Trade, Environmental Regulations and the World Trade Organization

New Empirical Evidence

Matthias Busse*
Hamburg Institute of International Economics (HWWA)
Department World Economy
Neuer Jungfernstieg 21
D-20347 Hamburg
Germany

Phone: +49-40-42834-435
Fax: +49-40-42834-451
Email: busse@hwwa.de

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Abstract

The paper empirically explores the linkages between environmental regulations and international trade flows. So far, empirical studies either have failed to find any close statistical relationship or have delivered questionable results due to data limitations. Using a comprehensive new database for environmental regulations across countries, a thorough empirical investigation of that linkage for 119 countries and five high-polluting industries is performed. No evidence is found to support the pollution hypothesis that industries facing above-average abatement costs with environmental regulations would prefer pollution havens and relocate their activities. The exception is iron and steel products, where a negative and statistically significant link is established, implying that higher compliance with international treaties and conventions and more stringent regulations are associated with reduced net exports. High-income countries, where environmental regulations are usually more stringent in comparison to middle or low-income countries, have experienced a considerable decline in the export-import ratio of iron and steel products since the late 1970s. There is no clear evidence that national governments choose sub-optimal policies that result in insufficient regulations, so the case for environmental standards within the WTO framework is relatively weak.

JEL Classification: F18, L50, O13, Q28
Key Words: Environmental Regulations, Trade, Comparative Advantage, WTO

1. Introduction

The past 15 years have seen an increasing debate over the linkages between trade and environmental regulations. In part, this debate has reflected concerns in developed countries that their competitive position would be eroded by environmental regulations that encourage pollution-intensive industries to move to countries with lower standards (the so-called pollution haven hypothesis). Environmentalists fear that increasing trade integration and the competition for investment and jobs may lead to a "race to the bottom" on environmental regulations, as national governments find it more difficult to internalize environmental and social costs in prices. Hence, trade unions and environmentalists usually demand binding international environmental standards, preferably within the framework of the World Trade Organisation (WTO) to ensure a "level playing field" for all exporters (Grether and De Melo 2003).

Based on standard trade models, economic theory would predict that a comparative advantage in pollution-intensive commodities would arise from relative factor endowments, that is, labor, capital, natural resources, and the stringency of environmental regulations (Van Beers and Van der Bergh 1996). It is well known that high-polluting industries, such as industrial chemicals or iron and steel, are highly capital intensive and require less labor in comparison to other manufacturing industries (Mani and Wheeler 1998). Environmental regulations, for instance, in a high-income country, with considerable abatement costs (as a percentage of total costs) would then lead to a relative cost disadvantage and a change in the relative comparative advantage in the production of "dirty" commodities toward countries with lower standards. As these industries move to lower-standards countries, not only the location of foreign direct investment (FDI) and trade patterns would be affected, but also overall pollution levels would increase.[1]

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[1] In the case of further trade integration, that is, a lowering of trade barriers, the overall effect for the environment is less straightforward. Here, it has become standard in the literature to distinguish three effects (Grossman and Krueger 1993, Copeland and Taylor 1994): (1) The *scale effect* will increase pollution levels, as long as trade integration induces economic growth and living standards, which, other things being equal, will increase environmental degradation; (2) the *technique effect* relates to the trade-induced change in access to technology (through imports of capital goods), which may have a positive impact on environmental degradation, as new technologies may result in savings on energy and other inputs, reducing the pollution intensity of growth; and (3) the

In contrast to the theoretical advances on the linkages between environmental regulations and trade, the empirical evidence for the pollution haven hypothesis has been anything but mixed. Kalt (1988) finds that United States environmental regulation had a significantly negative effect on US competitiveness, as measured by net exports of manufacturing goods. According to Birdsall and Wheeler (1993), pollution intensity in developing countries grew fastest when environmental regulations in high-income countries were toughened. Analyzing import-export ratios for five heavily polluting industries, Mani and Wheeler (1998) find that pollution havens may exist only temporarily, if at all. Wilson et al. (2002) regress – in addition to several control variables – measures of environmental regulations on dirty exports of 24 OECD and non-OECD countries. Their results indicate that in some industries a significant negative linkage can be established. On the other hand, Tobey (1990), Low and Yeats (1992), Van Beers and Van den Bergh (1997), Jänicke et al. (1997), Xu (2000), Xu and Song (2000), Harris et al. (2002), Grether and De Melo (2003) and Kahn (2003) find very little or no evidence that differences in environmental regulations across countries are a significant determinant of trade flows.[2]

It has been argued that most, if not all, empirical attempts to examine the linkage between trade and environmental standards suffer from the lack of adequate and comprehensive data on the stringency of regulations across countries (Hilton and Levinson 2001). Applying emissions by companies or pollution-level changes over time as a proxy for compliance costs, which has been frequently done for time-series analysis, may result in a severe bias in the estimated coefficients. Depending on geography, environmental quality, total emissions and regulations in a specific

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composition effect is associated with changes in the relative endowments of factors, as integration and growth affect the composition of output, and may have a positive or negative impact on environmental degradation. The overall effect then depends on the nature and strength of these three effects.

[2] See also the literature reviews by Jaffe et al. (1995) and Copeland and Taylor (2004). In contrast to trade flows, there is some (weak) evidence that differences in environmental regulations might affect FDI flows (List and Co 2000, Becker and Henderson 2000, Smarzynska and Wei 2001, Keller and Levinson 2002, Eskeland and Harrison 2003). Partly due to the availability of data, most of these studies focus on inward or outward US FDI. For trade flows between US states, on the other hand, Levinson (1999) found a statistically significant link between disposal state taxes and interstate hazardous waste shipments.

area may vary to a considerable extent. For instance, the Los Angeles area has arguably the worst air quality and at the same time the most stringent regulations and thus abatement costs in the United States (Berman and Bui 2001).

