

Measuring the Pollution Terms of Trade with Technique Effects*

Jean-Marie Grether, University of Neuchâtel**
Nicole A. Mathys, Swiss Federal Office of Energy and University of Neuchâtel

January 20, 2008

PRELIMINARY DRAFT – ALL COMMENTS WELCOME

Abstract

The pollution terms of trade (PTT) index introduced by Antweiler (1996) allows potentially to identify "pollution-haven" countries on the basis of trade-embodied pollution emissions and controlling for input-output relationships. However, due to lack of data, its application has been limited to the between sector composition effect that remains when US pollution technology is arbitrarily imposed to all partners and computations are limited to one year. This paper applies the PTT concept to a new database on SO₂ manufacturing emissions that includes variation of emission intensities across countries, sectors and over time. This allows to identify in addition the between country and the technique effect. Using this new database, it is possible to show that Antweiler (1996) results have been based on less than 30 percent of the overall variance. Hence, not surprisingly, the present results are different and are more in line with the "pollution-haven" argument, as they suggest that low income countries tend to have higher PTT indices, meaning that their exports are dirtier than their imports, while in high income countries the reverse is observed.

Keywords: international trade, environment, pollution-haven

JEL Classification: F18, Q56

*Financial support from the Swiss National Science Foundation under research grant No 100012-117872 is gratefully acknowledged. We thank Kilian Stoffel for his insightful comments and support, Marcelo Olarreaga for providing us with the trade data and Valentine Favre for her excellent preparatory work. The usual disclaimers apply.

** *corresponding author*, Institut de recherches économiques, Université de Neuchâtel, Pierre-à-Mazel 7, CH-2000 Neuchâtel. Email: jean-marie.grether@unine.ch

1. Introduction

Are differences in the stringency of environmental policy sufficiently important across countries so as to induce a "pollution-haven" effect, according to which dirty industries migrate towards poorer economies with softer environmental standards? Antweiler (1996) proposed a simple way to test for this conjecture by defining the pollution terms of trade (PTT) index as the ratio between the average pollution content per dollar of exports and the average pollution content per dollar of imports. This index controls for trade imbalances and takes input-output relationships into account. If pollution-haven effects were prevalent, one would expect rich (poor) countries to exhibit an index lower (larger) than 1. The empirical evidence reported by Antweiler's original application, which is based on a relatively large range of pollutants (CO₂, SO₂, NO₂, lead, particulate matter, volatile organic compounds), came to the reverse conclusion, namely that most pollution-havens were in fact rich economies. One caveat of this study, already recognized by Antweiler himself, was that because of lack of available data, he had to rely on US technological parameters, and apply them universally, as if there were no technological differences across countries. Relying on his own words the original PTT was only capturing the "trade-composition" part of PTT variation, not the "technological" part. Since then, to our knowledge, there has been no systematic attempt to reconsider the issue at the world-wide level.

This paper proposes to revisit the problem of PTT calculations, completing the analytical framework and relying on the largest possible set of newly available data for the empirical evidence. The methodology is directly borrowed from Antweiler (1996), the basic difference being that, as we include time variation into the analysis, we present a decomposition of the PTT index into three components: a between-sector, a between-country, and a technique effect. The first effect corresponds to the "trade-composition" index measured by Antweiler, the other two effects are novel, as they reflect technological differences across countries and over time. Regarding empirics, the sample period is 1990-2000 with a reasonable coverage (62 developed and developing economies), and a particular care has been given to capturing technological heterogeneity. Trade and country-specific input-output tables are taken from the Trade Production and Protection database of the World Bank (Nicita and Olarreaga, 2007), while country and time-specific polluting manufacturing emission intensities come from the recent database elaborated by Grether, Mathys and de Melo (2008). This allows to estimating each one of the three effects governing variations of the PTT index, but this time for a single

pollutant: sulphur dioxide (SO₂). We also propose an original approach to control for reexports, which may bias trade-embodied emissions calculations in the presence of technological differences across countries. As it turns out, the new empirical evidence is more akin to the pollution-haven argument, because of the impact of the two novel effects introduced into the analysis.

The next section outlines the theoretical derivation of the PTT index while section 3 shortly describes the data. Section 4 reports the main results, and the last section concludes.

2. Methodology

Following Antweiler (1996), define I as the total number of industries. Then, the following input-output relationship holds for each country and year:

$$Q = BQ + D = (\tilde{I} - B)^{-1}D \quad (1)$$

where $Q_{[I \times 1]}$ is the output vector, $B_{[I \times I]}$ is the intermediate input coefficient matrix, $D_{[I \times 1]}$ is final demand and $\tilde{I}_{[I \times I]}$ is the identity matrix.

Total SO₂ emissions embodied in a given final demand vector, denoted by e , are given by:

$$e = PQ = P(\tilde{I} - B)^{-1}D = AD \quad (2)$$

where $P_{[1 \times I]}$ is the vector of direct emission intensities (in physical pounds per US dollar) and $A_{[1 \times I]} = P(\tilde{I} - B)^{-1}$ is the vector of total emission intensities including input-output relationships.

Using c as a country index and t as time index, the pollution content per unit of exports is given by:

$$F_{ct}^X = \frac{A_{ct}X_{ct}}{\sum_i J_i X_{ct}} \quad (3)$$

where $X_{ct[I \times 1]}$ is the export vector of country c at year t and j_I^i is a unit vector $j_I^i = [1, 1, \dots, 1]$.

Similarly the pollution content per unit of imports is given by:

$$F_{ct}^M = \frac{\sum_{j \neq c} (A_{jt} M_{cjt})}{j_I^i M_{ct}} \quad (4)$$

where $M_{jct[I \times 1]}$ is the vector of imports of country c from country j at time t .

