

# International Trade

## 11. The Effects of Trade on Poverty, Inequality, and the Environment

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# 1. Introduction

- Without international agreements, countries would have strong incentive to choose policies such as tariffs that benefit their own welfare.
  - If all countries act selfishly, world welfare decreases due to deadweight losses from trade restrictions.
  - WTO seeks to avoid this outcome by requiring members to reduce tariffs.
  - Regional trade agreements serve similar purpose, though for smaller group of countries.
    - Free-trade area: elimination of tariffs among members but maintenance of separate tariffs on nonmembers.
    - Customs union: elimination of tariffs among members and common tariffs on nonmembers.

# 1. Introduction

- Two areas where free trade and international trade agreements are particularly controversial are labor and the environment.
  - Global agreements on labor require judgment and comparison of labor (and also salary) standards across countries.
  - Global agreements on the environment try to regulate the use of a common property to avoid tragedy of the commons – overuse of a resource without clear property rights.
- This chapter presents evidence from studies on the effects of trade on poverty and inequality, and on the environment, along with a discussion of relevant (trade) agreements.

# 2. The effects of trade on poverty and inequality

## The theory

- According to H-O theory and particularly Stolper-Samuelson theorem, trade liberalization leads to increase in relative returns of abundant factor:
  - Capital gains in developed (capital-rich) countries, (unskilled) labor gains in developing (labor-rich) countries.
  - Consequence should be
    - more inequality in developed countries as capital owners get richer and labor gets poorer;
    - less inequality in developing countries as labor sees increasing (real) wages.
  - Theory confirmed by early globalizers such as Taiwan.

# 2. The effects of trade on poverty and inequality

Case study based on two articles:

- Dollar, David and Aart Kraay (2004). Trade, Growth, and Poverty, *The Economic Journal*, 114, F22-F49.
  - Globalization has reduced inequality *between* countries, but not *within* countries during last two decades.
  - Globalizing developing countries have seen higher growth than non-globalizers.
- Arbache, Jorge S., Andy Dickerson and Francis Green (2004). Trade Liberalisation and Wages in Developing Countries, *The Economic Journal*, 114, F37-F96.
  - Globalization of past two decades has run counter to H-O theory: wages of highly skilled workers in developing countries have grown, while those of unskilled labor have fallen.

# 2. The effects of trade on poverty and inequality

Dollar & Kraay (2004)

- Two questions:
  - Are globalizing developing countries catching up with the rich countries?
  - Is inequality within globalizing developing countries increasing?
- Separation of sample into three country groups:
  - rich countries (24 OECD countries before recent expansions, plus Chile, HK, Korea, Taiwan, and Singapore);
  - globalizing developing countries (top 1/3 of growth in trade/GDP between 1975-9 and 1995-7, or top 1/3 trade barrier reducers);
  - non-globalizing developing countries (rest of group of 72 developing countries).

# 2. The effects of trade on poverty and inequality

Dollar & Kraay (cont'd)

- Two-pronged approach: comparative analysis and regression analysis.
- Results of simple comparative analysis:
  - Globalizing developing countries have had higher growth rates than non-globalizing developing countries AND rich developed countries over past 20 years.
  - No significant or systematic tendency to greater inequality within globalizers.