Due to these data deficiencies, we do not know whether environmental regulations significantly affect trade patterns and trade performance in pollution-intensive industries. Total abatement costs even in these industries might be relatively low and constitute thus an insignificant cost disadvantage. On the other hand, the empirical results might have been driven by the specific indicators or the usually limited number of countries included in the studies. This paper aims to augment the literature by using a unique, new and comprehensive database on environmental indicators, provided by the Centre for International Earth Science Information Network (CIESIN), which will be discussed in Section 2.

More specifically, a Heckscher-Ohlin model of trade will be employed to test whether environmental regulations across 119 countries affect trade patterns in five highly polluting industries. Using a consistent database for such a considerable number of countries allows us to test whether the results hold up for many low and middle-income countries that have not been included in previous studies. Obviously, it would be better still if changes in environmental regulations could be regressed on changes in trade patterns. But reliable data for any modifications in environmental regulations across countries are still not available. Using the CIESIN database for a single year, on the other hand, is an important foundation for further analyses in this field.

The paper is organized as follows: The CIESIN database and the selection of high-polluting industries are explained in the following section, whereas the empirical results are presented in Section 3. Based on the results, Section 4 discusses likely consequences for the multilateral trading system, that is, whether environmental regulations should be incorporated within the WTO framework. The paper ends with a summary of the major results and some concluding remarks.

2. Data

For a long time, there were virtually no reliable data on environmental regulations available. Although the situation has improved in recent years, as many institutions have undertaken surveys to investigate the extent and stringency of environmental regulations, totally accurate measures of the abatement costs of environmental regulations are still difficult to obtain. The major difficulty lies in trying to measure the exact abatement costs that a regulation imposes on manufactures. Unfortunately, many costs associated with pollution abatement also generate a certain amount of cost savings, the so-called cost offsets. Many efficiency-enhancing investments that companies might have made in the absence of pollution regulations may be environmentally friendly. It would be very difficult to segregate the components of investment or operating costs that have purely environmental purposes (Hilton and Levinson 2001). Moreover, the enforcement of existing regulations may vary across countries, which may give a somewhat misleading impression of the stringency of regulations in practice.

Bearing these shortcomings in mind, a new index has been created by the Centre for International Earth Science Information Network (CIESIN), which is a nongovernmental organization and the result of collaboration among the World Economic Forum's Global Leaders for Tomorrow Environment Task Force, the Yale Centre for Environmental Law and Policy, and the Earth Institute at Columbia University (CIESIN 2003). One of the main indicators they compile is the Environmental Sustainability Index, a measure of overall progress toward environmental sustainability, developed for 146 countries. The scores for this index are based on a set of 22 core indicators, each of which combines two to six variables for a total of 67 underlying variables.

Regarding the main linkages between environmental regulations and trade patterns, two of the CIESIN core indicators are appropriate: environmental governance and participation in international cooperative efforts. The former has been compiled based on a number of indicators that relate to environmental regulations, such as the ratio of petrol price to international average, World Economic Forum survey questions on environmental governance, the percentage of land area under protected status, the number of sector environmental impact assessment guidelines,

accredited forest area as a percentage of total forest area, measures of corruption, the World Economic Forum subsidies survey question, and the WWF (World Wide Fund for Nature) subsidy measure.[3] This indicator, called ENV_REG in the following analysis, thus provides a comprehensive measure of the stringency of environmental regulations across countries.

The second core indicator, participation in international cooperative efforts (called ENV_CONV), relates to a country's involvement in international attempts to deal with environmental problems across nations. It combines a set of seven variables: the number of memberships in environmental intergovernmental organizations, the percentage of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) reporting requirements met, levels of participation in the Vienna Convention/Montreal Protocol, levels of participation in the Climate Change Convention, Montreal Protocol multilateral fund participation, global environmental facility participation, and compliance with international agreements.

Whereas ENV_CONV focuses on participation in international efforts and ratification of conventions and treaties, ENV_REG concentrates more on the observance and enforcement of national laws and international treaties/conventions. Both are calculated by taking the average of the Z-scores of the underlying variables. ENV_REG and ENV_CONV range from -1.20 to +1.47 and -1.18 to 1.27, respectively, where higher numbers indicate more stringent regulations or a higher commitment to international treaties and conventions.

To our knowledge, this is the first attempt to combine the appropriate data for such a large number of countries. Both ENV_REG and ENV_CONV permit cross-national comparisons of environmental regulations in a systematic and quantitative fashion. Even though both indicators cannot address all the problems involved with measuring compliance cost with environmental regulations, they represent a first comprehensive step toward such an approach and allow an analytical examination of the linkages between environmental regulations and international trade. Both indicators are positively correlated with GNI per capita, indicating that higher

[3] See CIESIN (2003) for details.

income levels are associated with more stringent environmental regulations (Table 1). This strengthens the impression that the income level is a very important determinant of the extent of environmental regulations (Copeland and Taylor 2003).[4]

Table 1: Correlation Matrix, Environmental Regulations Indicators

Variable	ENV_REG	ENV_CONV	GNI[1]
ENV_REG	1.00		
ENV_CONV	0.60	1.00	
GNI[1]	0.69	0.62	1.00

Notes: All variables refer to the year 2001. [1]Gross National Income per capita in current US dollars.

As environmental regulations aim to reduce pollution levels, they will most of all affect industries that are highly polluting, implying that the analysis should focus on those industries with above-average pollution abatement costs as a percentage of total costs. But even for these dirty industries, that figure is usually in the range of 2 to 4 percent, which is much smaller than other production factors, such as capital costs (Low 1992). Table 2 shows the industries and corresponding SITC trade categories with the highest abatement costs: industrial chemicals, paper and pulp, non-metallic minerals, iron and steel, and non-ferrous metals. They have been selected based on the study by Low (1992), who calculated relative abatement costs for United States industries. All of them have abatement costs of at least 1.8 percent of total costs. What is more, these industries comprise the usual categories that are subject to empirical studies on environmental regulations and trade.[5]

[4] See also Antweiler et al (2001) and Fredriksson and Mani (2002) for an analysis of the determinants of environmental regulations. Openness to trade is another major factor that influences the level of regulations.