The pollution terms of trade (PTT) index is then given by the ratio between the pollution content per unit exports (equation 3) and the pollution content per unit imports (equation 4):¹

$$\chi_{ct} = \frac{F_{ct}^X}{F_{ct}^M} \quad (5)$$

If the PTT is larger than one, this means that country c 's exports are more pollution intensive than its imports. The reverse is true if the PTT index is smaller than one.

The PTT index captures three different effects. It reflects compositional effects in trade flows both between sectors and between countries, and it reflects technological changes over time. Hence, equation (5) can be decomposed in these three effects:

$$\chi_{ct} = \tilde{\chi}_{ct} \bar{\chi}_{ct} \hat{\chi}_{ct} \quad (6)$$

¹ Antweiler (1996) has multiplied the index by 100 and was hence working with a benchmark of 100.

where $\tilde{\chi}_{ct} = \left[\frac{A_{US,90}X_{ct}}{J_I^i X_{ct}} \right] / \left[\frac{A_{US,90}M_{ct}}{J_I^i M_{ct}} \right]$ stands for the between sector effect,

$$\bar{\chi}_{ct} = \left[\frac{A_{C,90}X_{ct}}{A_{US,90}X_{ct}} \right] / \left[\frac{\sum_{j \neq c} (A_{j,90}M_{cjt})}{A_{US,90}M_{ct}} \right]$$
 identifies the between country effect and
$$\hat{\chi}_{ct} = \left[\frac{A_{ct}X_{ct}}{A_{C,90}X_{ct}} \right] / \left[\frac{\sum_{j \neq c} (A_{jt}M_{cjt})}{\sum_{j \neq c} (A_{j,90}M_{cjt})} \right]$$
 reflects the technical effect. One is left with the

first part, $\tilde{\chi}_c$, when country specific and time varying emission intensities are not available as this was the case in the Antweiler (1996) study.²

Based on this theoretical framework, the next sections investigate the empirical importance of the inclusion of country-specific technologies for PTT indices.

3. Data

To be able to identify the three distinct components of the PTT index shown in equation (6), a first condition is that environmental data must contain a specific pollution coefficient for each sector in each country and over time. This type of data has been recently made available for direct SO₂ emissions (vector P in equation (2)) by Grether, Mathys and de Melo (2008), combining information from various sources (Hettige et al (1995), Olivier and Berdowski (2001) and Stern (2006)).

A second condition is to rely on input-output figures that are both country-specific and consistent with trade data for a large sample of countries. The Trade, Production and Protection (TPP) database of the World Bank (Nicita and Olarreaga, 2007) is the most recent one satisfying these criteria. A number of adjustments were necessary to prepare the data for the empirical analysis. First, original input-output shares (of intermediate sales into total production) have been converted into input-output coefficients using the relevant output figures (these IO coefficients are needed to compute the A vector of total emission intensities). Second, trade data have been aggregated from the 28 ISIC-3 digit categories into the 17 input-

² Note that the product of the between country and the technical effects here corresponds to the technical effect in the Antweiler (1996) paper.

output sectors reported in the TPP database (see the correspondence in table A1 in the Appendix). Third, simple ad hoc conventions were adopted to check material balances and to make sure that trade, production and input-output data are consistent with each other (e.g. no negative value added or no negative final demand for domestic or foreign goods). Most of these adjustments took the form of a reduction in input-output coefficients, so that the total emission intensities used in the present paper may be considered as a lower bound (see Appendix for the details).

A third condition to identify reliable PTT indices is to trace imports back to their original production site. Failing to do so may generate important biases in PTT calculations as reexports represent a substantial share of trade flows and pollution intensities differ markedly from one country to another.³ Although COMTRADE data on reexports are only available for roughly a quarter of the TPP countries, we rely on this subsample to calibrate a simple and original allocation methodology that allows to control trade flows for reexports (see the Appendix for the details).

