

Trade and the Environment

International Trade

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Lecture Slides

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Outline

- 1 Hypotheses and the effect of trade on the environment
- 2 Previous studies
- 3 The model
- 4 Empirical work

3 Observations

1.

- By many measures the environment is improving, at least in developed countries.
- The level of emissions for regulated pollutants is falling, and the quality of air in cities is rising.
- The U.S. and other advanced industrial countries have seen secular improvements in the quality of their environments over the last 30 years.
- To a large extent cities are cleaner than in the past, emissions of health-threatening toxics are reduced, and in some cases the changes in environmental quality are quite dramatic.

3 Observations

2.

- Pollution control measures have been both relatively successful and relatively cheap.
- Environmental compliance costs of at most 1-2% of GDP for the U.S.
- Comparable results for OECD countries.

3.

There is a tendency for the environment to at first worsen at low levels of income but then improve at higher incomes (Environmental Kuznets Curve).

Hypotheses and the effect of trade on the environment

The **pollution haven hypothesis** suggests that relatively low-income developing countries will be made dirtier with trade as they will attract pollution intensive industries. Environmental quality is a normal good. Lower income means lower demand for clean environment and hence more lax environmental regulation.

The **factor endowment hypothesis** suggests that -dirty- capital intensive processes should relocate to the relatively capital abundant developed countries with trade. Trade will make the rich countries dirtier.

Three effects of trade on the environment:

Indirect effects

- 1 Scale of economic activity (the scale effect): Negative environmental consequences. Higher trade leads to higher production and hence a greater level of pollution
- 2 Level of income (the technique effect): Positive environmental consequences. Higher trade leads to higher income, which increases the demand for clean environment and leads to cleaner production methods

This distinction is important: A-C-T find that a 1% increase in the scale of economic activity raises concentrations by approximately .3%, but the accompanying increase in income drives concentrations down by approximately 1.4% via a technique effect.

Direct effect

- 1 Composition of output (the composition effect):
Both the pollution haven hypothesis and the factor endowment hypothesis predict openness to trade will alter the composition of national output in a way that depends on a nation's comparative advantage. For example in the pollution haven hypothesis, poor countries get dirtier with trade while rich countries get cleaner.

(That is, the composition effect of trade for poor countries makes them dirtier while the composition effect for rich countries makes them cleaner. The full effect of trade may be positive even for poor countries depending on the strength of the technique and scale effects).

The opposite prediction arises in the factor endowment model.

Hence looking for a relationship between pollution and openness to trade (across a panel of both rich and poor countries) is unlikely to be conclusive. It is more useful to calculate trade's composition effect after conditioning on country characteristics.

Previous studies

- 1 Regress pollution levels on economic growth (scale and technique effects) + measure of openness
- 2 Examine whether trade flows are themselves affected by the level of abatement costs or strictness of pollution regulation in the trading partner countries.

Finding: There is very little evidence linking liberalized trade in general with significant changes in the environment.

In addition, there is little evidence that differences in abatement costs are a significant determinant of trade flows.

There is, however, evidence that increases in income will, after a point, lead to lower concentrations of some pollutants.

Findings (A+C+T):

1. Openness per se has very little impact on pollution concentrations.
2. Openness conditioned on country characteristics has however a highly significant, but relatively small, impact on pollution concentrations.

3. The pollution consequences of income changes brought about by changes in openness from those created by capital accumulation or technological progress.

Income gains brought about by further trade or neutral technological progress tend to lower pollution, but income gains brought about by capital accumulation raise pollution.

The key difference is that capital accumulation favors the production of pollution intensive goods whereas neutral technological progress and further trade do not.

One immediate implication of this finding is that the pollution consequences of economic growth are dependent on the underlying source of growth.

The model

1. Consider two economies which are identical, except with respect to openness (that is, they have the same scale, per capita income, population, tastes, technology, and relative factor abundance).
 - (a) Suppose that both countries export the polluting good. Then pollution is higher in the country that has lower trade frictions.
 - (b) Suppose that both countries import the polluting good. Then pollution is lower in the country that has lower trade frictions.
2. Suppose the world price p is fixed. Suppose home exports X . For such a country, the pure composition effect of trade liberalization will be to increase pollution.

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3. In autarky, the relative price of the pollution intensive good rises with per capita income if we control for relative factor abundance. Hence high income, all else equal, tends to generate a comparative disadvantage in pollution intensive goods. More concretely, if a country is *sufficiently* rich, it must export the labor intensive (clean) good.

Empirical work

Sulfur dioxide is a noxious gas produced by the burning of fossil fuels. Emissions in developed countries accrue to a large extent from electricity generation and the smelting of non-ferrous ores; in some developing countries diesel fuel and home heating are also large contributors.

Energy intensive industries are also typically capital intensive, a reasonable proxy for dirty SO₂ creating activities may be physical capital intensive production processes.

We will present the results of "Is Free Trade Good for the Environment?" by Antweiler, Copeland and Taylor, American Economic Review 2001.

SO2 emissions can be controlled by altering the techniques of production in three ways.

The data set consists of 2621 observations from 293 observation sites located in 109 cities representing 44 countries spanning the years 1971-1996.