[5] Nearly all of the empirical studies cited in the first section used a very similar set of industries. Sometimes, differences in the selection of categories occur due to changes in the trade or industry classification system.

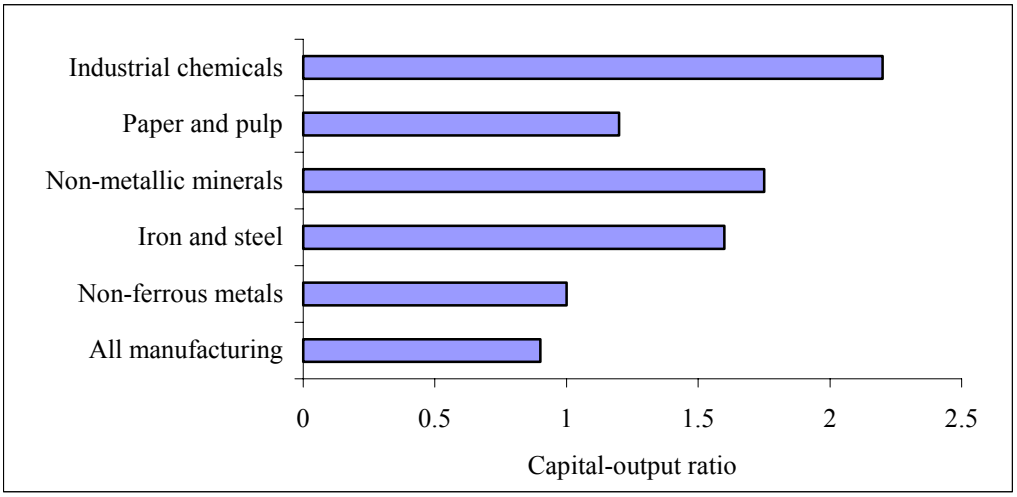
Table 2: Classification of Pollution-Intensive Industries

Industry	SITC No.[1]	Description
Industrial chemicals	51	Organic chemicals
	52	Inorganic chemicals
	562	Manufactured fertilisers
	59	Other chemical material and products
Paper and pulp	251	Pulp and waste paper
	641	Paper and paperboard
	642	Articles of cut paper and board
Non-metallic minerals	66	Non-metallic mineral manufactures
Iron and steel	67	Iron and steel
Non-ferrous metals	681	Silver and platinum
	682	Copper
	683	Nickel
	685	Lead
	686	Zinc
	687	Tin
	689	Other non-ferrous base metal

Notes: Selection of industries based on Low's (1992) calculations. [1] SITC Rev. 3.

Based on figures for Japan and the late 1980s, these five industries are – on average – more capital intensive than other manufacturing industries (Figure 1). Apart from non-metallic minerals, they also use less labor than other manufacturing industries (Figure 2).

Figure 1: Capital Intensity in Japanese Manufacturing, 1985-1989



Source: Mani and Wheeler (1998).

Figure 2: Labor Intensity in Japanese Manufacturing, 1985-1989

Source: Mani and Wheeler (1998).

3. Empirical Results

Following the identification of high-polluting industries and the introduction of the two measures of environmental regulations, we now turn to the linkages between these indicators and trade patterns. For a start, consider a standard Heckscher-Ohlin trade model with two countries (A and B), two basic production factors (capital and labor), and two products (high-polluting chemicals low-polluting musical instruments).[6] Assume that both countries produce both goods by using both factors, trade with each other and have identical environmental regulations in the initial situation. Now consider a decline in environmental regulations only in country B. In the short run, the decrease in the stringency in environmental regulations will lead to less abatement costs and hence lower total production costs and expand production possibilities with a bias toward the high-polluting good (chemicals). As the production of chemicals increases relative to that of musical instruments, country B (gains or) improves its comparative advantage in the production

[6] The choice of a Heckscher-Ohlin trade model is relatively straight forward, as it allows the incorporation of differences in factor endowments, which are the most important determinants of comparative advantage in the five industries.

of chemicals. As an important further result, worldwide environmental degradation would increase.

Note, however, that this clear-cut result depends on the relative impact of environmental regulations on abatement costs and, thus, total costs. If abatement costs are very small in comparison to other factors of production, there might be no clear influence of environmental regulations on trade pattern (Antweiler et al. 2001). Usually, total abatement costs do not exceed 4 percent of total costs, which is a much smaller figure in comparison to, for instance, capital costs, considering the capital intensiveness of high-polluting industries.

Moreover, it is the absolute difference in regulatory stringency that matters for comparative advantage, not abatement costs in any particular country. If regulations in country B are, for instance, half as stringent as in country A and total abatement costs are 2.2 percent for chemicals, the cost disadvantage would be limited to 1.1 percent of production costs.[7] It might be argued that other factors that determine comparative advantage could easily dominate such small policy-induced differences (Hilton and Levinson 2001). Nevertheless, whether or not environmental regulations do have an impact on trade flows in any of the high-polluting industries remains an empirical question that has still not been answered conclusively.

To serve as the dependent variables in the regressions, net exports of each of the five high-polluting industries in the most recent period (2001) have been chosen.[8] Using net exports, that is, exports minus imports, has the advantage that import flows are taken into account along exports and thus gives a more comprehensive picture of comparative advantage in the industries concerned. To test for the robustness of the results, several measures of revealed comparative advantage have been used as the dependent variables. Yet the results do not change much with respect to the significance and sign of the estimated variables, which points to the robustness of the subsequent results. Included in the country sample are all 119 nations that provide information on trade data, the control variables used in the regressions and the environmental

[7] The abatement cost figure for chemicals refers to the United States and the year 1988 (Low 1992).

[8] The variables are called NETEXPORTS Non-metallic minerals, NETEXPORTS Paper and pulp, etc.

policy indicators.[9] All indicators relate to the year 2001, the most recent year for which data for such a heterogeneous set of countries are available.