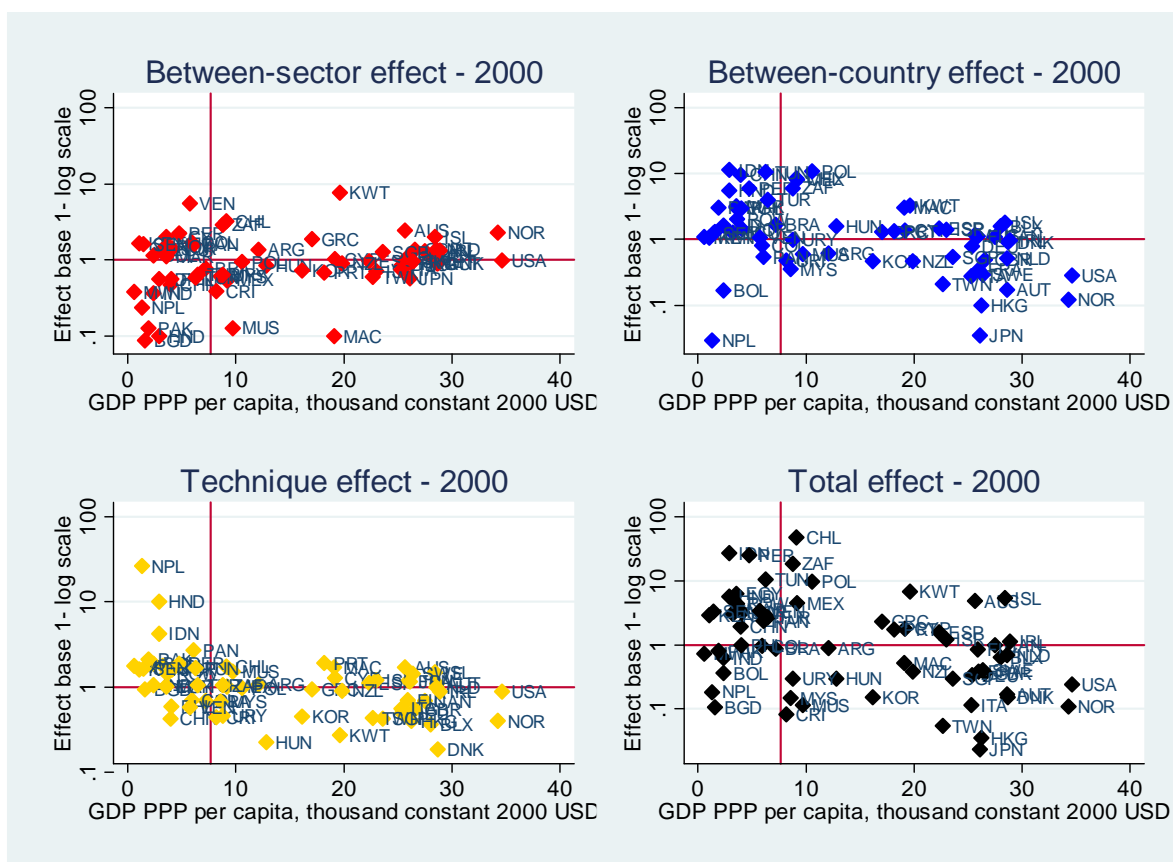
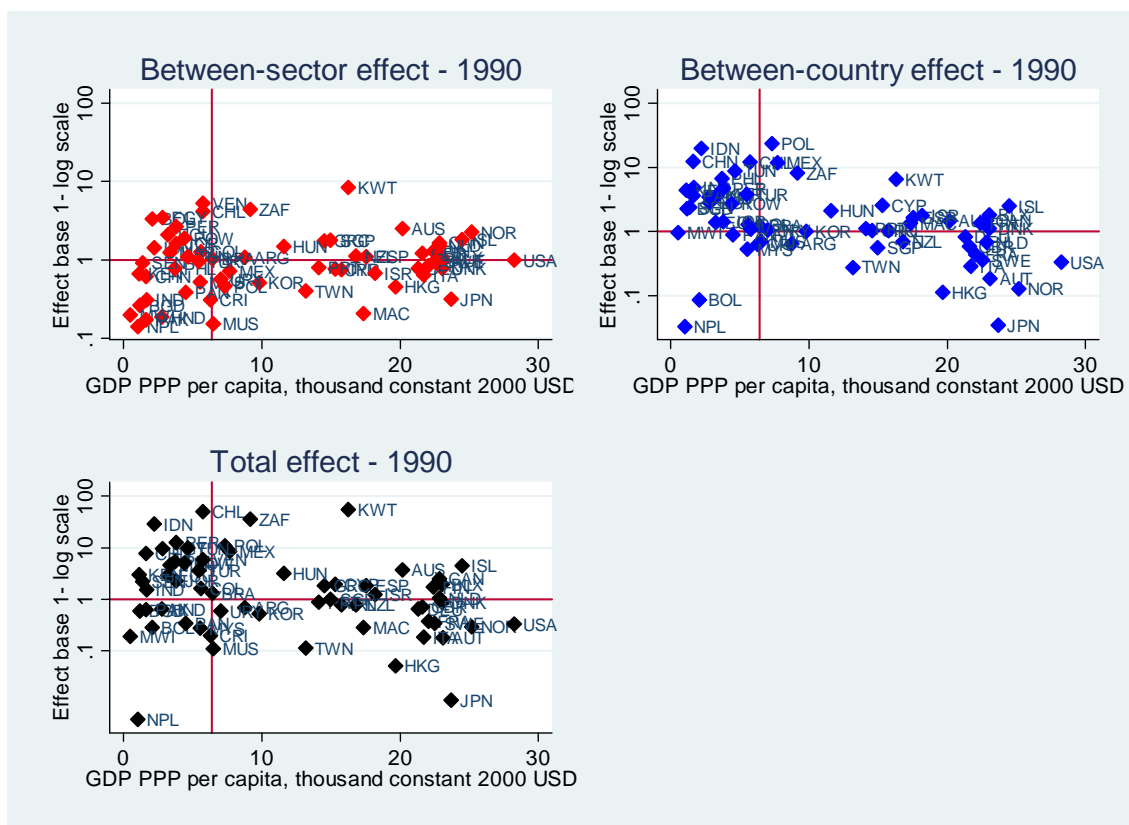
Following these adjustments, a consistent data set is made available on trade, pollution and production variables, covering 62 countries, 3 years (1990, 1995, 2000) and 17 manufacturing sectors.

4. Empirical Findings

The PTT index has been computed for each one of our 62 countries, for 1990 and 2000. Moreover, following equation (6), the different indices based on limited information have also been computed, providing a complete decomposition of the PTT index into three components. Detailed results are reported in Appendix Table A2. To ease interpretation and relate our results with the pollution-haven debate, we present our results with figures that plot the different indices against GDP per capita. Each panel is split into four quadrants by a horizontal line at the $PTT=1$ reference level and a vertical line representing average GDP per capita. A distribution of points in the upper-left and bottom-right quadrants would be consistent with the pollution-haven view.

³ This was not a source of concern for Antweiler (1996) as he had to impose the same pollution intensities to every country because of lack of available data on pollution intensities.

Figure 1: PTT against GDP per capita by country, for 1990 and 2000



Notes: cf. equation (6) in text for a definition of each effect / GDP per capita figures are taken from the World Bank Development Indicators, 2007.