## 2. The effects of trade on poverty and inequality

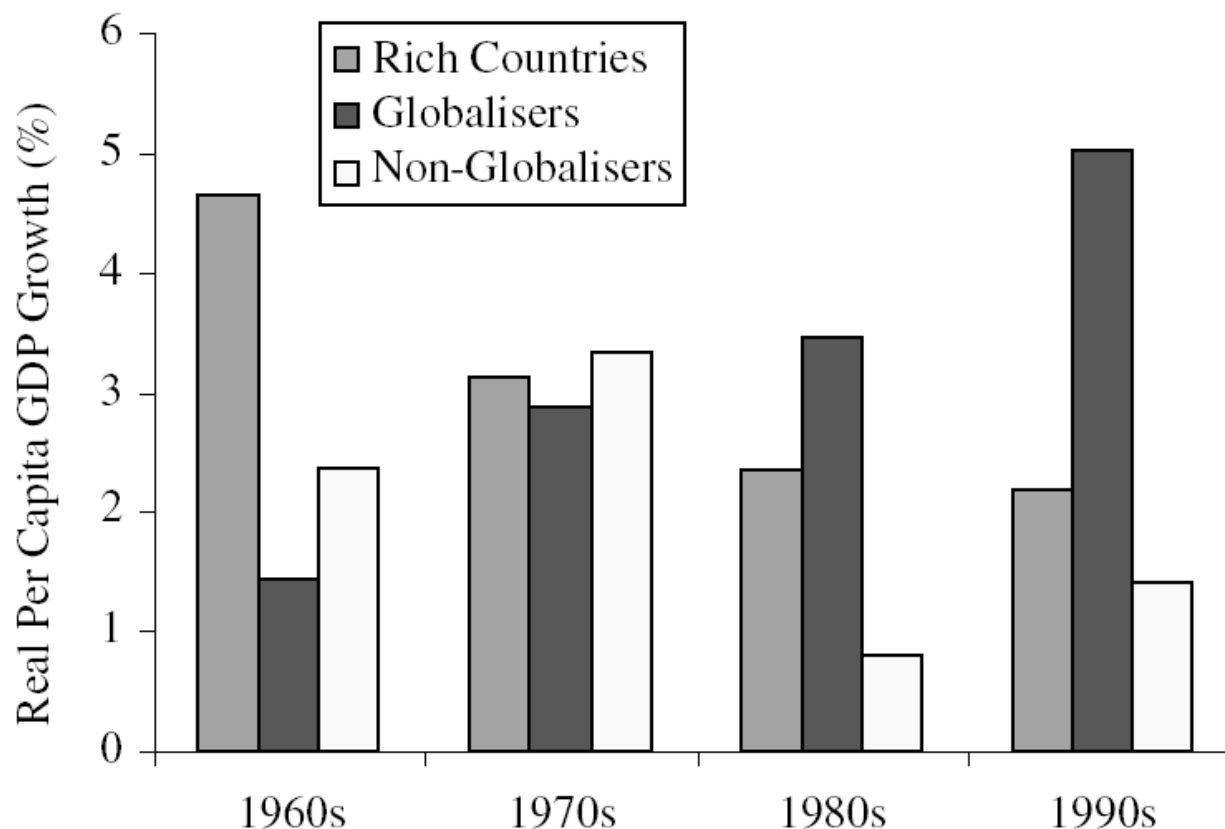


Fig. 3. *Real Per Capita GDP Growth*

## 2. The effects of trade on poverty and inequality

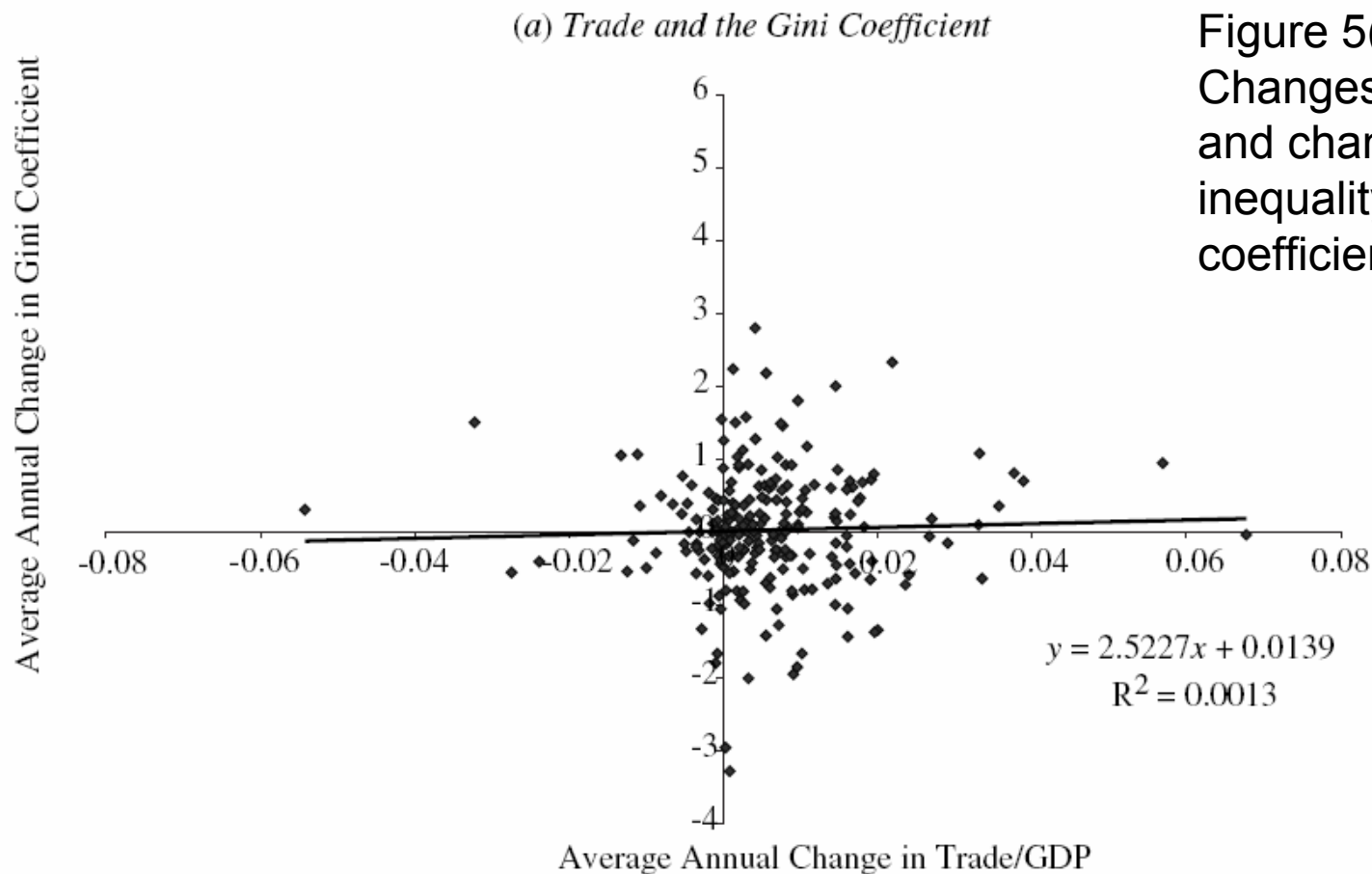
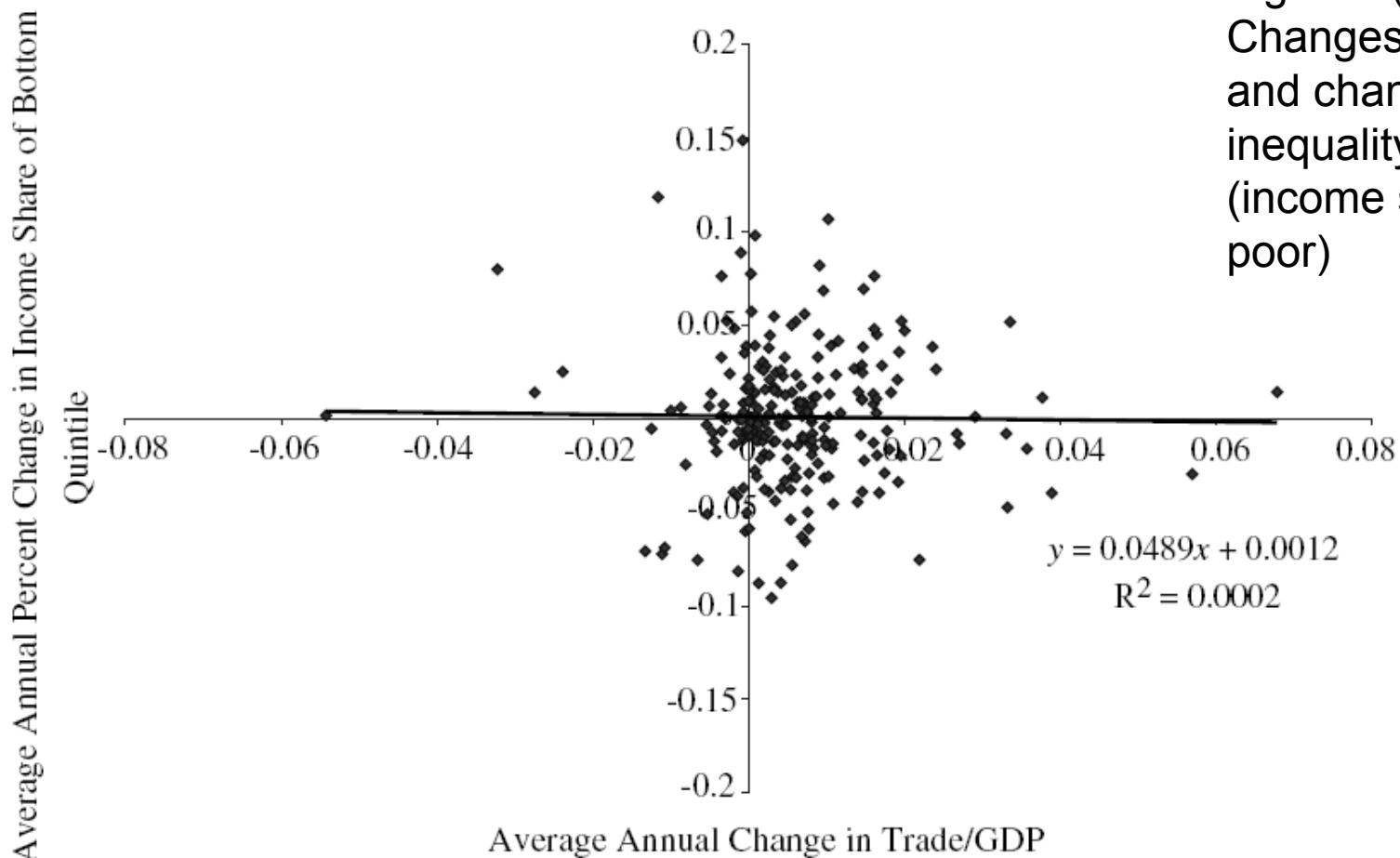