Since comparative advantage in a Heckscher-Ohlin model is influenced by relative factor endowments, a number of control variables are used: (1) CAP_AREA, representing the sum of total investment over the period 1992 to 2001 divided by land area, as a proxy for the relative capital endowment; (2) LAB_AREA, the total labor force divided by land area, as the equivalent indicator for relative labor endowments.[10] It can be argued that absolute capital and labor endowments have to be seen in a relative context, as the size of the countries in the sample obviously differs. Thus, both capital and labor endowments enter the regressions in the relative form. In general, capital endowments are expected to be positively associated with comparative advantage in high-polluting industries, whereas labor endowments are likely to be negatively correlated with NETEXPORTS. This does not, however, apply to all five selected industries to the same extent (see Figures 1 and 2).

As further control variables, we include (3) CROP and (4) FOREST, representing total cropland and forest land area, which may act as proxies for other than manufacturing land use and can be expected to be negatively associated with NETEXPORTS. The exception is net exports of paper and pulp, since a natural endowment like a large forest area is highly likely to be an important determinant of paper and pulp products. A set of six dummies for mineral resources has also been entered into the regressions. Here, the focus is on coal, copper, iron, lead, oil, and zinc (5 to 10), which might contribute to comparative advantage, in particular in the production of non-metallic minerals, iron and steel, and non-ferrous metals. Finally, to control for other country and regional characteristics, a set of seven regional dummy variables have been added to all regressions.[11] Descriptive statistics for the (main) variables are shown in Table 3.

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[9] See Appendix B for the country sample and the values for ENV_REG and ENV_CONV. While both environmental regulations indicators would be available for a total of 146 countries, 27 observations had to be excluded due to deficiencies in the trade data or the control variables.

[10] Breaking down total labor endowments into skilled and unskilled labor would have been the preferred choice in the empirical approach. However, the data is not yet available for a large number of developing countries.

[11] See Appendix A for a definition of the regions.

Table 3: Descriptive Statistics of the Variables, 2001

Variable	Mean	Stand. Dev.	Maximum	Minimum
GNI	6,345	9,508	38,330	100
CAP_AREA	0.02	0.05	0.34	0.00001
LAB_AREA	0.49	0.67	5.44	0.008
CROP	12.01	29.08	175.34	0.000
FOREST	29.09	97.83	851.39	0.001
ENV_REG	0.00	0.62	1.47	-1.20
ENV_CONV	0.07	0.56	1.27	-1.18
NETEXPORTS Industrial chemicals	-0.27	2.09	15.42	-8.53
NETEXPORTS Paper and pulp	-0.02	1.75	11.82	-5.11
NETEXPORTS Non-metallic minerals	0.00	1.82	5.24	-17.38
NETEXPORTS Iron and steel	-0.05	1.75	10.79	-9.34
NETEXPORTS Non-ferrous metals	-0.06	1.18	4.88	-10.00

Notes: See Appendix A for data sources. Despite using Z-scores, the mean of ENV_CONV is not equal to zero, because only 119 out of 146 observations have been used in the sample.

The specification of the model is as follows:

$$(1) \quad \text{NETEXPORTS} = \alpha_0 + \alpha_1 \text{ CAP\_AREA} + \alpha_2 \text{ LAB\_AREA} + \alpha_3 \text{ CROP} + \alpha_4 \text{ FOREST} + \alpha_5 \text{ COAL} + \alpha_6 \text{ COPPER} + \alpha_7 \text{ IRON} + \alpha_8 \text{ LEAD} + \alpha_9 \text{ OIL} + \alpha_{10} \text{ ZINC} + \alpha_{11} \text{ ENV} + \alpha_{12} \text{ REGIONAL DUMMIES} + e,$$

where NETEXPORTS stands for net exports of each of the five industries, e is an error term, α_i are parameters and ENV represents the two environmental variables.

The results of the regressions, reported in Table 4, show most of the explanatory variables with the expected signs and, depending on the net export variable, a considerable share with statistical significance of at least the 10 percent level. The variable for relative capital endowments for the five industries is roughly in line with expectations that these industries are capital intensive. On the other hand, producing paper and pulp products requires less capital in comparison to the other four dirty industries (except non-ferrous metals). Regarding the labor endowments, we can observe that LAB_AREA has predominately the expected negative sign. The exception is, again, paper and pulp (positive but not significant), as this industry uses relatively more labor than the other high-polluting industries (except non-metallic minerals, see Figure 2).

Table 4: Environmental Regulations and Comparative Advantage, 2001

Independent Variables	Dependent Variable: NETEXPORTS of									
	Industrial chemicals		Paper and pulp		Non-metallic minerals		Iron and steel		Non-ferrous metals	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CONSTANT	0.597*	0.473*	0.112	0.090	-0.604**	-0.151	-0.372	-0.431	-0.166	-0.144
CAP_AREA	16.511***	17.446***	-6.401	-6.183	23.247**	22.650**	28.764***	27.340***	9.279**	9.104**
LAB_AREA	-0.308*	-0.346*	0.024	0.013	-0.250	-0.254	-0.391**	-0.351**	-0.081	-0.073
CROP	-0.012	-0.012	-0.028**	-0.027**	-0.014	-0.014	-0.019	-0.020	-0.008**	-0.008**
FOREST	0.002	0.002	0.007**	0.007**	0.002	0.002	0.007***	0.007***	0.003*	0.003*
COAL	-0.722	-0.663	-0.467	-0.446	0.764**	0.630*	0.722**	0.704**	0.196	0.183
COPPER	-0.600	-0.591	0.328	0.406	0.097	0.061	0.102	-0.114	0.570***	0.552***
IRON	-0.539	-0.496	0.894**	0.835**	-0.020	-0.014	0.300	0.422	0.546**	0.553***
LEAD	-0.014	0.041	-1.860	-1.941	-0.816	-0.742	-1.851**	-1.658*	-1.727**	-1.701**
OIL	0.214	0.160	-0.265	-0.306	-0.215	-0.169	-0.526	-0.432	-0.067	-0.051
ZINC	0.784	0.850	2.152*	2.119*	1.023*	0.997	1.477**	1.492*	1.607**	1.599**
ENV_REG	0.107		0.297		-0.371		-0.776**		-0.077	
ENV_CONV		-0.385		0.201		-0.288		-0.579*		0.011
REGIONAL DUMMIES	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.21	0.21	0.26	0.26	0.53	0.51	0.46	0.43	0.65	0.65
F-Value	2.7	3.8	3.3	3.3	8.3	8.3	7.0	6.3	13.3	13.3
No. of Obs.	119	119	119	119	119	119	119	119	119	119

Notes: See Appendix A for data sources; t-values for all variables, based on White's (1980) correction for heteroskedasticity, and coefficients for the regional dummy variables have not been reported due to reasons of space; levels of statistical significance are indicated by asterisks: *** significant at 1% level; ** significant at 5% level; * significant at 10% level.