Figure 1 reports the results at the country level. We start with the left upper panel, which represents the between-sector effect in 1990, i.e. the PTT index based on the assumption made by Antweiler (1996), namely that US emission intensities for different industries are applicable to all other countries. This leads to a distribution of points that has no clear orientation. If any, the relationship with GDP per capita appears to be slightly positive, restating the paradox that has been found in the Antweiler (1996) paper, namely that rich countries have relatively dirty average exports compared to low income countries. When shifting to the right-hand side panel, representing the between-country effect, the opposite pattern emerges. Apart from Bolivia and Nepal, the large majority of poor countries locate above the horizontal line, and a substantial number of rich countries are below the same line. This suggests that compared to US figures, large emission intensities seem to be biased towards exports in poor countries and towards imports in rich countries, a pattern that is more akin to the pollution-haven view. The total effect in 1990 results from the combination of the two previous effects (there is no technique effect as this is the base year). Broadly speaking, the overall pattern looks closer to the between-country effect, suggesting an inverse relationship between PTT indices and GDP per capita.

The evidence for 2000 is reported in the lower part of the figure. The between-sector and between-country effects look quite similar to what was observed for 1990. The novelty comes from the technique effect, which exhibits a clear inverse relationship with GDP per capita. This suggests that technological changes over time work in favor of the pollution-haven effect, leading to more export rather than import-embodied emissions in poor countries and the reverse in rich countries. This strengthens the average pollution-haven pattern of the total effect, that appears in the bottom-right panel of the figure.

Overall, although the dispersion of points is quite large, country-level estimates suggest that if one is limited by US technology coefficients, PTT indices seem either unrelated or slightly positively related with GDP per capita. However, the evidence also suggests that the two effects that control for technological differences (the between-country and the technique effect) exhibit a negative relationship with per capita GDP, and that those effects prevail over

the previous one in shaping a total pattern that is consistent with the pollution-haven argument.⁴

As a final source of evidence, and abstracting from the large number of countries, Figure 2 plots the same kind of graphs for 6 broad regions (see Appendix Table A3 for the country groupings).

The picture that emerges is now even clearer. Similarly to the country-level graphs, and whatever the year the between-sector evidence is inconclusive as regional dots are located in the four panels of the figure. For each other effect (including the total effect), the pattern is totally consistent with the pollution-haven view, as all points are located in the upper-left and the bottom-right panel of each figure.

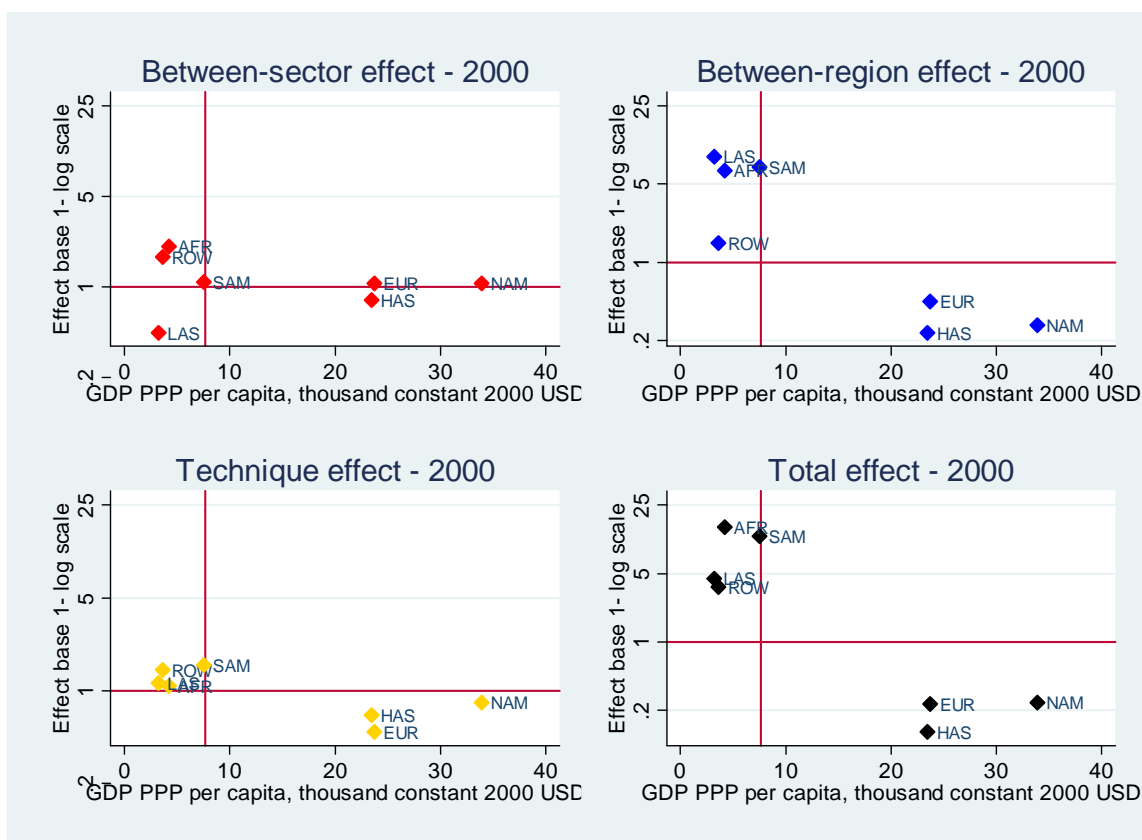
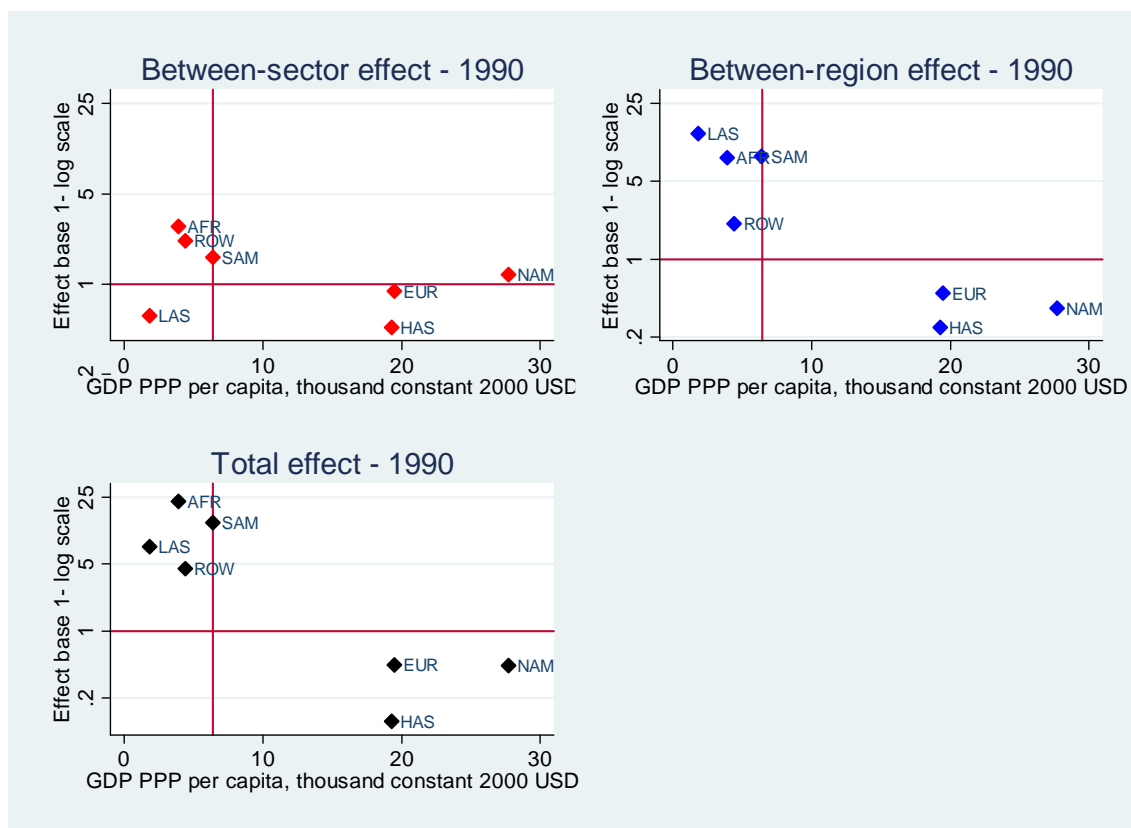
5. Conclusions