Figure 5(a)  
Changes in trade  
and changes in  
inequality (Gini  
coefficient)

# 2. The effects of trade on poverty and inequality

*(b) Trade and the Income Share of the Poor*

Figure 5(b)  
Changes in trade and changes in inequality  
(income share of poor)



# 2. The effects of trade on poverty and inequality

Dollar & Kraay (cont'd)

- Further analysis with variants of panel regression of log of per capita income of poor  $y^P$  on log of average per capita income  $y$ :

$$y_{ct}^P = \alpha_0 + \alpha_1 y_{ct} + \alpha_2' \mathbf{X}_{ct} + \mu_c + \varepsilon_{ct}$$

- where  $c$  and  $t$  index countries and years, resp.,  $\mathbf{X}_{ct}$  is vector of other determinants of mean income of poor, and  $(\mu_c + \varepsilon_{ct})$  is composite error term.
- Main interest on two parameters:
  - $\alpha_1$  – elasticity of income of poor w.r.t. mean income ( $\alpha_1 = 1$  means growth in mean income is translated one-to-one into growth in income of poor)
  - $\alpha_2$  – impact of other determinants of income of poor (in particular trade volumes) over and above their impact on mean income.

# 2. The effects of trade on poverty and inequality

Dollar & Kraay (cont'd)

- Results of regression analysis (see next slide for representative table):
  - Confirmation that globalizers have had higher growth rates than non-globalizing developing countries AND rich developed countries over past 20 years.
  - Changes in trade volumes positively and significantly related to changes in growth rates.
  - No correlation between trade volumes and inequality.

# 2. The effects of trade on poverty and inequality

*Growth and Incomes of the Poor* (Dependent Variables is ln(Per Capita Income in the Bottom Quintile))

|  | Trade volumes |          | Government consumption/GDP |          | log(1 + inflation rate) |          | Financial development |          | Rule of law index |          | All growth variables |          |
|--|---------------|----------|----------------------------|----------|-------------------------|----------|-----------------------|----------|-------------------|----------|----------------------|----------|
|  | Coef          | Std.Err. | Coef                       | Std.Err. | Coef                    | Std.Err. | Coef                  | Std.Err. | Coef              | Std.Err. | Coef                 | Std.Err. |
| ln(per capita GDP)                           | 1.094         | 0.108*** | 1.050                      | 0.085*** | 1.020                   | 0.089*** | 0.995                 | 0.119*** | 0.914             | 0.105*** | 1.140                | 0.100*** |
| (Exports + Imports)/GDP                      | -0.039        | 0.088    |                            |          |                         |          |                       |          |                   |          | 0.023                | 0.056    |
| Government consumption/GDP                   |               |          | -0.571                     | 0.419    |                         |          |                       |          |                   |          | -0.746               | 0.386*   |
| ln(1 + Inflation)                            |               |          |                            |          | -0.136                  | 0.103    |                       |          |                   |          | -0.163               | 0.107    |
| Commercial bank assets/<br>total bank assets |               |          |                            |          |                         |          | 0.032                 | 0.257    |                   |          | -0.209               | 0.172    |
| Rule of law                                  |               |          |                            |          |                         |          |                       |          | 0.084             | 0.069    | -0.032               | 0.060    |
| P-Ho: $\alpha_1 = 1$                         | 0.386         |          | 0.555                      |          | 0.825                   |          | 0.968                 |          | 0.412             |          | 0.164                |          |
| P-OID  | 0.257         |          | 0.168                      |          | 0.159                   |          | 0.350                 |          | 0.279             |          | 0.393                |          |
| T-NOSC                                       | -0.751        |          | -0.506                     |          | -0.261                  |          | -0.698                |          | -0.945            |          | -0.762               |          |
| No. of Obs.                                  | 223           |          | 237                        |          | 253                     |          | 232                   |          | 268               |          | 189                  |          |

Source: Dollar and Kraay (2002a), Table 5.

Notes: All regressions include regional dummies. The row labelled P-Ho:  $\alpha_1 = 1$  reports the p-value associated with the test of the null hypothesis that  $\alpha_1 = 1$ . The row labelled P-OID reports the p-value associated with the test of over identifying restrictions. The row labelled T-NOSC reports the t-statistic for the test of no second-order serial correlation in the different residuals. Standard errors are corrected for heteroscedasticity and for the first-order autocorrelation induced by first differencing using a standard Newey-West procedure.

# 2. The effects of trade on poverty and inequality

- Summary points for Dollar & Kraay (2004):
  - Substantial increases in integration among globalizing developing countries (i.e. greatly increased trade).
  - Per capita income growth increased in globalizers from 1980s to 1990s.
  - Globalizers have grown faster than non-globalizers and rich countries in 1980s and 1990s.
  - Small overall changes in inequality; income of poor changes with mean income, so positive link between globalization and growth means that poverty may have been reduced.

# 2. The effects of trade on poverty and inequality

- Summary points for Dollar & Kraay (2004) cont'd:
  - Some globalizers have greatly reduced inequality (e.g. Malaysia, Thailand), and income of poor has consequently grown faster than mean income.
  - China however has seen increased inequality, though poor have also become better off (ascribed mainly to specific policies such as poor transport links to underdeveloped regions and migration barriers).

# 2. The effects of trade on poverty and inequality

Arbache et al. (2004)

- Main question: what are the effects of trade liberalization on inequality in developing countries?
- Globalizers of last 20 years do not confirm traditional trade theory: growing gains for skilled labor and more inequality.
- Alternative explanations: technology inflows into open economies are skill-biased, may outweigh reduction in skilled labor predicted by traditional trade theory.
- Approach: study presents empirical evidence from Brazilian household surveys, separating wages in traded and non-traded sector, education levels, and comparing before and after trade liberalization of 1990-3.
- Simple comparison and regression analysis.

