency (e.g., abatement costs) and industry characteristics (such as cost shares of labor, capital, and maybe tariff rates).
- The PHH implies that the coefficient on the environmental stringency variable should be negative (more stringent environmental policies lower net exports.)
- Studies do not find a significant negative relation between environmental stringency and trade flows.

# Statistical reasons why these studies might incorrectly reject PHH

- Small sample leads to lack of statistical significance.
- Several reasons why models might produce biased estimates:
  - (i) Measurement error
  - (ii) Endogenous explanatory variables
  - (iii) Omitted explanatory variables that are correlated with included variables
- Three examples follow. In the first, a statistical model correctly identifies relation between pollution control costs and trade. In the second two examples, statistical model leads to *biased* estimates. The bias could go in either direction.

# Example 1: statistical model correctly identifies a relation between pollution control costs and trade

- Draw a downward sloping (industry) demand curve for pollution (the pollution tax is on vertical axis).
- Suppose that there is an exogenous increase in pollution tax (maybe preferences become more green). The higher tax increases abatement costs per unit of output.
- Since production costs (inclusive of abatement) increase, domestic supply (as a function of output price) shifts in.
- At a constant relative commodity price, net exports fall. Here more stringent policy lowers exports (or raises imports) of the dirty good, as the PHH predicts.

## Example 2: statistical model *understates* relation between abatement costs and trade (or gets sign wrong), due to endogenous explanatory variable

- Suppose that the pollution tax is endogenous; it is determined (optimally) by the intersection of a (industry) demand and (society's) supply function for pollution.
- An increase in factor (e.g. capital) used intensively in polluting industry shifts out demand curve for pollution.
- This change leads to a higher pollution tax, and higher abatement costs.
- However, the increase in the factor also shifts out domestic supply function of dirty good. (Higher tax and larger supply of factor "cut in the opposite direction.") Net exports increase.
- Here pollution taxes are *positively* correlated with net exports, contrary to PHH.
- The higher pollution tax does not *cause* the increased export of the dirty good. Instead, the exogenous growth in a factor leads to higher output of the dirty good and to higher pollution costs.
- The higher tax does reduce exports (since the relative supply curve would have shifted out more in the absence of the tax increase.)

### Example 3: statistical model *overstates* relation between abatement costs and trade, due to omitted explanatory variable

- The model regresses exports on abatement costs, omits transportation costs.
- Dirty industries (in this example) have higher transport costs (e.g. cement) relative to clean industries.
- High transport costs provide natural protection against imports. Suppose that transport costs (e.g. energy costs) increase.
- The higher transport costs have a disproportional effect on dirty goods (because transport is more important in those sectors). The higher transport costs promote domestic production of the dirty good, reducing imports of those goods.
- In this case we have an excluded variable (transport costs) that is positively correlated with an included variable (abatement costs).
- In this example, the estimate on the coefficient of abatement costs is upwardly biased. Here the statistical results exaggerate the trade effect of abatement costs.

# Some recent statistical evidence

- Evidence from US studies shows that these endogeneity and missing variable issues might be part of the explanation for the failure of statistical evidence to support the PHE. Intra-US trade data is better than world trade data.
- US studies estimate the relation between investment (into US states or counties) and measures of environmental stringency. When the studies account for endogeneity and heterogeneity, they often find a significant negative relation between inward investment and abatement costs, as the PHH suggests.
- In other words, correcting for endogeneity and other statistical problems might uncover stronger evidence for PHH.
- Even if stronger pollution control alter investment and trade flows on the margin, it is unlikely to be strong enough to offset other considerations, such as factor endowments.
- PHH may be more important in future. Pollution abatement capital expenditures have risen from 2.8% of new capital expenditures in US in 1984 to 7% in 1993.

# Related (older) trade and environment studies

- Grossman and Krueger estimated that the “composition effect” of Mexico joining NAFTA would likely reduce pollution.
- This composition effect appears to have actually occurred. However, it was swamped by “scale effect” (increased aggregate production), leading to increased pollution in Mexico.
- Of course, we do not know that this higher pollution was a consequence of NAFTA.

# Summary

- Trade is determined by many things (e.g. factor endowments, technology, infrastructure, institutions).
- Costs of environmental measures are small in most sectors, so they likely have only small effect on investment decisions and trade flows.
- There is some (emerging) statistical evidence that identifies these small effects.
- Environmental costs and cost differences might increase over time, (e.g. next version of Kyoto Protocol), making PHH more important in the future.
- In some sectors these costs are already large enough to effect pattern of trade (e.g. battery disposal, ship breaking). Basel Convention can regulate trade in these sectors (better than general trade restrictions).

# Summary, continued

- There are many reasons why countries have different levels of environmental protection. (Differences in competing needs and constraints, preferences, assimilative capacity.)
- Statistical evidence cannot determine the rationale for level of environmental protection.
- In addition to (possibly) reallocating production of dirty goods from rich to poor countries, globalization is (plausibly) associated with income growth and technology transfers that at least offer the opportunity of environmental improvements.

# And most importantly...

- Trade policy is a poor substitute for environmental policy.
- Remember the Principle of Targeting.