Do poorer countries tend to export "dirty" goods and import "clean" ones from richer economies? Based on the concept of the pollution terms of trade (PTT) and on SO₂ manufacturing emissions, and controlling for reexport activities, this paper proposes an answer in three steps.

In the first step, we propose a thought experiment in which there are no technological differences across countries (i.e. everyone is using the US technology). In such a simplified world, the notion of what is a "dirty" and what is a "clean" good is universal: it does not depend neither on the country nor on the time period. So everything boils down to the question of: how is trade structured across sectors? And there the evidence is unclear. Some relatively poor countries like Peru or Bolivia present indeed a dirty bias in their exports vis-à-vis their imports, but opposite cases like Poland or Honduras are almost as frequent. Thus within this simplified and technologically unified world there is no clear pollution-haven pattern.

⁴ Taking logs of equation (6), we also computed a simple variance decomposition of PTT indices. Whatever the year, the between-country effect represents a rough two-third of the total variance, while the technique and between-sector effects share the remaining third in roughly equal parts in 2000.

Figure 2: PTT against GDP per capita by region, for 1990 and 2000



Notes: cf. equation (6) in text for a definition of each effect / GDP per capita figures are taken from the World Bank Development Indicators, 2007 / Regional definition: AFR: Africa, EUR: Europe, HAS: High Income Asia, LAS: Low Income Asia, NAM: North America, ROW: Rest of the World, SAM: South America / For a detailed country list by region see Appendix table A2.

However the world is technologically diverse. In the second step, we take technological differences across countries into account, so that what is considered as a dirtier or a cleaner good becomes country-specific. And the correction term related to this second step does present a clear pattern, as it is higher for poor countries. This means that the use of US technological parameters in the first step undermined the true PTT of poor countries in a systematic way. In other words still, inter-country differences in emission coefficients between poor and rich countries tend to be biased towards the export products of the former group, a pattern that is consistent with the pollution-haven conjecture.

The same pattern emerges in the third step, where we control for technological change over time. In this case also, the correction term is higher for poor countries (and dramatically so for certain cases like Honduras or Nepal), suggesting that pollution intensities reduction (most countries becoming cleaner over time) tend to be smaller for exports in poor countries, which is again sympathetic to the pollution-haven argument. The total effect is obtained by the combination of the three steps. Although it is always possible to select a couple of countries that follow an inverse relationship, the overall pattern for the total effect is broadly consistent with the pollution-haven view.