## 2. The effects of trade on poverty and inequality

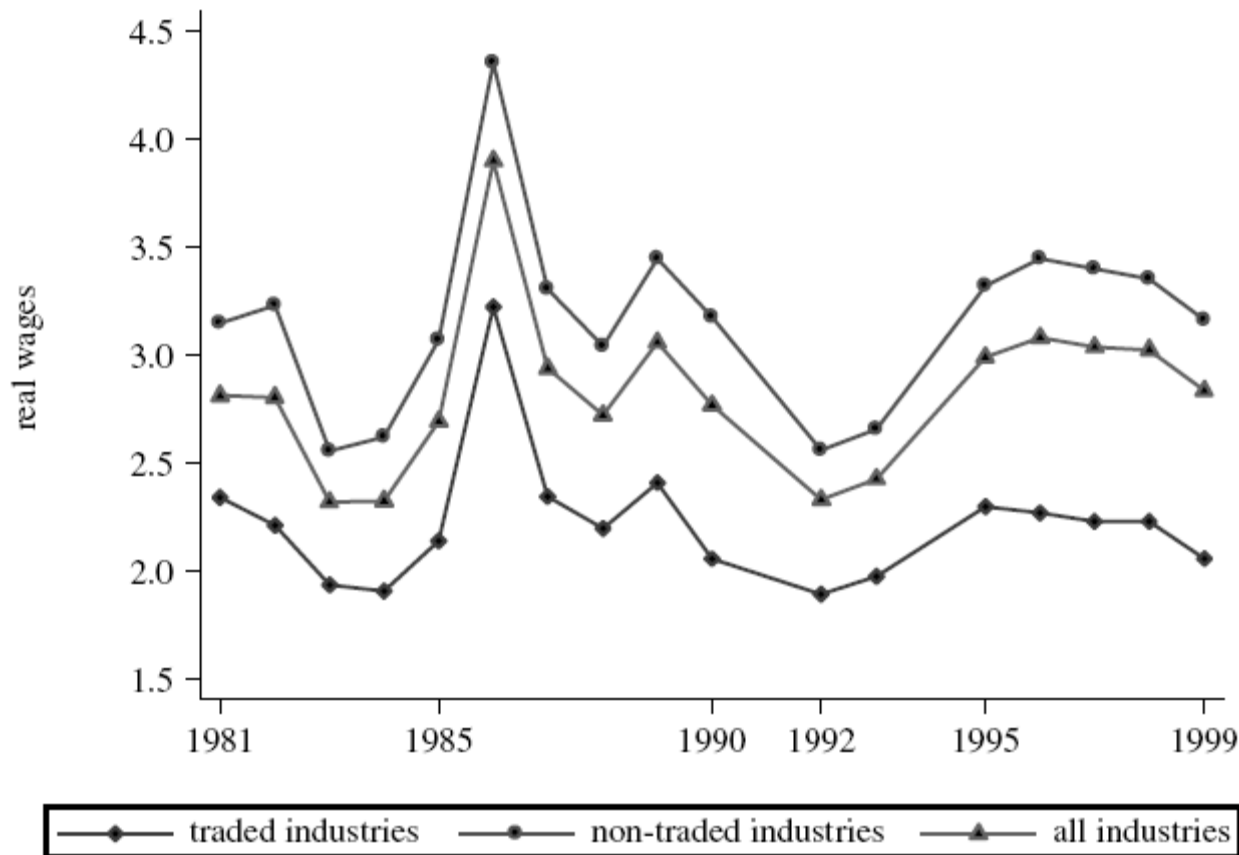


Fig. 1. Mean Wages by Sector: 1981-99

# 2. The effects of trade on poverty and inequality

*Mean Wages, Wage Dispersion and Employment Composition 1981–90, 1992–9*

(a): Mean hourly real wages

| <i>reals</i> | pre-liberalisation | post-liberalisation | average |
|--------------|--------------------|---------------------|---------|
| Non-traded   | 3.21               | 3.15                | 3.18    |
| Traded       | 2.28               | 2.13                | 2.22    |
| average      | 2.85               | 2.83                | 2.84    |

(b): Composition of employment

| percent    | pre-liberalisation | post-liberalisation | average |
|------------|--------------------|---------------------|---------|
| Non-traded | 60.8               | 68.5                | 64.3    |
| Traded     | 39.2               | 31.5                | 35.7    |
| total      | 100                | 100                 | 100     |

(c): Gini coefficient of hourly real wages

| <i>reals</i> | pre-liberalisation | post-liberalisation | average |
|--------------|--------------------|---------------------|---------|
| Non-traded   | 0.568              | 0.559               | 0.564   |
| Traded       | 0.572              | 0.564               | 0.569   |
| average      | 0.575              | 0.566               | 0.571   |

(d): Female employment share

| per cent   | pre-liberalisation | post-liberalisation | average |
|------------|--------------------|---------------------|---------|
| Non-traded | 39.4               | 42.9                | 41.1    |
| Traded     | 21.9               | 23.3                | 22.5    |
| average    | 32.5               | 36.7                | 34.5    |

*Note:* Real wages in 1998 *reals*.

# 2. The effects of trade on poverty and inequality

Table 2(a)  
Sectoral Composition of Employment: 1981–90, 1992–9

| Sector and Period:  | Proportion with highest education level |         |         |         |         |         |
|---------------------|---|---------|---------|---------|---------|---------|
|                     | Level 1                                 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
| Non-traded          |   |         |         |         |         |         |
| pre-liberalisation  | 0.112                                   | 0.160   | 0.318   | 0.142   | 0.188   | 0.081   |
| post-liberalisation | 0.082                                   | 0.125   | 0.303   | 0.163   | 0.233   | 0.094   |
| Mean                | 0.097                                   | 0.143   | 0.310   | 0.152   | 0.210   | 0.087   |
| Traded              |   |         |         |         |         |         |
| pre-liberalisation  | 0.273                                   | 0.238   | 0.307   | 0.087   | 0.072   | 0.024   |
| post-liberalisation | 0.218                                   | 0.202   | 0.326   | 0.118   | 0.108   | 0.028   |
| Mean                | 0.251                                   | 0.223   | 0.315   | 0.099   | 0.086   | 0.026   |
| Overall Mean        | 0.152                                   | 0.172   | 0.312   | 0.133   | 0.166   | 0.065   |

Note: Education classification:  
Level 1: Basically illiterate (less than one year of study).  
Level 2: Some elementary education.  
Level 3: Completed elementary, no or some primary education.  
Level 4: Completed primary, no or some secondary education.  
Level 5: Completed secondary, no or some college education.  
Level 6: Completed college education.

Note: These are row proportions in each case.

