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The Impact of Environmental Policy on Foreign Trade: Tobey revisited with a bilateral flow model

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Abstract

Whereas theoretical analyses of trade and environment indicate that relatively strict environmental policies can have a strong impact on foreign trade, empirical studies present mixed results. This study presents new empirical results that tie together two previous empirical studies employing a multicountry econometric framework, notably Tobey (1990, 1993) and van Beers and van den Bergh (1997). Such a link is useful since most empirical studies on trade and environment use unique assumptions and models, thus making a comparison of findings very difficult if not impossible. Since Tobey's study has been particularly influential on writings in this area a statistical analysis has been performed using a data set that shares many characteristics with his study. The main improvement of the approach adopted here is the use of more disaggregate data. In addition, as the effect of environmental policy on international trade is likely to differ between sectors analyses are performed for a variety of sectors. The results provide partly support for Tobey, namely no significant effects for dirty trade. Results for total trade flows, however, show a positive effect of relatively strict environmental policy on exports. This suggests that either Tobey's policy indicator is inaccurate, or essential variables are missing in the regression model, or countries employed complementary measures such as export subsidies in combination with relatively strict environmental regulations. Sector specific regressions results allow for further comparison with Tobey and provide additional support for the previous conclusions.

1. Introduction

Theories of international trade and location support the idea that relatively strict environmental policies can have a strong impact on international trade and location of firms, notably in the case of "footloose" industries (see, for instance, the surveys by Ulph 1999 and Markusen 1999). Nevertheless, empirical studies present mixed results (see Low and Yeats 1992, Jaffe *et al*. 1995, and Steininger 1999). A problem in trying to compare empirical studies is that they differ in many ways, with regard to model assumptions, statistical methods employed and data used. This article links two previous econometric studies of the environmental-policy-trade relationship, namely Tobey (1990, and Tobey 1993) and van Beers and van den Bergh (1997). Tobey's study was particularly influential for a while due to lack of other econometric studies in this area. van Beers and van den Bergh is closest to Tobey of all empirical studies in terms of a multi-country econometric specification used. Moreover, this study is one of the few to come up with significant effects for particular types of trade flows. The main aim of the "linking exercise" performed here is to provide additional information on the reliability of the results found by Tobey.

In order to examine the implications of different assumptions the present analysis will concentrate on three kinds of bilateral trade flows: (1) total bilateral trade flows; (2) "dirty" bilateral trade flows that consist to a substantial degree of resource based (non "footloose") industries; and (3) trade flows relating to specific "dirty" sectors, which will cover mining, paper, chemicals, steel and non-ferrous metals sectors. Analysis of each of these will allow for a direct comparison with Tobey's results.

Section 2 briefly surveys the main findings of the empirical literature on trade impacts of environmental policy. Section 3 describes the own model, data and types of analyses performed. Section 4 presents results of regressions for total trade as well as for two types of dirty trade flows. Section 5 presents results obtained for the five mentioned sectors. Section 6 concludes.

2. Empirical studies

There are quite many empirical studies on the impact of inter-country differences of environmental policy stringency on inter-country competitiveness differences have been performed. Nevertheless, most studies are incomparable to other ones with the consequence that results do not lead to a uniform conclusion. Mainly due to differences in model assumptions, methods employed and data used a comparison of results across studies is extremely difficult. The following categorization of empirical studies illustrates the wide diversity of approaches:

- trade-in-goods (Tobey 1990, van Beers and van den Bergh 1997) versus factor content of trade (Xu and Song 2000);
- simple statistical indicators (Low 1992) versus (multivariate) regression models (Tobey, van Beers

and van den Bergh) or applied equilibrium modelling (Steininger 1999);

- multilateral trade flows (Tobey) versus bilateral trade flows (van Beers and van den Bergh);
- single country (Low and Yeats 1992, studies in Fredriksson 1999) versus multi-country or multi-region (Tobey, van Beers and van den Bergh, Xu and Song 2000);
- static (Tobey, van Beers and van den Bergh) versus dynamic (Bjørn *et al.* 1997, Xu and Song);
- analysis at the individual firm level (van der Linde 1992, Bjørn *et al.*) versus sector level (all of the other studies mentioned in this list).