References

- Antweiler W. (1996), "The Pollution Terms of Trade", *Economic Systems Research*, Vol. 8 (4), pp. 361-365.
- Grether, J.M., N. A. Mathys and J. de Melo (2008) "Scale, Technique and Composition Effects in Manufacturing SO₂ Emissions", *Environmental and Resource Economics*,. doi:10.1007/s10640-008-9237-5.
- Hettige, H.P., Martin, P., Singh, M. and Wheeler, D. (1995), "The Industrial Pollution Projection System", WPS# 1431, The World Bank, Washington, D.C.
- Nicita, A. and M. Olarreaga (2007) "Trade, Production and Protection, 1976-2004", *World Bank Economic Review*, Vol. 21(1) , pp. 165-71.
- Olivier, J.G.J. and J.J.M. Berdowski (2001), "Global Emission Sources and Sinks", in Berdowski, J., R. Guicherit and B. Heij eds. *The Climate System*, A.A. Balkema Publishers, Swets & Zeitlinger Publishers, Lisse, The Netherlands, pp. 33-78.
- Stern, D. I. (2006), "Reversal of the Trend in global anthropogenic sulfur emissions", *Global Environmental Change*, Vol. 16, pp. 207-220.

Appendix on data preparation

Import data being considered as more reliable than export data, all exports in this closed sample are estimated by mirror imports. Missing output data were extrapolated on the basis of simple rules already described in Grether et al (2008). All trade and output figures used in this paper correspond to 3-year moving averages around each “base” year (1990,1995,2000).

a) Adjusting input-output coefficients

Regarding input-output matrices, there are four inconsistencies in the original data leading to negative values of key variables for certain sectors:⁵

- (i) negative total absorption, obtained as the difference between output and net exports;
- (ii) negative expenses on imported intermediate inputs, obtained as the difference between expenses on intermediate inputs (from the input matrix) and expenses on domestic intermediate inputs (from the output matrix);
- (iii) negative sum of final demand on imported products plus reexports, obtained from the imports material balance (equation [A2] below);
- (iv) negative value added, obtained as the difference between production and intermediate expenses (from the output matrix⁶);
- (v) negative global final demand, obtained from the aggregate material balance (equation [A3] below);

These inconsistencies are eliminated by adjusting input-output coefficients (always in the same proportion for a given line or column) or the output level of the corresponding sector in a conservative fashion, i.e. by limiting the adjustment to what is just necessary to convert the negative key variable from negative to zero. Trade data are kept unchanged, as they are considered as more reliable.

The adjustment procedure runs as follows: A first output upward adjustment is performed for each case (i). Then cases (ii) and (iii) are treated by adjusting downwards the corresponding output (respectively input) matrix coefficient. For cases (iv) and (v), the “adjustment burden” is shared between an output increase or a decrease of the relevant input-output coefficient in an equal way. As those steps are interdependent, the procedure is repeated until all negative occurrences disappear.

The adjustment procedure converges after 6 iterations. For coefficients of the output matrix, the average decrease is less than 20% in more than 90% of the cases (the largest decrease being for Macao in 1995, with -24%). For coefficients of the input matrix, the average decrease is less than 27% in more than 90% of the cases (the largest adjustment is for the Philippines in 2000, with -48%). Regarding output figures, for more than 90% of the cases, the average increase in national production is smaller than 13% (the maximum is Honduras in 2000: plus 94%, then it drops to 73% and 64%, i.e. Panama in 1990 and 1995 respectively).

⁵ Case (i) affects 3% of the observations, case (ii) 25%, cases (iii) and (v) around 20%, and case (iv) roughly 6%. Note that for 8 countries, the IO matrices were not available and had to be borrowed from a neighbouring similar country (Netherlands for Benelux, Greece for Hungary, Mexico for Brazil, Norway for Iceland, Turkey for Israel, Philippines for Mauritius, Cameroon for Senegal and Morocco for Tunes). On average, these 8 countries do not present a higher occurrence of inconsistencies than the rest of the sample.

⁶ There are no cases of negative value added based on the input matrix, apart from Argentina, where all input coefficients had to be decreased by 21%.

b) Estimating reexports

The objective here is to “clean” trade data from reexports, keeping only direct trade relationships between the originally producing country and the finally consuming country. For this purpose we have to solve two questions for each country and sector: how much of gross exports correspond to reexports? and where do these reexports come from?

Starting with the first question, a first option is to rely on external data. The COMTRADE database provides reexport data, but only for a subset of our sample countries (16 out of 62). These data suggest that the average share of reexport in gross exports is substantial and rising over time. Moreover, it differs markedly between “entrepôt” countries like Hong-Kong (where it rises on average from 66% in 1990 to 88% in 2000) and other countries (where the corresponding figures are 4% and 7.5%). One **first** possibility would be to apply these average figures to the non-subset countries.

Another option is to infer reexports from material balances and some assumption on final demand structure. Making the distinction between domestic and foreign (i.e. imported) production, the following three material balance relationships must apply to any sector i :

$$\begin{aligned} q_i &= v_i^d + f_i^d + x_i^d & [A1] \\ m_i &= v_i^m + f_i^m + x_i^m & [A2] \\ q_i + m_i &= v_i + f_i + x_i & [A3] = [A1]+[A2] \end{aligned}$$

where q stands for domestic output, m for imports, x for exports, v for intermediate sales, f for final demand and a d (m) superscript indicates domestic (imported) production. Equations [A1] and [A2] look like a two-equation four-unknowns ($f_i^d, f_i^m, x_i^d, x_i^m$) system. As we know total exports and total final demand in each country, $x_i^d + f_i^d$ can be replaced by $x_i + f_i - (x_i^m + f_i^m)$ in [A1], so that we are left with two unknowns (x_i^m and f_i^m). However at this stage there is over-determination as both equations include the same sum of the two unknowns. We need to keep only [A1] or [A2], and impose some additional restriction. Our assumption is simply that reexports are a given share, noted ε , of final demand on imported goods (i.e. $x_i^{m*} = \varepsilon(m_i - v_i^m)$), subject to the constraints: $x_i^{m*} \leq x_i, f_i^{m*} \leq f_i$.⁷ We estimated that ε should be close to 10% to lead to more realistic figures regarding average reexport shares. This is our **second** possibility, which is conditional on an appropriate calibration of ε .