Table 2(b)  
Mean Real Hourly Wages by Sector and Education Level: 1981–90, 1992–9

| Sector and Period:  | Highest education level |         |         |         |         |         |
|---------------------|-------------------------|---------|---------|---------|---------|---------|
|                     | Level 1                 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
| Non-traded          |                         |         |         |         |         |         |
| pre-liberalisation  | 1.18                    | 1.62    | 2.13    | 2.84    | 4.63    | 10.81   |
| post-liberalisation | 1.26                    | 1.56    | 1.94    | 2.52    | 3.99    | 9.82    |
| Mean                | 1.21                    | 1.59    | 2.04    | 2.67    | 4.28    | 10.29   |
| Traded              |                         |         |         |         |         |         |
| pre-liberalisation  | 0.96                    | 1.49    | 2.18    | 3.13    | 5.55    | 13.77   |
| post-liberalisation | 0.86                    | 1.25    | 1.84    | 2.56    | 4.29    | 11.64   |
| Mean                | 0.92                    | 1.40    | 2.04    | 2.85    | 4.91    | 12.81   |
| Overall Mean        | 1.04                    | 1.50    | 2.04    | 2.72    | 4.40    | 10.64   |

## 2. The effects of trade on poverty and inequality

- Summary points for Arbache et al. (2004):
    - Average (high) wage inequality changed little after liberalization of 1990-3.
    - Workers in traded sector earned less than those in non-traded sector before liberalization, and even less after (narrowed rents due to increased competition).
    - Analysis shows (relative) marginal returns to education higher in traded sector; rose post-liberalization in both sectors, leading to small overall change in inequality.
    - Wages for lower-educated workers fell in traded sector.
- Trade liberalization had different effects across education groups and within sectors, increasing returns to college education in both sectors, and lowering wages for lower-educated workers in traded sector.

# 3. International agreements on labor issues

- Labor standards refer to all issues that directly affect workers, including occupational health and safety, child labor, minimum wages, etc.
- Labor standards, especially wage levels, generally not directly addressed in international trade agreements.
  - WTO agreements do not deal with labor standards as such. 1996 Singapore conference affirmed commitment to core labor standards, but these should not be used for trade protectionism. The economic advantage of low-wage countries should not be questioned.
  - International Labour Organization (ILO) seen as relevant body.

# 3. International agreements on labor issues

- Internationally regulated living wage – above-norm wage paid by foreign firms in developing countries – is controversial.
  - Difficult comparison of labor standards across countries.
  - Risk of rising unemployment: higher wages mean higher labor supply and less demand.
  - Rejection of living wage does not mean other types of labor standards should be abandoned!
- Underlying question: could trade actions be used to impose labor standards, or would enforcing labor standards simply be excuse for protectionism?

# 3. International agreements on labor issues

- Basic positions:
  - Consumers and policymakers argue against “sweat shop” conditions.
  - Unions seek improved labor conditions, partly to level playing field with developing country workers.
  - Economists, developing country representatives, UN note that labor standards can be trade barriers in disguise.
- Example: labor standards were included in NAFTA to satisfy two different groups: consumers and policymakers on one side, and labor unions on other.

# 3. International agreements on labor issues

- Consumers can demand improved working conditions for labor (e.g. Nike), though willingness to pay for goods produced under good labor standards is low.
  - One survey shows willing-to-pay premium for guaranteed good-labor-standards was \$2.80 for a \$10 item and \$15 for a \$100 item.
  - When “bad” product was discounted, willing-to-pay premium for a shirt produced under “good” conditions was \$1.83.
- Many companies now monitor labor standards in own production plants and subcontractors as part of corporate responsibility.
- NGOs can have more targeted impact than governments in case of violation of basic labor rights.

# 4. The effects of trade on the environment

## The theory

| <b>Environmental effects of trade</b> | <b>- via growth in income (dynamic)</b><br><i>Env'tal Kuznets Curve</i> | <b>- for a given level of income (static)</b>                                 |
|---------------------------------------|---|---|
| <b>Harmful effects</b>                | Larger scale of economic activity                                       | “Race to the bottom” in national regulation                                   |
| <b>Beneficial effects</b>             | Shifts to cleaner techniques and composition of economic activity       | “Gains from trade”:<br>increasing standards,<br>consumer power,<br>innovation |

# 4. The effects of trade on the environment

Case study based on three articles:

- Copeland, Brian R. and M. Scott Taylor (2004). Trade, Growth and the Environment, *Journal of Economic Literature*, 42 (1), 7-71.
  - No evidence for pollution haven hypothesis (relocation of polluting firms to country with lenient environmental regulation).
  - Trade has small but measurable positive impact on environmental quality, especially via composition and technical effects.
- Antweiler, Werner, Brian R. Copeland and M. Scott Taylor (2001). Is Free Trade Good for the Environment?, *American Economic Review*, 91 (4), 877-908.
  - Free trade has measurable effects on environmental quality.
  - If free trade increases production and income by 1%, pollution concentration decreases by 1%.

# 4. The effects of trade on the environment

- Frankel, Jeffrey A. and Andrew K. Rose (2005). Is trade good or bad for the environment? Sorting out the causality, *Review of Economics and Statistics*, 87 (1): 85-91.
  - Trade tends to reduce three measures of air pollution.
  - Results less encouraging for other measures of env'tal quality, but no clear evidence for detrimental effects.

# 4. The effects of trade on the environment

Copeland & Taylor (2004)

- Survey article of current state of research on trade, growth and environmental quality.
- Three main conclusions:
  - Rising incomes have positive or inverse-U shaped effect on environmental quality (EKC).
  - Environmental policy matters; both trade and investment respond to env'tal regulation. There is also negative relationship between import penetration and pollution abatement costs.
  - No evidence for pollution haven hypothesis (dirty industry relocation), but some evidence for pollution haven effect (less dirty-good production with high env'tal standards). Comparative advantage prevails for determining trade patterns.

# 4. The effects of trade on the environment

TABLE 1  
RANKING OF THE DIRTIEST MANUFACTURING INDUSTRIES

| Rank | Air               | Water             | Metals              | Overall           |
|------|-------------------|-------------------|---------------------|-------------------|
| 1    | Iron and steel    | Iron and steel    | Nonferrous metals   | Iron and steel    |
| 2    | Nonferrous metals | Nonferrous metals | Iron and steel      | Nonferrous metals |
| 3    | Nonmetal. min.    | Pulp and paper    | Indust. chemicals   | Indust. chemicals |
| 4    | Petro. coal prod. | Misc. manufac.    | Leather prod.       | Petro. refineries |
| 5    | Pulp and paper    | Indust. chemicals | Pottery             | Nonmetal. min.    |
| 6    | Petro. refineries | Other chemicals   | Metal products      | Pulp and paper    |
| 7    | Indust. chemicals | Beverages         | Rubber products     | Other chemicals   |
| 8    | Other chemicals   | Food products     | Electrical products | Rubber products   |
| 9    | Wood products     | Rubber products   | Machinery           | Leather products  |
| 10   | Glass products    | Petro. products   | Nonmetal. min.      | Metal products    |

Source: Mani and Wheeler (1997, p. 4)

# 4. The effects of trade on the environment

Copeland & Taylor (cont'd)

- Policy conclusions:
  - Scarce evidence for tariff substitution (env'tal instead of direct trade policy) to create race to bottom.
    - With trade liberalization, env'tal policy generally second-best and less efficient option than domestic taxes.
  - Scarce evidence for use of trade policy instead of env'tal policy.
    - Also second-best option, although sometimes employed to influence foreign env'tal policy.