The differences in study outcomes are mainly related to three factors. First, different studies use different policy stringency indicators.[1] These comprise input versus output-oriented indicators (van Beers and van den Bergh 1997), costs versus physical measures, objective (observed) versus subjective (self reported, expert judgemental) measures. Second, studies use different types of temporal data, ranging from early 1970s to late 1990s. Third, different methods are employed: simple statistical indicators or econometric studies; cross-section, time series or panel data econometric studies; and studies at country, state, firm or plant level.

The present study aims to link the empirical studies by Tobey (1990) and van Beers and van den Bergh (1997). Tobey (1990) presented the first multi-country analysis of the impact of domestic environmental regulations on international trade. His study employed a Heckscher-Ohlin-Vanek model. Based on two approaches, namely including a qualitative indicator for policy strictness, and performing an omitted (policy) variable test, he concluded that there is no measurable evidence for a negative environmental policy impact on trade. The main disadvantage of his approach is that it is based on multilateral trade flows, implying that differential effects of environmental policy on various trade flows may cancel out due to aggregation of bilateral trade flows to a multilateral trade flow. In order to avoid this problem van Beers and van den Bergh (1997) undertook a more disaggrate analysis, based on a bilateral trade flow equation or gravity model, originating from Tinbergen (1962) and Linnemann (1966). They used data from 1992 and developed two output-oriented policy strictness measures, namely a broad and a narrow (energy based) one. The results show significant effects of stricter policies on both exports and imports for total trade flows. For dirty trade flows the effects are insignificant, which may be due to most dirty industries being resource based.

Bjørn *et al.* (1998) is a recent study of the impact of environmental regulations on firm exit. It is especially interesting as it uses a a Norwegian panel dataset that includes establishments (plants or functional units in a single location) in three manufacturing sectors, namely: Pulp, paper and

[1] Ossokina and Vollebergh (1999) present a survey of environmental policy strictness indicators that have been developed or in various studies (not merely restricted to trade and environment).

paperboard; Irons, steel and ferroalloys; and Basic industrial chemicals. These have been selected on the basis of having a substantial share of plants that have been subject to stringent environmental regulations. For the Pulp, paper and paperboard sector it is concluded that there is evidence that the exit probability of regulated plants is significantly lower than the exit probability of non-regulated plants. The authors state that this cannot reflect regulators imposing strict standards mainly on plants with a low predicted probability of exit, since it is too difficult to identify plants or firms based on historical information. Instead, they suggest the results lend support to the Porter hypothesis stating that strict environmental regulations stimulate firms to revise their technology and organization such that their environmental and economic performance will improve relative to (international) competitors that are not subject to so strict policies. In the sector Iron, steel and ferroalloys the difference between exit probabilities of regulated and non-regulated plants is not significant (Bjørn *et al.* 1998, p50).[2] Finally, no significant results are obtained for the Basic industrial chemicals sector due to too few exits. Some comparisons with these results will be made in Section 5.

3. The analytical framework

The presentation of the approach adopted is kept brief. A more detailed account is given in van Beers and van den Bergh (1997). The present study differs from this previous one with regard to the policy strictness indicator used (Tobey's (1990) one), the sample of countries (slight difference), and the sectors focused on (in Section 6).

The approach uses a trade flow equation or gravity model, which is based on bilateral trade flows. For the present analysis it is specified as follows:

$$\begin{aligned}\log X_{ij} = \log b_0 + b_1 \log Y_i + b_2 \log Y_j + b_3 \log N_i + b_4 \log N_j + b_5 \log D_{ij} \\ + b_6 A_{ij} + b_7 EC_{ij} + b_8 EFTA_{ij} + b_9 \log LAND_i + b_{10} \log LAND_j \\ + b_{11} \log SER_i + b_{12} \log SER_j + u_{ij}\end{aligned}$$

with:

X_{ij} = Trade flow of country i to country j in thousands of US $.

Y_i = Gross Domestic Product of country i in billions of US $.

Y_j = Gross Domestic Product of country j in billions of US $.

N_i = Population of country i in millions.

N_j = Population of country j in millions.

D_{ij} = Distance between country i and j in nautical miles.

A_{ij} = Dummy with value 1 if both exporter i and importer j are adjacent countries and zero

[2] For some reason the authors do not mention this result in their conclusions and instead suggest a result similar to that for Pulp, paper and paperboard.

otherwise.