Obviously, having large forest areas and not using the land area for cropland are natural advantages for the production of paper and pulp. On the other hand, some of the mineral dummies are highly significant determinants for a comparative advantage in non-ferrous metals. Coal resources seem to be closely associated with above-average net exports of non-metallic mineral and iron and steel products.

The overall fit of the regressions are reasonable in the case of non-metallic minerals, iron and steel, and non-ferrous metals, but show a relatively low adjusted R^2 for industrial chemicals and paper and pulp products. The regression results for these two industries suffer from a few statistical outliers: Ireland and Germany in the case of industrial chemicals and Canada, Finland and Sweden in the case of paper and pulp products. If these countries were left out, the adjusted R^2 would increase by 0.3 to 0.4 percentage points. Yet it seems more appropriate to include the outliers, since the empirical analysis should focus on all countries and these countries are very important exporters of industrial chemicals and/or paper and pulp products.[12]

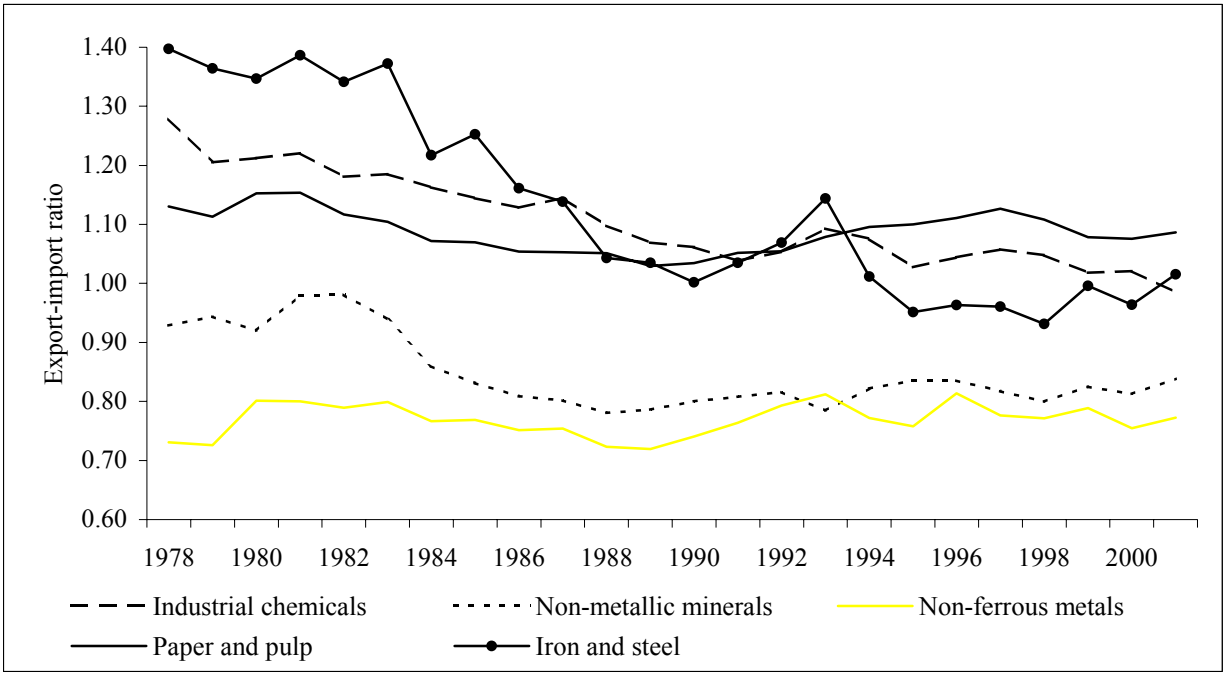
The stringency of environmental regulations is not closely associated with net exports in the five high-polluting industries, as both ENV_REG and ENV_CONV are not statistically significant, indicating that environmental regulations are not a major determinant of comparative advantage in these industries. The exception is iron and steel, as both environmental regulations indicators have a negative sign and are significant at the 5 percent level. The negative sign implies that more stringent regulations and a higher compliance with international treaties and conventions are associated with reduced net exports of iron and steel products, even taking into account other country characteristics. More importantly, this result holds up if the main focus of the analysis is on developing countries only or if certain independent variables, for instance, the regional dummies, are excluded from the regressions. For reasons of space, the results for various robustness checks are not reported here.[13]

[12] Also, the estimates of both ENV_REG and ENV_CONV with respect to sign and significance do not change if the outliers are excluded from the country sample.

[13] The results can be obtained from the author upon request.

In comparison to the previous literature on the linkage between environmental regulations and trade patterns, this indicates a potentially interesting result, as it underlines the importance of regulations across countries. In addition to the cross-sectional regressions for a single year, changes in export and import trade flows for the five industries since the late 1970s have been computed (Figure 3). Allowing an easier comparison of the figures across industries, export-import ratios are used instead of net exports. Moreover, the focus is only on high-income countries, since the equivalent figures for many middle or low-income countries are not available for much of the late 1970s and the 1980s. Nevertheless, changes in the export-import ratios are of particular interest for high-income countries, which have – on average – much stricter environmental regulations than middle or low-income countries (Figure 4).