# 4. The effects of trade on the environment

Antweiler et al. (2001)

- Main question: how does trade openness affect pollution concentrations?
- Distinction between scale, composition and technique effects of trade on pollution.
- Trade liberalization will have different effects in dirty-good importers and –exporters, with total effect depending on strength of three channels.
- Theoretical model leads to testable equation.

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Theoretical model
  - Two-good, two-factor model for SMOPEC: Y is labor-intensive and clean; X is capital-intensive and pollutes.
  - *Pollution emissions*:  $z = e(\theta)x$ ,  
where  $e(\theta)$  is emissions per unit of X dirty good produced, decreasing in measure of abatement intensity  $\theta$ .

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- *Pollution emissions function* (in differential form): pollution supply and demand combine to link pollution emissions to a few economic factors:

$$\hat{z} = \pi_1 \hat{S} + \pi_2 \hat{\kappa} - \pi_3 \hat{I} + \pi_4 \hat{\beta} + \pi_5 \hat{p}^w - \pi_6 \hat{T},$$

where all  $\pi_i$  are positive,  $S$  gives the overall scale of the economy,  $\kappa$  is the capital/labor ratio,  $I$  is real per capita income,  $\beta$  measures the importance of trade frictions,  $p^w$  is the common world relative price of  $X$ , and  $T$  is a measure of “country type” (hats denote percentage changes).

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Model shows that:
  - Trade openness, or fall in trade frictions  $\beta$ , produces *scale effect*, *technique effect*, and *trade-induced composition effect*.
  - Trade liberalization raises pollution for dirty-good exporter (scale effects dominate technique effects, and composition effect is positive), while it has ambiguous effects on pollution of dirty-good importer.
  - Pattern of trade is determined by both factor abundance and income-driven differences in pollution policy.
  - Capital abundance and real income are key country characteristics.

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Empirical strategy:
  - Sulfur dioxide (SO<sub>2</sub>) concentrations in different stations in 43 countries as proxy for pollution intensity.
  - Sample period 1971-1998.
  - Random and fixed effects panel analysis on unbalanced panel dataset.

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Basic estimation equation (model A) for pollution concentrations derived from model

$$Z_{ijkt}^C = X'_{jkt} \alpha + Y'_{ijkt} \gamma + \varepsilon_{ijkt}$$

- where  $i$  is observation station in city  $j$  in country  $k$  in year  $t$ .  $X$  is a vector of economic variables including scale measure (GDP/km<sup>2</sup> in city), nat'l capital-labor ratio, per-capita income, and trade intensity multiplied by other factors;  $Y$  includes site-specific variables; and  $\varepsilon$  is site-specific error term.
- Model B accounts for possible non-linear effects of income and capital-labor ratio.
- Model C additionally accounts for possible non-linearity of scale of economy.

# 4. The effects of trade on the environment

| Estimation method:<br>Model specification:<br>Variable/column:                               | Random effects |                       |                       | Fixed effects |                    |                    |
|--|----------------|-----------------------|-----------------------|---------------|--------------------|--------------------|
|  | A<br>(1)       | B<br>(2)              | C<br>(3)              | A<br>(4)      | B<br>(5)           | C<br>(6)           |
| Intercept  | -2.865***      | -3.279***             | -3.311***             | -2.506***     | -4.324***          | -4.299***          |
| City economic intensity GDP/km <sup>2</sup><br>(City economic intensity) <sup>2</sup> /1,000 | 0.042***       | 0.058***              | 0.070***              | 0.024*        | 0.058***           | 0.089*             |
| Capital abundance (K/L)<br>(K/L) <sup>2</sup>  | 0.102**        | 0.293**<br>0.014      | 0.286*<br>0.013       | 0.165**       | 0.461**<br>0.006   | 0.437*<br>0.008    |
| Lagged per capita income<br>(Income) <sup>2</sup><br>(K/L) × (I)                             | -0.982***      | -1.248***<br>0.708*** | -1.312***<br>0.669*** | -1.326***     | -0.096<br>0.559*** | -0.228<br>0.578*** |
| Trade intensity TI = (X+M)/GDP   | -0.915         | -0.488                | -0.510                | -3.677***     | -3.142**           | -3.216**           |
| TI × REL.K/L   | -0.462         | -1.952*               | -1.828*               | 0.159         | -2.252*            | -2.121             |
| TI × (REL.K/L) <sup>2</sup>  | 0.018          | -0.230                | -0.248                | -0.168        | -0.123             | -0.176             |
| TI × REL.INC   | 0.470          | 1.056*                | 1.011*                | 2.128**       | 2.687***           | 2.614***           |
| TI × (REL.INC) <sup>2</sup>  | 0.118          | -0.308*               | -0.285*               | -0.108        | -0.595**           | -0.584**           |
| TI × (REL.K/L) × (REL.INC)   | -0.165         | 0.870***              | 0.822***              | -0.280        | 0.900**            | 0.924**            |
| Suburban dummy   | -0.299         | -0.435*               | -0.422*               |               |                    |                    |
| Rural dummy  | -0.623         | -0.674                | -0.631                |               |                    |                    |
| Communist country (C.C.) dummy   | 0.312          | -0.252                | -0.257                |               |                    |                    |
| C.C. dummy × income  | -0.283         | 4.569*                | 4.641*                | 1.170         | 9.621**            | 9.639**            |
| C.C. dummy × (income) <sup>2</sup>   |                | -5.755**              | -5.788**              |               | -8.931***          | -8.806**           |
| Average temperature  | -0.055***      | -0.052***             | -0.052***             | -0.060*       | -0.057*            | -0.056*            |
| Precipitation variation:   | 3.446          | 5.860                 | 6.158                 | 8.599         | 10.810*            | 10.716*            |
| Helsinki Protocol:   | -0.232*        | -0.092                | -0.114                | -0.179        | 0.016              | 0.016              |
| Observations   | 2,555          | 2,555                 | 2,555                 | 2,555         | 2,555              | 2,555              |
| Groups   | 290            | 290                   | 290                   | 290           | 290                | 290                |
| R <sup>2</sup>   | 0.3395         | 0.3737                | 0.374                 | 0.2483        | 0.131              | 0.1499             |
| Log-likelihood   | -2550          | -2523                 | -2522                 | -3964         | -3906              | -3905              |
| LR test/χ <sup>2</sup> (df)  | 55.596***      | 1.604                 |                       | 118.42***     | 2.035              |                    |
| Hausman test/Wald χ <sup>2</sup> (df)  | 65.761**       | 15.158                | 53.789                |               |                    |                    |
| Scale elasticity   | 0.192***       | 0.265***              | 0.315***              | 0.112*        | 0.266***           | 0.398**            |
| Composition elasticity   | 0.583**        | 0.948***              | 0.993***              | 0.945**       | 1.006**            | 0.975*             |
| Technique elasticity   | -0.905***      | -1.577***             | -1.577***             | -1.222***     | -1.153**           | -1.266**           |
| Trade intensity elasticity   | -0.436***      | -0.388***             | -0.394***             | -0.641***     | -0.864***          | -0.882***          |

Notes: To conserve space, no standard errors or *t*-statistics are shown. The dependent variable is the log of the median of SO<sub>2</sub> concentrations at each observation site. Model A follows directly from our empirical implementation, whereas model B allows for additional interaction between capital abundance and income. In addition to model B, model C allows for nonlinearity in our scale variable. All model specifications use time-fixed effects. Elasticities are evaluated at sample means using the Delta method.