EC_{ij} = Dummy with value 1 if both exporter i and importer j are a member of the European Community and zero otherwise.

$EFTA_{ij}$ = Dummy with value 1 if both exporter i and importer j are a member of the EFTA and zero otherwise.

$LAND_i$ = Land area of country i in millions of ha.

$LAND_j$ = Land area of country j in millions of ha.

SER_i = A measure for the strictness of environmental regulations in exporting country i.

SER_j = A measure for the strictness of environmental regulations in importing country j.

u_{ij} = Log-normally distributed disturbance term.

The crucial variables are SER_i and SER_j , which describe the strictness of domestic environmental regulations. These variables allow to test the hypothesis that stringent domestic environmental regulations exert a negative influence on competitiveness. This falls apart in two sub-hypotheses, namely that exports will be lower due to higher production costs, and that imports will be higher due to a substitution of relatively more expensive domestically produced goods by foreign goods.

In line with these hypotheses, the coefficients b_6, b_7, and b_8 are expected to have positive values, as they represent a geographical situation or specific trade arrangements that increase the level of bilateral trade. In addition, b_9 and b_{10} are expected to be negative. The parameters relating to the environmental policy-variables b_{11} and b_{12} are expected to have negative and positive values, respectively.

Data sources for national income, population, distance and land area data are reported in Appendix II. The regression analyses have been performed for 1975 to get as close as possible to the exercise of Tobey (1990).

Table 1 shows the various regressions performed. Eight different regressions will be performed. The model will be estimated for four kinds of bilateral trade flows as the independent variable: (1) total bilateral trade flows (X_{ij}); (2) bilateral trade flows composed of highly pollution intensive sectors that are resource based (*Xdir*); and (3) bilateral trade flows composed of highly pollution intensive sectors.

The first regression represents the approach most close to Tobey's (1990) analysis, given the framework of the extended gravity model adopted here. It is based on a 1975 sample consisting of 23 developed and developing countries, which resembles the one used by Tobey (see Appendix I). The slight difference is that in the present study for reasons of lack of bilateral trade flows Malta and Liberia have been dropped from Tobey's selection of countries and instead two other developing nations, Pakistan and Trinidad and Tobago, have been included. Liberia and Malta revealed zero bilateral trade flows in all dirty commodities to all bilateral trading partners in the sample.

Table 1. Regression analyses performed

Regression analyses (# = 8); all for 1975 and with Tobey's policy measure	
# = 1:	• 14 OECD countries and 9 developing countries • Similar to Tobey's sample but with aggregate bilateral trade flows
# = 2:	• 14 OECD countries • Total and dirty bilateral trade flows
# = 5:	• 14 OECD countries • Bilateral trade flows for five highly pollution intensive sectors

The second group of (2) regressions is based on a sample limited to 14 OECD-countries to realise a more homogeneous data set. Indeed, differences can be assumed relatively small between OECD-countries compared with differences between OECD countries on the one hand and developing countries on the other hand. An alternative would be much more complicating, namely correcting the larger sample including with both groups of countries for differences in technology and political stability, since data on the latter are not easily available. The first regression with this sample is based on total bilateral trade flows. The other two regressions with this sample use as the dependent variable "dirty" bilateral trade flows.

The third group of (5) regressions covers trade relating to specific "dirty" sectors: Mining, Paper and pulp, Chemicals, Primary iron and steel, and Primary non-ferrous metals. These sectors have been studied by Tobey, so that the results allow for a detailed comparison.

The indicator for strictness of environmental policy used is adopted from Tobey. This was based on a measure developed by the UNCTAD (Walter and Ugelow 1979), which was based on self-reporting by countries (national governments replies to questionnaires). The results for each country were evaluated against the benchmark country USA, because its federal air and water quality legislation and administrative procedures were regarded as most strict among the cluster of countries in the survey (UNCTAD 1976; Walter and Ugelow 1979, p. 106).