Figure 3: Changes in Export-Import Ratios of High-Polluting Industries for High-Income Countries, 1978-2001

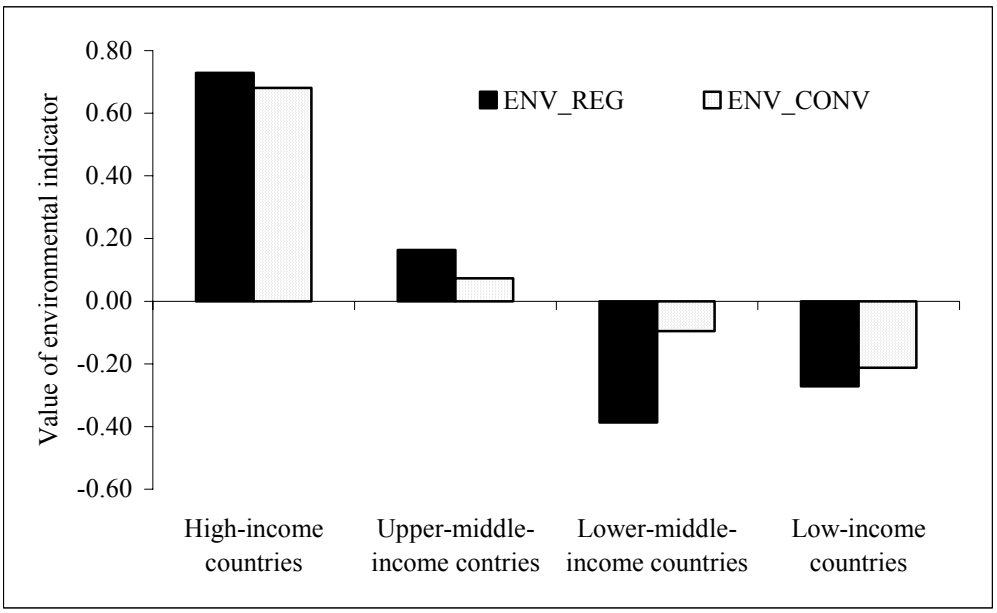


Source: UN COMTRADE (2003) and own calculations. Note: According to a World Bank (2003) definition, high-income nations can be classified as countries with a GNI per capita of US $9,206 or more in 2001.

Even though information about changes over time in environmental standards is still not at hand, it is interesting to see what has happened to the relative competitive position of high-income countries with tougher regulations. Apart from non-ferrous metals, the results indicate that high-income countries have lost (world) market shares in four out of five high-polluting industries:

While the ratio was roughly unchanged in the case of non-ferrous metals, it declined slightly for non-metallic minerals and paper and pulp products, but fell significantly for industrial chemicals and iron and steel products. Interestingly, the decline in the export-import ratio is largest for iron and steel products, which would underline the results suggested by the cross-sectional analysis indicating that this sector saw a negative impact from regulations.

Figure 4: Environmental Indicators and Income Levels, 2001



Source: CIESIN (2003) and own calculations. Note: The classification of countries with respect to income levels is based on the World Bank (2003) definition.

More revealingly, the loss in competitiveness for high-income countries took place at the same time as these countries tightened their regulations and abatement costs were likely to increase (World Bank 2001). Yet the interpretation on changes over time has to be viewed with caution, since changes in factor endowments or other determinants of comparative advantage might have contributed to this result. Nevertheless, a statistically significant result in the cross-sectional analysis for iron and steel products has been found, implying that environmental regulations are negatively associated with net exports in this industry.

4. The WTO and Environmental Regulations

Considering the evidence presented in the former section – in particular with respect to iron and steel products – it might be argued that internationally binding environmental regulations should be introduced, preferably within the WTO, to ensure a level playing field.[14] In general, economists recognize four fundamental principles when pondering the negotiation of a set of multilateral standards to restrain government action in environmental issues (Maskus 2002). More specifically, the question is posed whether differences in environmental regulations across countries meet the following four principles: (1) The issue is clearly trade related such that trade flows are distorted; (2) there are international externalities, such as environmental spillovers, involved that limit the attainment of global optimality, and multilateral rules are an appropriate way to internalize those externalities; (3) in the case of no multilateral rules, national governments would choose sub-optimal policies that result in insufficient regulations or a "race to the bottom" on regulations; and (4) any damages from not complying with international regulations can be assessed in financial terms and, thus, allow the dispute settlement to function.

Based on the previous empirical results for iron and steel products, there would be some support for the first principle. Note, however, that a negative linkage between regulations and trade patterns has been found only for one out of five high-polluting product groups. The findings presented in the previous section nonetheless underline the need for further research in this area, preferably a comprehensive analysis of changes over time as the data become available in a couple of years. The second principle, concerning the existence of international spillovers, is relatively straightforward in environmental matters. Problems like global warming or acid rain clearly underline the need for international efforts to negotiate common standards (Suranovic 2002).

Though somewhat convincing in theory, the evidence for the third principle, the "race to the bottom" on environmental standards to due international competition, is rather limited (Levinson

[14] See demands for environmental regulations by non-governmental organisations, such as those reported within the Global Trade Watch division of Public Citizen (2003).

1996, Schulze and Ursprung 2001).[15] Over the last couple of decades, environmental regulations have become much more stringent, in particular in high-income countries such as the European Union or the United States, despite the relative decline of some of these sectors (Low and Yeats 1992, Levinson 2003). Above all, the relative level of environmental regulations is influenced by income levels. As GNI per capita figures have increased, so has the stringency of environmental regulations in many countries (Fredriksson and Mani 2002).[16]

Finally, the last principle, a meaningful trade dispute resolution for environmental issues, seems to be very difficult to implement, thereby making any inclusion within the WTO framework highly doubtful (Maskus 2002). For instance, it would be extremely difficult to assess in monetary terms the damage done to Scandinavian forests by acid rain caused by producers located in other parts of Europe. Who exactly would be affected and by how much? Precisely who is responsible for the degradation of forests? And what about local producers in Scandinavia? Did they contribute to acid rain in the past? It would be very difficult to settle these questions in a meaningful way, which would be the prerequisite for any WTO dispute resolution process. In short, based on these four principles, and in particular in view of the third and fourth principles, the case for WTO involvement is not very convincing.