\* Significance at the 95-percent confidence level.

\*\* Significance at the 99-percent confidence level.

\*\*\* Significance at the 99.9-percent confidence level.

# 4. The effects of trade on the environment

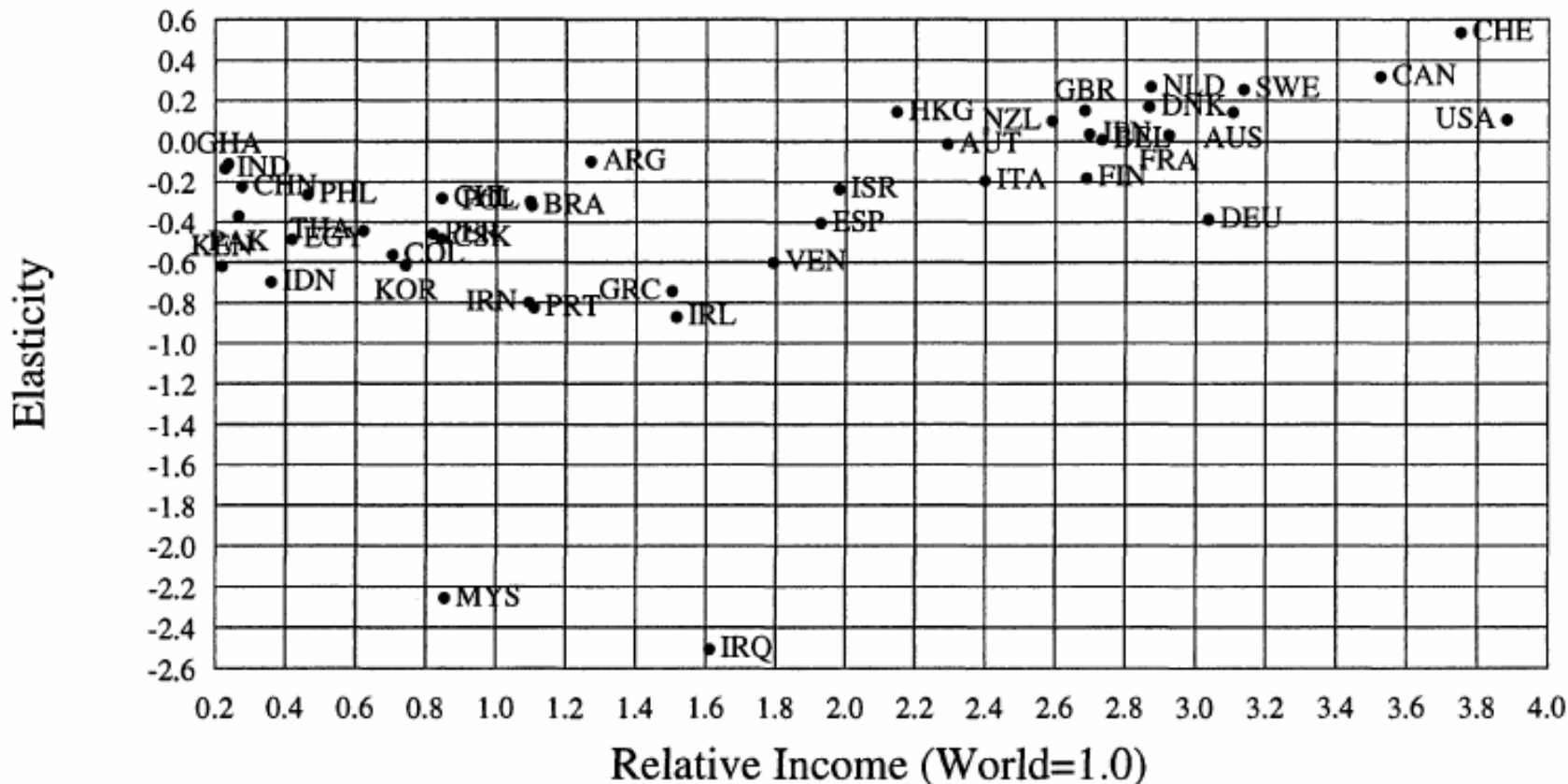


FIGURE 2. COUNTRY-SPECIFIC TRADE ELASTICITIES [MODEL B, RANDOM EFFECTS, CORRESPONDING TO TABLE 1 COLUMN (2)]

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Main empirical results:
  - Scale elasticity is positive.
  - Composition elasticity is negative.
  - Technique elasticity is negative.
  - Trade intensity elasticity is negative.

# 4. The effects of trade on the environment

Antweiler et al. (cont'd)

- Increased trade creates small but measurable changes in pollution concentration by altering pollution intensity of national output:
  - Small effect via composition channel;
  - Larger effect via scale and technique channels, implying fall in pollution concentration by 1% for every 1% increase in output and income caused by trade;
  - Technique dominates scale effect.
- No evidence of pollution haven effects; instead importance of comparative advantage.