The above two possibilities provide an estimate of a country’s reexports that has still to be allocated between trading destinations, i.e. those partners that are importing our reexports (and across sectors regarding the first possibility). A straightforward assumption regarding allocation across partners would be to assume that reexport shares across partners are identical to gross exports shares. But there are at least two other alternatives: reexport shares of a given country are (i) identical to average reexport shares on the subset of reporting countries or (ii) identical across all partners (uniform distribution). As the same three assumptions regarding reexport shares are also applicable across sectors, this leads us to 9 (3 times 3) possible combinations.

⁷ We also made the alternative and common conjecture that the share of intermediate sales in domestic expenses is the same for the national and the foreign good (i.e. $f_i^d / v_i^d = f_i^m / v_i^m = f_i / v_i$). However this led to unrealistically high estimates of total exports in gross exports (more than 40% on average).

We rely on the subset of reporting countries as a benchmark to make the various choices reported above (which procedure to estimate national reexports? and which shares distribution across partners and sectors?). The objective to minimize is the (emission-weighted) average relative error in total export-embodied emissions. It turns out that the best option (which dampens the average error to 35%, from a maximum of more than 900%) is to consider:

- the average reexport shares obtained from the subset of reporting countries (considering only three entrepôt economies: Cyprus, Hong-Kong and Singapore)
- the gross export shares for the distribution of reexports across partners
- the uniform distribution for the distribution of reexports across sectors

This procedure was applied to all non-subset countries, while of course original data were kept for the 16 subset countries.

This leaves us with the second question, namely, how to allocate national reexports across origin countries, i.e. those partners that are exporting our reexports. As no additional information sources are available, we relied on the following three-step procedure to allocate re-exports to the putative original producers:⁸

- (i) for each re-exporter, re-exports are deduced from all export flows;
- (ii) for each re-exporter, imports are reduced proportionately across all providers so that all declared re-exports are subtracted from imports (when the destination country is also a reexporter, the double subtraction may lead to a negative residual; in this case the corresponding trade flow is set to zero and the absolute value of the negative residual is shared proportionately across all non-problematic source countries);
- (iii) for each source country, the total export reduction of step (ii) is reallocated across destination countries according to the average reexport shares that can be calculated from step (i).

⁸ We thank Kilian Stoffel for having designed this procedure. As our sample is closed and all exports are in fact mirror imports, the best way to visualize this procedure is to think about a 62x62 export matrix where each line (column) represents a country's exports (imports), with the changes implied by each one of the three steps being saved in a transitory correction matrix. Total corrections correspond to the sum of the three transitory correction matrices.

Table A1: Correspondence table between input-output and ISIC sectors

Input-output sector	ISIC 3-digit
1	311/312
2	353/354
3	313/314
4	321
5	322
6	323/324
7	331/332
8	341/342
9	351/352/355/356
10	361/362/369
11	371
12	372
13	381
14	384
15	382
16	383/385
17	390
18	.