Van Beers and van den Bergh (1997) distinguish between input-oriented and output-oriented measures for environmental stringency. The first type includes input efforts devoted to environmental protection, such as public R&D expenditures or investment expenditures in pollution abatement and control. Nevertheless, a country spending a substantial part of its financial resources to pollution abatement may also provides financial assistance - like export rebates and import surcharges - to

pollution cost-sensitive industries (UNCTAD 1976, p10). To avoid this bias, output-oriented indicators can be used. These reflect the ultimate outcome of environmental regulations, so that they provide a more accurate proxy for environmental policy strictness. The measure used by Walter and Ugelow (1979) can be considered to be input-oriented measure. By using this indicator we do not claim that it is the best available. Using this indicator is opportunistic for two reasons: for the period considered no other indicator is immediately available; and the results obtained will allow for a direct comparison with Tobey's results.

4. Results for aggregate and disaggregate trade flows

Table 2 reports the results of the first four regressions from Table 1. Regression 1 is closest to the sample used by Tobey (1990). The number of observations is 506 (23 x 22) of which 43 bilateral trade flows were zero. The use of a loglinear specification would require the elimination of zero flows when estimating with ordinary least squares, which in turn would lead to biased estimates. To avoid this problem Tobit estimations were used. These allow to take into account the possibility that the zero trade flows were caused by rounding off small flows, which is useful given that trade flows with a value of less than US $100,000 are not reported in the data source (*United Nations Statistical Papers, Series D*).[3]

The estimates show theoretically expected signs for coefficients b_1 till b_{11}. The exception is b_7, the EC-dummy. This is the result of not incorporating all intra-EC flows in the sample as for countries like France, Ireland, Italy no *SER*-values were available. For the same reason the adjacency dummy is not significant. We also included a UK-dummy to account for the fact that in 1975 the United Kingdom had just entered the European Community (namely in 1973), which suggests that the preferential treatment between the United Kingdom and its Commonwealth partners had not fully eroded at the time.

[3] The results are not very different from OLS-estimates based on leaving out zero trade flows (the latter are not presented here).

Table 2. Estimation results 1975: gravity model with environmental strictness variable.

Regression	1	2	3
Trade Flow	X_{ij}	X_{ij}	$Xdir_{ij}$
Constant	-9.91**	-7.25**	-14.18**
	(-12.48)	(-6.75)	(-5.68)
Yi	1.20**	1.44**	2.71**
(b_1)	(13.14)	(8.80)	(6.33)
Yj	1.20**	1.17**	1.00*
(b_2)	(13.44)	(6.08)	(2.34)
Ni	-0.10	-0.55**	-1.73**
(b_3)	(-0.98)	(-3.46)	(-4.20)
Nj	-0.14	-0.48**	-0.21
(b_4)	(-1.44)	(-2.47)	(-0.52)
Dij	-0.78**	-0.80**	-1.46**
(b_5)	(-9.24)	(-16.36)	(-12.83)
A_{ij}	0.54	0.34*	-0.34
(b_6)	(1.33)	(2.31)	(-0.76)
EC_{ij}	-0.89*	-0.07	-0.89*
(b_7)	(-2.30)	(-0.45)	(-2.08)
$EFTA_{ij}$	0.43	0.25	0.66
(b_8)	(0.97)	(1.40)	(1.35)
UK_{ij}	0.79**	2.34**	1.98**
(b_9)	(3.25)	(7.84)	(3.37)
$LAND_i$	-0.16**	-0.08*	0.11
(b_{10})	(-4.11)	(-1.65)	(1.25)
$LAND_j$	-0.20**	-0.02	0.16
(b_{11})	(-4.94)	(-0.48)	(1.84)
SER_i	0.70**	0.67**	0.58
(b_{12})	(3.83)	(2.88)	(1.05)
SER_j	0.05	0.08	-0.11
(b_{13})	(0.30)	(0.29)	(-0.20)
Log-Likelihood	-833.92	-160.87	-303.44
R^2 adjusted		0.885	
Observations	506	182	182

Notes

- ** = significant at 1%; * = significant at 5%.
- Explanation of variables: see text; for data sources see Appendix II.
- Trade flow and GNP data are nominal for regression 1 and real in 2 - 4.
- The estimates of regression 1, 3 and 4 are Tobit estimations. In regression 2 estimates are OLS as zero trade flows were not present. However, *t*-values have been calculated on White heteroscedasticity standard errors and reported in parentheses (White 1980). The *SER*-values have been divided by 7 to standardise them on the range [0,1].