In any event, the WTO necessarily becomes involved only in the first principle, as any direct impact on trade favors (or implicates) an agreement at the multilateral level (Maskus 2002). The second and third principles may be addressed by other international agreements, such as multilateral environmental agreements (MEAs) or within a possible World Environmental Organization (WEO).[17] Likewise, any other multilateral agreement could include provisions on a

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[15] Among a large number of studies, only Ederington and Minier (2003) found some evidence that US environmental regulations may have been influenced by changes in trade flows. If their results do hold up for other countries, the assumption of exogenous environmental regulations has to be viewed with caution.

[16] Obviously, there are a few exceptions, such as Kuwait, where standards are relatively low, despite very high GNI per capita levels (see Appendix B for the figures for both environmental indicators).

[17] See Runge (2001), Shaw and Schwartz (2002), and Lodefalk and Whalley (2002) for a discussion of proposals for MEAs and WEOs and the interaction with WTO rules.

dispute settlement to resolve conflicts on environmental issues with international spillovers or policy imperfections as a likely result.

The Doha Round will be, nevertheless, the first WTO round to deal with environmental concerns as an official issue. Whereas the WTO has always held sustainable development to be a principle of trade liberalization, it has had to face a rising number of MEAs that often conflict with WTO principles. Countries that have agreed to an MEA, for instance, can restrict trade with non-complying countries in an attempt to use trade as an incentive for nations to adopt stricter environmental regulations. As in the case of regional trade agreements, the WTO now confronts the problem of deciding how MEAs and WTO commitments should interact. So far, the WTO has struck down trade restrictions based on MEAs (Shaw and Schwartz 2002).

At present, the WTO has the burden of resolving the relationship between environmental regulation and trade in the middle of a highly controversial trade battle on the subject of genetically modified organisms between the European Union and the United States. What is more, given the failure of the WTO Cancun meeting in September 2003, it is also less obvious where the Doha Round is heading. Similar to their stance on other issues like labor standards, developing countries fiercely resist any binding environmental standards within the WTO. Both the European Union and the United States favor a more flexible interpretation of GATT Article XX, which lists the reasons for which trade restrictions are permitted, and a more transparent WTO dispute settlement process (Vogel 2004). Developing countries, which confront little or no pressure from domestic non-governmental organizations to make the WTO more accountable to environmental issues, fear protectionist abuses of any new environmental provisions.

Apart from WTO provisions or MEAs, probably the best way to address environmental issues is to remove obstacles to incomplete markets (Motaal 2001). The vast majority of environmental degradation can be attributed to situations in which environmental resources are not properly valued, leading to so-called positive or negative externalities. Above all, these arise due to inefficient property rights systems, imperfect or asymmetric information, and government failure, where government policy focuses more on special interest groups rather then the general

public. Enforceable property rights and good governance, in particular in developing countries, are thus high on the policy agenda to deal with this type of market failure.

Another approach that has been discussed to address environmental degradation of individual firms or countries is eco-labeling schemes (World Bank 2001, Motaal 2001). Product labeling requires that (imported) goods be correctly distinguished by labels that state, for instance, that the product has been produced without, or with very little, environmental degradation. Consumers in industrial countries might be ready to pay a higher price for improved standards. This approach could also lessen concerns about low standards expressed by trade unions (in high-income countries) and non-governmental organizations and could provide an incentive for firms in the exporting nations to upgrade their standards without binding rules. In particular the voluntary participation of all parties involved is the most appealing argument for labeling, as it allows the willingness-to-pay rule to decide the level of harmonization of environmental standards and avoids internationally binding trade restrictions.

Notwithstanding these clear advantages, there are also important problems involved with labeling: First, due to the likely premium on commodities with higher standards, labeling might create incentives for private firms to overstate the standards by which they abide. Consumers in importing countries cannot easily check the statements made on the labels, since information about the production process regarding working practices cannot be obtained for free. A remedy for this problem would be close governmental monitoring, but this involves bureaucratic interference and the problem of protectionism of lobbying groups anew.

Second, it might be doubtful whether eco-labeling for iron and steel products is an appropriate way to deal with the negative linkages between environmental regulations and comparative advantage. Usually, iron and steel products, such as tubes, pipes or flat rolled alloy steel, are intermediate commodities that firms use in the production process, but are not for (direct) sale to consumers. It would be questionable whether meaningful eco-labeling schemes could work for these products. International agreements or adequate government policy are probably the more appropriate way for these types of goods.

5. Concluding Remarks

Concerns that industries facing above-average abatement costs with environmental regulations would prefer "pollution havens" and relocate their activities have been around for some time. So far, empirical studies on the linkage between trade patterns and environmental regulations either have failed to find any close statistical relationship or have delivered questionable results due to data limitations. This paper provides new empirical evidence on that linkage and the main results can be summarized as follows: First, drawing on a relatively large sample of 119 countries and using two new and comprehensive indicators for the stringency of environmental regulations, no evidence has been found to support the pollution hypothesis for five high-polluting industries. The exception has been iron and steel products, where a negative and statistically significant link has been established. For these products, the results imply that a higher compliance with international treaties and conventions, as well as more stringent regulations, are associated with reduced net exports, based on cross-country analysis that takes other country characteristics into account.

Second, the evidence for iron and steel products might hold up for changes over time. High-income countries, where environmental regulations are usually more stringent in comparison to middle or low-income countries, have seen a considerable decline in the export-import ratio of iron and steel products since the late 1970s, which is roughly the time when the stringency of environmental regulations in high-income countries increased. Note, however, that we do not have appropriate indicators for the precise change in environmental regulations, which restricts the analysis to observable changes over time, without a clear statistical validation of the reasons for changes in the export-import ratios. This type of analysis may be performed in a few years, as comparable information for the stringency of environmental regulations over time will become available.