Estimated equation:

$$z_{ijkat} = b_0 + b_1 GDP_{jkt} + b_2 KL_{kt} + b_3 (KL_{kt})^2 + b_4 I_{kt} + b_5 (I_{kt})^2 + b_6 R_{ijk} + b_7 B_{ijk} + b_8 M_{jkt}^T + b_9 M_{jkt}^P + b_{10} O_{kt} + b_{11} RKL_{kt} + b_{12} O_{kt} (RKL_{kt})^2 + b_{13} O_{kt} RI_{kt} + b_{14} O_{kt} (RI_{kt})^2 + e_{ijkat}$$

where GDP_{jkt} is measured by real GDP/km², KL_{kt} is measured by the capital to labor ratio, I_{kt} is one period lagged three year moving average of GDP per capita, R_{ijk} is a dummy indicating site ijk is in a rural location, B_{ijk} is a dummy indicating site ijk is in a suburban location, M_{jkt}^T is average temperature in city j at time t , M_{jkt}^P is the variation in precipitation in city j at time t , O_{kt} is measured by the ratio of exports and imports to GDP, O_{kt} , RKL_{kt} and $O_{kt} (RKL_{kt})^2$ are interactions of openness with country k 's relative capital to labor ratio and its square, and O_{kt} , RI_{kt} and $O_{kt} (RI_{kt})^2$ are interactions of openness with country k 's income per capita and its square.

In addition to these determinants a dummy for communist countries was included in all of the estimations.

The scale of economic activity is measured by GDP/km^2 .

The composition effect is captured by capital abundance, k , as measured by a nation's capital to labor ratio.

The technique effect is proxied by a moving average of lagged income.

TABLE 2: ISOLATING TRADE'S EFFECT: A FIRST STEP

	Openness (X+M) /GDP	Black Market Premium	Avg. Tariff [%]	Avg. Quota [%]	Sachs& Warner Dummy
Estimate	-0.00239	0.02606	0.00088	0.00594	0.03934
t-Stat.	(1.819)	(1.496)	(0.349)	(1.917)	(0.454)
Obsv.	2621	2621	2369	2298	2621
Groups	293	293	270	263	293
R^2	0.326	0.324	0.354	0.364	0.324

Note: The results shown were obtained through a random-effects estimation. T-statistics are shown in parentheses. Significance at the 95% and 99% confidence levels are indicated by * and **, respectively. Dependent variable is the log of the median of SO₂ concentrations at each observation site. Note that the black market premium, average tariff and quota coverage variables measure the *inverse* of openness; their sign has thus to be reversed to interpret the direction of the estimates as an increase in openness.

Figure : Effects of trade on SO₂

TABLE 1: THE DETERMINANTS OF SO₂ CONCENTRATION

Variable	Fixed Effects		Random Effects	
Intercept	-4.27278**	(8.80)	-3.57378**	(12.26)
GDP/km ²	0.04659**	(4.41)	0.05342**	(8.62)
Capital abundance (K/L)	0.05061**	(3.10)	0.03176**	(2.63)
$(K/L)^2$	-0.00078**	(4.51)	-0.00054**	(3.98)
Lagged p.c. income (I)	-0.11068**	(2.84)	-0.13462**	(4.60)
I^2	0.00286**	(2.98)	0.00316**	(3.86)
Communist Country			0.34283	(1.65)
Suburban			-0.48528**	(2.69)
Rural			-0.73596	(1.90)
Average Temperature	-0.04400	(1.80)	-0.06034**	(5.88)
Precipitation Variation	6.13769	(1.45)	3.73900	(0.96)
Time Trend	-0.03491**	(6.76)	-0.03501**	(8.63)
Observations / Groups	2621	293	2621	293
R^2 (overall)	0.204		0.329	
Hausman Test	$\chi^2_8 = 21.38$			

Note: T-statistics are shown in parentheses. Significance at the 95% and 99% confidence levels are indicated by * and **, respectively. Dependent variable is the log of the median of SO₂ concentrations at each observation site.

Figure : Effects of trade on SO₂

E 4: SCALE, COMPOSITION, TECHNIQUE, & TRADE ELASTIC

Elasticity	Estim.	Std.Err.	95%-Conf. Iv.
Fixed Effects Regression			
Scale	0.193	0.053	0.089 / 0.297
Composition	1.135	0.301	0.546 / 1.724
Technique	-1.611	0.366	-2.328 / -0.894
Trade Intensity	-0.869	0.149	-1.161 / -0.576
Random Effects Regression			
Scale	0.245	0.030	0.186 / 0.305
Composition	0.783	0.230	0.332 / 1.233
Technique	-1.580	0.222	-2.015 / -1.146
Trade Intensity	-0.533	0.093	-0.715 / -0.351

Note: All elasticities are evaluated at sample means.

Figure : Effects of trade on SO2

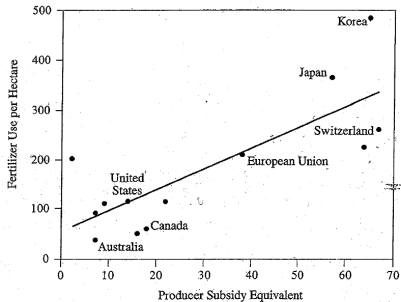


Figure 2.6

Protection of producers and use of fertilizers in agriculture, 1998. (Data from Organization for Economic Cooperation and Development 2000a, table III.5; Food and Agriculture Organization 1998, table 14.)

Figure : Trade and pollution