The most surprising result is the significant and positive estimate for the stringency of environmental regulations variable for total trade flows in regression 1. Apparently a more stringent environmental policy gives rise to more exports. It not only rejects the hypothesis tested but also means a counterintuitive result. This result is consistent with the results of Tobey (1990, p 203-204), who

performs an omitted variable test on the basis of a model that allows for product differentiation and economies of scale. In particular, he examines the impact of omitting the environmental policy stringency indicator on the bias in regression residuals. The model follows the approach presented in Helpman and Krugman (1986, p167) and shows strong resemblance with the model estimated in the present study. The omitted variable test led Tobey (1990, p. 204) to conclude:

> "Once again, Walter and Ugelow's policy strictness variable is not found significant in any of the five OLS regressions. In contrast, the test statistics comparing the sign of the estimated residuals of industrialized and developing countries are significant at the 95 % level of confidence, but, because they are negative, they also fail to support the hypothesis being tested". [4]

At least three explanations can be given for this result. First, in countries with relatively strict environmental policies the expected negative effect on exports can be eliminated by subsidisies to pollutive industries as a compensation for increased production costs. If this counteracting effect is strong enough it can result in a positive estimate. This effect is not picked up by an input-oriented *SER*-measure as used here.[5] Second, other than non-environmental factors like available labour skills and political (in)stability of countries might have influenced plant-relocation and export decisions. If this is the case, then the regressions do not include sufficient information. Instead, set of explanatory variables needs to be extended with appropriate indicators reflecting these additional influences. As already indicated, this is extremely difficult and has not been tried here. Third, the results may points at the inaccuracy of the *SER*-measure used in Tobey's study. This is in line with the imperfections noted in van Beers and van den Bergh (1997), implying that output-oriented indicators of environmental strictness based on observed data are more suitable than input-oriented or subjective indicators for analysing the net effect of environmental policy on trade.

Regression 2 responds to the imperfections noted under the second reason, using a limited (OECD) sample of countries to realise a more homogeneous and reliable database, in which political factors – such as instability of developing countries affecting trade and location of firms – are less likely to disturb the analysis. The results do not change much relative to the first regression. Again, a significant positive effect of a stringent environmental policy on exports is found. Similar explanations might hold

[4] Note that this result has almost not been noted in later studies referring to Tobey. These usually have focused the attention entirely on the insignificant estimates.

[5] It is quite impossible that this result reflects the use of cleaner technologies as a response to strict regulation Porter, 1990), because such a process would require more time. Note that most OECD-countries introduced environmental regulations after 1970 (Leonard 1988, p1), whereas the present analysis uses data that reflect the situation of 1975.

to those noted above.

Regression 3 presents empirical results for bilateral trade flows with a high pollution-intensity in the limited OECD sample. No significant effect of strict environmental regulations on exports can be found. This result is consistent with the results reported by Tobey (1990).

Finally, it should be noted that all regressions lead to insignificant estimates for b_{13}, whereas the expected sign for this parameter is positive. The hypothesis is that relatively strict pollution standards imply an increase in production costs, stimulating domestic consumers to replace expensive domestic products by cheaper foreign substitutes. The insignificant parameter does not support this hypothesis. This can be due to the existence of import barriers that complement relatively strict environmental regulations. Alternatively, it can be related to the inaccuracy of the *SER*-measure.

5. Results for specific sectors

This section examines which polluting sectors possibly contributes importantly to the positive influence of environmental stringency on exports as assessed in the previous section. For this purpose regressions are performed for five polluting sectors distinguished by Tobey, namely Mining, Paper and pulp, Chemicals, Primary iron and steel, and Primary non-ferrous metals. Table 3 shows the estimation results. These allow for a more detailed comparison with Tobey's findings.

The estimations for the non-environmental policy variables are in line with those reported in regression 3. The distance variable is significantly negative for all pollutive sectors, as expected. The coefficients are, however, relatively large in absolute terms for mining and steel. This points at the phenomenon that for these heavy commodities transport costs are more important than for the other three sectors. Being a neighbour is not relevant for any of the sectors investigated. While commodities from the sectors considered are not dominantly present in intra-EC trade, they are dominant in intra-EFTA trade for chemicals, steel and non-ferrous metals. The *LAND*-variable is important in case of mining. A larger size of the land area increases the chance that mining becomes an important production sector and provides a push factor for the exports of mining products. The estimates of the parameters of SER_i and SER_j show no significant export effect of a relatively stringent environmental policy for chemicals and steel, which is in line with Tobey. The export effect is, however, significantly negative for mining and non-ferrous metals and significantly positive for paper. The negative effects support the hypothesis that environmental regulations negatively affect exports.