Finally, the case for environmental standards within the WTO framework is relatively weak, considering that no clear evidence has been found that national governments choose sub-optimal policies that result in insufficient regulations or a "race to the bottom" on regulations. Moreover,

it would be very difficult to assess any damages from not complying with international regulations in financial terms, which is a prerequisite for the functioning of the dispute settlement. Obviously, agreeing on MEAs or enforcing property rights as well as good governance might be a better choice for ensuring that trade patterns are not negatively affected by differences in environmental regulations across countries.

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Appendix A: Definition of Variables and Data Sources

Variable	Definition	Source
NETEXPORTS	Exports – imports (billion US dollars), 2001	UN COMTRADE (2003)
CAP_AREA	Total capital stock in trillion US dollars (investment in the period 1992-2001) divided by land area (mill. km of land)	World Bank (2003)
LAB_AREA	Total labor force divided by land area (mill. km of land), 2001	World Bank (2003)
CROP	Total cropland area (1,000 hectares), 2001	World Resources Institute (2003)
FOREST	Total forest area (1,000 hectares), 2001	World Resources Institute (2003)
COAL, COPPER, IRON, LEAD, OIL, ZINC	Set of dummies for production of different minerals (0-1), 2001	British Geological Survey (2003)
REGIONAL DUMMIES	Set of regional dummies: (1) Sub-Saharan Africa, (2) East Asia & the Pacific, (3) South Asia; (4) Middle East & North Africa, (5) Latin America & the Caribbean, (6) High-income OECD countries (USA, Canada, Japan, Western Europe, Australia & New Zealand); (7) Central and Eastern Europe	World Bank (2003) classification of regions
GNI	GNI per capita in current US dollars, 2001	World Bank (2003)
ENV_REG	Stringency of environmental regulations (called CAPGOV in the CIESIN-file), average of the Z-scores of the underlying variables, range from -1.20 to +1.47, 2001	CIESIN (2003)
ENV_CONV	Participation in international cooperate attempts to deal with environmental problems across countries, e.g. conventions and treaties (called GLOPAR in the CIESIN-file), average of the Z-scores of the underlying variables, range from -1.18 to 1.27, 2001	CIESIN (2003)

Appendix B: Country Sample and Indicators for Environmental Regulations

Country	ENV_REG	ENV_CONV	Country	ENV_REG	ENV_CONV
Albania	-.61	-.88	Italy	.56	.67
Algeria	-.93	.09	Jamaica	-.09	-.14
Argentina	.24	.10	Japan	.89	.85
Armenia	-.46	-.85	Jordan	-.33	.52
Australia	.23	.86	Kazakhstan	-.83	-.59
Austria	1.17	1.00	Kenya	-.40	-.02
Azerbaijan	-.56	-.33	Korea (South)	.20	.33
Bangladesh	-.76	-.45	Kuwait	-.65	-.64
Belarus	-.66	-.60	Kyrgyz Rep.	-.69	-1.18
Belgium	.67	.92	Latvia	.28	.09
Benin	-.39	.52	Lebanon	-.59	.22
Bhutan	.35	-.14	Lithuania	.45	-.51
Bolivia	.56	.21	Macedonia	-.16	.79
Botswana	.16	-.04	Madagascar	-.32	-.30
Brazil	.17	-.13	Malawi	-.15	.81
Bulgaria	-.35	.73	Malaysia	-.05	.29
Burkina Faso	-.09	.11	Mali	-.33	.13
Burundi	.21	-.19	Mexico	-.20	.10
Cameroon	-.66	-.10	Moldova	-.64	-.82
Canada	.97	.88	Mongolia	-.34	.68
Central African Rep.	.34	-.53	Morocco	-.14	.37
Chile	1.01	.13	Mozambique	-.53	-.31
China	-.48	-.12	Namibia	.50	-.47
Colombia	-.29	-.14	Nepal	.01	-.53
Costa Rica	.74	.24	Netherlands	1.17	1.17
Cote d'Ivoire	-.07	.03	New Zealand	1.05	.73
Croatia	.56	-.51	Nicaragua	-.48	.00
Czech Republic	.36	.57	Niger	-.55	.03
Denmark	1.03	1.04	Nigeria	-1.15	-.54
Egypt	-.29	.14	Norway	.68	1.00
El Salvador	-.52	-.25	Oman	-.28	-.52
Estonia	.21	.62	Pakistan	-.22	-.16
Ethiopia	-.12	-.32	Panama	.27	.25
Finland	.92	1.12	Papua New Guinea	-.54	-.01
France	1.04	1.02	Paraguay	-.80	-.23
Gabon	-.69	-.11	Peru	-.31	-.08
Gambia	-.08	-.60	Philippines	-.68	-.03
Germany	1.21	1.27	Poland	.43	.53
Ghana	-.81	.31	Portugal	.23	.24
Greece	-.22	.49	Romania	-.84	.08
Guatemala	.03	-.66	Russian Federation	-.42	.00
Guinea	-.19	-.87	Rwanda	.50	-1.05
Honduras	-.37	-.65	Saudi Arabia	.05	-.69
Hungary	.65	.66	Senegal	.02	.52
Iceland	.80	.45	Slovak Republic	.23	.73
India	-.22	-.02	Slovenia	.14	-.39
Indonesia	-.26	.09	South Africa	.42	-.13
Iran.	-1.02	-.07	Spain	.42	.98
Ireland	.56	.22	Sri Lanka	-.03	.08
Israel	.72	-.10	Sudan	-.88	-.60

Appendix B, cont'd.

Country	ENV_REG	ENV_CONV
Sweden	1.13	1.15
Switzerland	1.39	.60
Syria	-.81	-.21
Tajikistan	-.81	-.94
Tanzania	.12	-.23
Thailand	-.21	.07
Togo	-.36	-.23
Trinidad & Tobago	-.42	-.23
Tunisia	-.53	.43
Turkey	-.23	-.52
Turkmenistan	-1.20	-.61
Uganda	.42	.20
Ukraine	-1.00	-.78
United Kingdom	1.47	1.07
United States	1.17	.78
Uruguay	.61	.15
Venezuela	-.42	-.26
Zambia	.83	.22
Zimbabwe	.39	-.07

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