# 4. The effects of trade on the environment

Frankel and Rose (2005)

- Empirical analysis of the effects of trade on the environment for a given level of GDP
  - consider endogeneity of openness (gravity model) and income
  - control for income, institutional setup (democracy), population density
- Basic estimation equation:

mainly SO<sub>2</sub>, NO<sub>2</sub>, PM; also CO<sub>2</sub> em. pc, deforestation, energy depletion (“genuine savings”), rural clean water access

log income pc and income pc squared

openness

$$EnvDam_i = \varphi_0 + \varphi_1 \ln(y/pop)_{90,i} + \varphi_2 [\ln(y/pop)_{90,i}]^2 + \beta([X+M]/Y)_{90,i} + \varphi_3 (Polity)_{90,i} + \varphi_4 \ln(LandArea/pop)_{90,i} + e_i$$

index of democracy/autocracy

population density

# 4. The effects of trade on the environment

| Determinant                             | OLS             |                 |                 | IV              |                 |                 |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|   | NO <sub>2</sub> | SO <sub>2</sub> | PM              | NO <sub>2</sub> | SO <sub>2</sub> | PM              |
| Trade/GDP                               | -0.29<br>(0.17) | -0.31<br>(0.08) | -0.37<br>(0.34) | -0.33<br>(0.19) | -0.23<br>(0.10) | -0.31<br>(0.41) |
| log(real GDP per capita)                | 409<br>(122)    | 287<br>(119)    | 567<br>(336)    | 461<br>(199)    | 296<br>(140)    | 681<br>(412)    |
| [log(real GDP per capita)] <sup>2</sup> | -22.8<br>(6.9)  | -16.6<br>(6.8)  | -35.6<br>(19.1) | -25.6<br>(10.9) | -17.1<br>(7.7)  | -42.0<br>(23.2) |
| Polity                                  | -3.20<br>(1.47) | -6.58<br>(2.05) | -6.70<br>(3.42) | -3.77<br>(1.37) | -6.41<br>(2.27) | -7.78<br>(4.07) |
| log(area per capita)                    | -5.94<br>(5.93) | -2.92<br>(1.39) | -13.0<br>(6.29) | -6.14<br>(6.43) | -1.54<br>(1.96) | -12.6<br>(6.84) |
| Observations                            | 36              | 41              | 38              | 35              | 40              | 37              |
| R <sup>2</sup>                          | 0.16            | 0.68            | 0.62            | 0.18            | 0.67            | 0.63            |
| Income peak (\$)                        | 7,665           | 5,770           | 2,882           | 8,015           | 5,637           | 3,353           |

Cross-country estimation across countries in 1990. (Robust standard errors in parentheses.) Regressands are averages per cubic meter. Intercept included but not reported. Instrument for trade constructed by aggregating predicted bilateral gravity equation of trade on distance, population, area, and dummies for language, land border, and landlocked status. Instruments for income (and square) constructed from regression of income on lagged income, population, openness, investment, population growth, and primary and secondary school enrollments.

Determinants of air pollution concentrations

# 4. The effects of trade on the environment

|                          | OLS             | IV              |
|--------------------------|-----------------|-----------------|
| CO <sub>2</sub>          | .016<br>(.008)  | .000<br>(.010)  |
| Deforestation            | .002<br>(.003)  | .001<br>(.004)  |
| Energy depletion         | -.014<br>(.009) | -.034<br>(.020) |
| Rural clean water access | .111<br>(.078)  | -.067<br>(.266) |

Estimation across countries in 1990. (Robust standard errors in parentheses.) Income, income squared, polity score, log area per capita, and intercept were included in the regression, but are not reported here, to save space.

Effect of openness on other types of environmental degradation

# 4. The effects of trade on the environment

Frankel and Rose (2005) cont'd

- Main results for SO<sub>2</sub> concentrations:
  - EKC: after income of ca. \$5700 pc, growth reduces pollution via regulation
  - Favorable effects of trade dominate for given income level.
- Main results for CO<sub>2</sub> emissions per capita:
  - No sign that total emissions decrease with trade; as global externality, national regulations only marginally affect CO<sub>2</sub> emissions
  - Trade may increase emissions even for given income level.
- Results less significant for NO<sub>2</sub>, PM and other measures of env'tal degradation.
- No evidence for pollution haven hypothesis.

# 4. The effects of trade on the environment

Frankel and Rose (2005) cont'd

- Updated analysis in 2009, 1990-2004 for 158 countries:
  - EKC for PM10 and water pollution
  - Trade still worsens CO2 emissions → lack of comprehensive global climate agreement.

# 5. International agreements on the environment

- Protestors at the Seattle WTO Ministerial meeting in 1999 launched first of big anti-globalization demonstrations; some wore turtle costumes. Why?
  - They felt that a WTO panel had, in the name of free trade, negated the ability of the US to protect sea turtles, simultaneously undermining national sovereignty and the international environment.
- Do the WTO and the environment conflict?



# 5. International agreements on the environment

- WTO affects environment only indirectly; 200 other multilateral agreements deal with environment directly.
  - Article XX of GATT (“green provision”) allows national env’tal laws uniformly applied to all producers.
  - Environmental issues have gained more prominence in WTO; rulings in favor of env’tal protection have increased since Seattle WTO meeting protests of 1999.
  - 2001 Doha Communiqué starting new round of negotiations: “the aims of ... open and non-discriminatory trading system, and acting for the protection of the environment ... must be mutually supportive.”

# 5. International agreements on the environment

- Examples of env'tal cases in GATT / WTO
  - Tuna-dolphin case (1991) filed by Mexico against U.S. after ban on Mexican tuna caught without dolphin-safe nets. Mexico won case, but consumer pressure led to wide adoption of “dolphin-safe” or “dolphin-friendly” label.
  - Shrimp-turtle case (1996) filed by India, Malaysia, Pakistan, Thailand against U.S. after ban on shrimp caught without turtle-safe nets. U.S. again lost, but worked with producers to enforce standards for shrimp exports.
  - Asbestos from Canada (2001): WTO ruled in favor of France, which had set import restriction on Canadian products containing asbestos.
  - Biotech foods in Europe (2006): WTO ruled in favor of U.S. and Brazil on EU ban on genetically modified food.

# 5. International agreements on the environment

- Avoiding tragedy of the commons in fishery
  - Free trade escalates depletion of ocean fisheries because world demand gives incentive for overuse of common property.
  - Convention on International Trade in Endangered Species (CITES) seeks to prevent over-harvesting of fish and other endangered species.
    - Example: CITES suspended export of Caspian Sea wild sturgeon eggs (caviar) or meat indefinitely in 2006.
- Historical example: international trade contributed to slaughter and near-extinction of buffalo in U.S. in 19th century.

# 5. International agreements on the environment

- International agreements on pollution
  - Montréal Protocol on Substances that Deplete the Ozone Layer led to global ban on use of chlorofluorocarbons (CFCs) in 1989.
  - Kyoto Protocol (1997) to reduce global greenhouse gas emissions, especially CO<sub>2</sub>. Adherents agreed to reduce GHG emissions by 5.2% against 1990 levels between 2008-2012, either through domestic measures or funding of emission-reducing measures in developing countries.

# 6. Conclusions

- Evidence shows free trade has increased income levels of poor countries and reduced inequality between countries. However, it has generally not reduced inequality within countries.
- International trade agreements do usually not directly include labor standard requirements (including minimum wage).

# 6. Conclusions

- Evidence shows free trade has decreased pollution levels for some more local pollutants.
- Free trade may increase emissions of global pollutant CO<sub>2</sub>; lack of comprehensive global agreement.
- Free trade may lead to tragedy of the commons, for example in fisheries.
- WTO does not directly address env'tal issues; however, many other international agreements seek to promote free trade while protecting the env't and preventing the tragedy of the commons.