Table A2: PTT indices for SO₂ emissions, 1990-2000

Country	1990				2000			
	Between-sector effect (1)	Between-country effect (2)	Technique effect (3)	Total effect (4)=(1)(2)(3)	Between-sector effect (1)	Between-country effect (2)	Technique effect (3)	Total effect (4)=(1)(2)(3)
Share of Variance	0.33	0.67	0	1	0.20	0.63	0.17	1
ARG	1.08	0.64	1.00	0.69	1.37	0.61	1.08	0.90
AUS	2.51	1.48	1.00	3.72	2.45	1.18	1.70	4.92
AUT	0.97	0.18	1.00	0.18	0.91	0.17	1.10	0.17
BGD	0.27	2.26	1.00	0.60	0.09	1.28	0.94	0.11
BLX	1.08	1.81	1.00	1.95	1.13	1.57	0.36	0.64
BOL	3.33	0.09	1.00	0.29	1.14	0.17	1.87	0.36
BRA	1.04	1.24	1.00	1.29	0.77	1.65	0.68	0.87
CAN	1.65	1.50	1.00	2.48	1.30	1.10	0.68	0.98
CHL	4.13	11.99	1.00	49.59	3.26	8.51	1.73	48.04
CHN	0.62	12.50	1.00	7.70	0.48	9.52	0.43	1.94
COL	1.25	1.30	1.00	1.63	1.70	0.81	0.70	0.96
CRI	0.31	0.64	1.00	0.20	0.39	0.48	0.44	0.08
CYP	0.76	2.55	1.00	1.94	1.02	1.36	1.28	1.78
DEU	0.78	0.82	1.00	0.64	0.88	0.78	0.50	0.34
DNK	0.78	1.13	1.00	0.88	0.90	0.91	0.19	0.15
ECU	2.11	1.38	1.00	2.90	1.38	1.27	1.76	3.08
EGY	3.43	2.81	1.00	9.66	2.02	3.03	1.03	6.32
ESP	1.10	1.67	1.00	1.84	0.96	1.47	1.11	1.56
FIN	1.28	1.35	1.00	1.73	1.09	1.11	0.70	0.84
FRA	0.85	0.44	1.00	0.38	0.92	0.35	1.19	0.38
GBR	1.21	0.59	1.00	0.71	1.36	0.48	0.55	0.36
GRC	1.77	1.05	1.00	1.85	1.87	1.31	0.94	2.30
HKG	0.45	0.11	1.00	0.05	0.90	0.10	0.40	0.04
HND	0.19	3.43	1.00	0.65	0.10	5.51	10.14	5.61
HUN	1.49	2.11	1.00	3.15	0.85	1.58	0.22	0.30
IDN	1.43	19.99	1.00	28.64	0.57	11.30	4.21	27.00
IND	0.31	4.89	1.00	1.51	0.36	1.64	1.05	0.62
IRL	0.75	1.03	1.00	0.78	1.33	0.96	0.89	1.14
ISL	1.81	2.50	1.00	4.52	2.00	1.79	1.50	5.34
ISR	0.68	1.80	1.00	1.23	0.71	1.41	1.21	1.21
ITA	0.64	0.29	1.00	0.18	0.75	0.27	0.56	0.11
JOR	1.60	1.44	1.00	2.30	1.41	1.42	1.62	3.25
JPN	0.32	0.03	1.00	0.01	0.58	0.04	1.16	0.02
KEN	0.67	4.41	1.00	2.96	1.67	1.06	1.62	2.88
KOR	0.52	1.01	1.00	0.52	0.73	0.46	0.45	0.15
KWT	8.36	6.52	1.00	54.53	7.63	3.26	0.27	6.74
MAC	0.21	1.36	1.00	0.28	0.10	3.07	1.70	0.53
MAR	1.24	3.71	1.00	4.60	1.12	3.16	1.00	3.56
MEX	0.71	11.76	1.00	8.41	0.54	8.10	1.01	4.46
MUS	0.15	0.71	1.00	0.11	0.13	0.60	1.52	0.12
MWI	0.20	0.96	1.00	0.19	0.38	1.08	1.77	0.73
MYS	0.52	0.54	1.00	0.28	0.62	0.36	0.67	0.15
NLD	1.53	0.68	1.00	1.04	1.38	0.51	0.99	0.70
NOR	2.29	0.13	1.00	0.29	2.30	0.12	0.40	0.11
NPL	0.14	0.03	1.00	0.00	0.24	0.03	26.65	0.18
NZL	1.11	0.70	1.00	0.78	0.91	0.47	0.91	0.39
PAK	0.17	3.63	1.00	0.63	0.13	3.02	2.10	0.81
PAN	0.39	0.88	1.00	0.34	1.61	0.54	2.72	2.35
PER	2.66	4.74	1.00	12.60	2.26	6.00	1.86	25.23
PHL	0.78	6.79	1.00	5.30	0.57	2.92	0.59	0.98
POL	0.46	23.62	1.00	10.89	0.94	10.81	0.96	9.81
PRT	0.80	1.12	1.00	0.89	0.68	1.32	1.90	1.72
ROW	1.90	2.68	1.00	5.09	1.51	2.04	1.43	4.40
SEN	0.92	2.41	1.00	2.21	1.61	1.24	1.65	3.29
SGP	1.80	0.56	1.00	1.00	1.29	0.54	0.42	0.30
SWE	0.96	0.36	1.00	0.35	0.97	0.29	1.43	0.40
TUN	1.11	8.87	1.00	9.81	0.59	10.63	1.68	10.58
TUR	0.95	3.78	1.00	3.58	0.65	3.99	1.06	2.73
TWN	0.40	0.28	1.00	0.11	0.61	0.21	0.43	0.06
URY	0.56	1.06	1.00	0.59	0.64	1.00	0.46	0.29
USA	1.00	0.33	1.00	0.33	0.99	0.28	0.88	0.24
VEN	5.33	1.10	1.00	5.85	5.51	1.05	0.58	3.36
ZAF	4.38	8.08	1.00	35.43	2.91	6.03	1.06	18.55

Notes: cf. equation (6) in text for the definition of each effect.

Table A3: Regional grouping of countries

N. America, NAM (2)	High Income Asia , HAS(10)	Europe, EUR (19)	Africa, AFR (8)	Low Income Asia, LAS (10)
Canada (CAN)	Australia (AUS)	Austria (AUT)	Egypt (EGY)	Bangladesh (BGD)
USA (USA)	Hong Kong (HKG)	Belgium & L. (BLX)	Kenya (KEN)	China (CHN)
	Israel (ISR)	Cyprus (CYP)	Morocco (MAR)	India (IND)
S. America, SAM (13)	Japan (JPN)	Denmark (DNK)	Mauritius (MAS)	Indonesia (IDN)
Argentina (ARG)	Korea (KOR)	Finland (FIN)	Malawi (MWI)	Jordan (JOR)
Bolivia (BOL)	Kuwait (KWT)	France (FRA)	Senegal (SEN)	Malaysia (MYS)
Brazil (BRA)	Macau (MAC)	Germany (DEU)	S. Africa (ZAF)	Nepal (NPL)
Chile (CHL)	New Zealand (NZL)	Great Britain (GBR)	Tunisia (TUN)	Pakistan (PAK)
Colombia (COL)	Singapore (SGP)	Greece (GRC)		Philippines (PHL)
Costa Rica (CRI)	Taiwan (TWN)	Hungary (HUN)		Turkey (TUR)
Ecuador (ECU)		Ireland (IRL)		
Honduras (HND)		Island (ISL)		
Mexico (MEX)		Italy (ITA)		
Panama (PAN)		Netherlands (NLD)		
Peru (PER)		Norway (NOR)		
Venezuela (VEN)		Poland (POL)		
Uruguay (URY)		Portugal (POR)		
		Spain (ESP)		
		Sweden (SWE)		