Table 3. Regression results for sector specific bilateral 'dirty' commodity trade flows

Regression	4	5	6	7	8
Trade Flow	Mining	Paper	Chemicals	Steel	Nonferrous metals
Constant	-16.00**	-7.96**	-22.91**	-18.14**	-23.97**
	(-2.65)	(-2.66)	(-8.63)	(-5.61)	(-8.09)
Yi	2.61*	1.95**	3.63**	2.13**	3.71**
(b_1)	(2.58)	(3.81)	(8.27)	(3.93)	(7.49)
Yj	0.18	0.59	1.39**	1.21*	1.71**
(b_2)	(0.19)	(1.16)	(3.18)	(2.24)	(3.49)
Ni	-3.01**	-1.09*	-2.13**	-0.61	-2.70**
(b_3)	(-3.04)	(-2.22)	(-5.09)	(-1.19)	(-5.71)
Nj	1.11	-0.01	-0.71	-0.47	-0.65
(b_4)	(1.18)	(-0.02)	(-1.68)	(-0.90)	(-1.65)
Dij	-2.16**	-1.58**	-1.34**	-1.70**	-1.32**
(b_5)	(-6.57)	(-11.58)	(-11.18)	(-11.50)	(-9.95)
A_{ij}	1.30	-0.29	-0.16	-0.18	-0.38
(b_6)	(1.32)	(-0.55)	(-0.35)	(-0.32)	(-0.75)
EC_{ij}	-1.59	-1.02*	-0.33	-1.43**	-0.65
(b_7)	(-1.65)	(-2.03)	(-0.76)	(-2.69)	(-1.35)
$EFTA_{ij}$	-0.74	0.37	1.11**	1.34*	1.48**
(b_8)	(-0.64)	(0.65)	(2.27)	(2.21)	(2.70)
UK_{ij}	-3.221	2.69**	0.50	1.96**	2.55**
(b_9)	(-1.84)	(3.89)	(0.81)	(2.64)	(3.80)
$LAND_i$	1.91**	-0.34**	-0.23**	-0.38**	0.23*
(b_{10})	(8.26)	(-3.25)	(-2.67)	(-3.44)	(2.43)
$LAND_j$	0.09	0.13	0.18**	0.25*	-0.12
(b_{11})	(0.40)	(1.31)	(2.11)	(2.30)	(-1.21)
SER_i	-3.33*	4.08**	-0.05	1.04	-1.62*
(b_{12})	(-2.40)	(6.18)	(-0.09)	(1.48)	(-2.58)
SER_j	-1.27	-1.03	0.47	-0.23	0.09
(b_{13})	(-0.97)	(-1.55)	(0.82)	(-0.32)	(0.15)
Log-Likelihood	-267.31	-310.89	-280.32	-316.75	-302.64
R^2 adjusted					
observations	182	182	182	182	182

Notes:

- ** = significant at 1%; * = significant at 5%; t-values in statistics
- Explanation of variables: see text; for data sources see Appendix II.
- Trade flow and GNP data are real
- The *SER*-values have been divided by 7 to standardize them between 0 and 1.
- All regressions result from a Tobit estimation procedure.

The export effect for paper suggests that a relatively stringent environmental policy has improved the competitive advantage of the sector paper. This result is consistent with results reported on the paper industry by Porter and van der Linde (1995), suggesting that this industry has responded to environmental regulations with important cost-reducing innovations. Looking into more detail into this

result, note that the sector "Paper" consists of "Pulp and waste paper" (SITC 251) and “Paper, paperboard” (SITC 64). In the production of wood pulp a new technology has been introduced in the 1970s, the thermomechanical pulping technology (TMP) (Wheeler and Martin 1992 p. 215). This technology was introduced as a reaction to stringent environmental regulations in the wood pulp industry. Nevertheless, this cannot satisfactorily explain the results obtained because the TMP technology really took off only after 1974. Since our data are from 1975 a substantial positive effect would be too premature. It is more likely that the positive significant effect of environmental regulations is due to the sample distribution. Indeed, four countries in the sample are main exporters in the Paper sector, namely Austria, Finland, USA and Sweden. These countries implemented relatively stringent general environmental regulations from the early seventies on. Finally, the results obtained here are consistent with those obtained by the earlier mentioned study of Bjørn *et al.* (1998) (see Section 2), which found that for regulated plants in the pulp and paper sector the exit probability is relatively low, while for steel and chemicals the effects of regulation on exit probabilities are insignificant.

6. Conclusions

This study can be regarded as a re-testing of results obtained in a much cited analysis of the trade impact of environmental regulation, namely Tobey (1990). The present analysis was aimed at improving upon this analysis by replacing its focus on multilateral trade flows by one on bilateral trade flows.

The results with respect to dirty trade flows are in support of Tobey’s findings, while others are not. At an aggregate level trade impacts of environmental regulation differences are counterintuitive. By using a limited OECD sample a more homogeneous and reliable database is realised, which reduces the biases due to political disturbance factors. The surprising result, however, is the significant and positive estimate for the stringency of environmental regulations variable. Apparently a more stringent environmental policy gives rise to more exports. This is consistent with an omitted variable test performed by Tobey with a model that show strong resemblance with the gravity model approach in the present study. Possible reasons for these results are complementary measures (export subsidies) and inaccuracy of the policy stringency measure. Analysis of dirty trade flows showed insignificant effects of strict environmental regulations on exports, which is was also found by Tobey.

Analysis of sector specific trade data provided no significant export effects of a relatively stringent environmental policy for chemicals and steel, which is in line with Tobey. The export effects are significantly negative for mining and non-ferrous metals and significantly positive for paper. The latter result can be attributed to the sample distribution. The negative effects for mining and steel do not

reject the hypothesis that a relative stringent environmental policy reduces export flows. This deviates from the results reported by Tobey.

A general conclusion is that effects for 1992 as found by van Beers and van den Bergh (1997) show more significant effects than for 1975. This can be due to the longer gestation period of environmental policy implementation and impacts. The results presented here provide a link between the approach and results for a later period in van Beers and van den Bergh (1997) and the different approach for an earlier period in Tobey (1990, 1993). Hopefully, this contributes to a more systematic comparison of empirical studies, which so far have shown too much heterogeneity. As a consequence, the evidence is too weak and inconsistent to hold any strong views about the link between environmental policy and trade. This would require that the by now large literature on theoretical and (partial or incomplete) empirical studies is complemented with more comprehensive analyses, preferably using multi-country and inter-temporal data and econometric formats, and ideally moving towards a panel data approach.

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Appendix I. Tobey's policy stringency measure

The *SER*-measures used in the 1975-estimations are reported by Tobey (1990). They are based on Walter and Ugelow (1979) who define 1 as strict and 7 as tolerant. we re-define it by setting 1 = tolerant and 7 = strict. The results are reported in Table I.1 together with the sample composition.

Table I.1 Stringency of Environmental Regulations in the Sample Countries

SER	Description	Countries
1	Tolerant	Cyprus, Pakistan
2	tolerant to moderate	Nigeria
3	moderate to tolerant	Belgium-Luxembourg, Trinidad & Tobago
4	Moderate	Austria, Chile, Israel, Panama, Spain, UK
5	moderate to strict	Australia, Colombia, Denmark, Germany, New Zealand, Netherlands
6	strict to moderate	Finland, Norway, Singapore
7	Strict	Japan, Sweden, USA

Note: Belgium-Luxembourg is considered to be one country; the indicator is calculated as an average.

Appendix II. Data sources

Sources of variables are as follows:

- The data for the bilateral trade flows are import data obtained from *United Nations Statistical Papers, Series D*.
- The income- and population data for 1975 are reported in *World Bank Atlas 1977*.
- The distances are those used by Linnemann (1966).
- The variables "LAND" (millions of ha. in 1990) are obtained from *Human Development Report 1992*.
- Price indices for exports and imports used to convert from nominal to real variables are reported in *World Tables 1994*.