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The Effects of Domestic Environmental Policies on Patterns of World Trade: An Empirical Test

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I. INTRODUCTION

In theory, environmental control costs encourage reduced specialization in the production of polluting outputs in countries with stringent environmental regulations [PETHIG, 1976; SIEBERT, 1977; MCGUIRE, 1982]. In contrast, countries that fail to undertake an environmental protection program presumably increase their comparative advantage in the production of items that damage the environment. This relationship between trade and environmental policy receives considerable attention whenever countries are in the process of passing new pollution control measures. Groups who oppose existing measures, or the implementation of stiffer measures, argue that they reduce the ability of polluting industries to compete internationally [1]. With foreign trade an increasingly important sector in many of the world's economies, the arguments of such groups are now frequently weighted very heavily.

The premise that trade suffers from the imposition of environmental policy has a strong element of a priori plausibility but, surprisingly, has little empirical support. Several macroeconometric models [D'ARGE, 1974; ROBISON, 1986; OECD, 1985] have predicted that

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1. In addition, the imposition of environmental regulations has often been suggested as a partial explanation for inflation in the U.S. and declines in productivity growth experienced by most industrialized countries in the 1970s.

pollution control measures should lead to a small but discernible effect on the balance of trade, but there are few studies to confirm this prediction.

The location-of-industry studies [LEONARD, 1988; PEARSON, 1987, 1985; WALTER, 1985] have explored the related ideas that stringent pollution control measures push industries out of the U.S. (the 'industrial-flight' hypothesis), and that less-developed countries compete to attract multinational industries by minimizing their own environmental policies (the 'pollution-haven' hypothesis). Their investigations, however, have been unable to find evidence in support of either hypothesis.

The present paper complements the results of the less rigorous location of industry studies by providing an empirical test of the hypothesis that stringent environmental policy has caused trade patterns to deviate in commodities produced by the world's 'dirty' industries.

The empirical tests are conducted using the cross-section Heckscher-Ohlin-Vanek (HOV) model of international trade. LEAMER [1984], BOWEN [1983] and others [MURRELL, 1990 and RYTERMAN, 1988] have popularized the application of this model to empirical tests of the sources of international comparative advantage. The basic HOV model is extended, in addition, to allow for non-homothetic preferences (NHP) and scale economies/product differentiation (EOS). Under all three specifications, two different approaches are taken to conduct the empirical tests. The first involves inclusion of a qualitative variable in the estimated equation to represent the stringency of pollution control measures. The second examines the signs of the estimated error terms when the variable measuring the stringency of a country's environmental policy is not included in the estimated equation.

It is found that the stringent environmental regulations imposed on industries in the late 1960s and early 1970s by most industrialized countries have not measurably affected international trade patterns in the most polluting industries. This result is consistent with and reinforces the results of the location-of-industry studies which use a very different empirical approach, but it may nevertheless be intuitively surprising to those who still fear the undesirable competitive effects of environmental policy.

Before proceeding with the empirical test, commodities whose production draws heavily on environmental resources – termed 'pollution-intensive' commodities – are defined.

II. DEFINITION OF POLLUTION-INTENSIVE COMMODITIES

A commodity's relative pollution intensity is defined in this study by the pollution-abatement costs incurred in its production in the

Table 1

I–O Industry	SITC	Description	Pollution Abatement Costs as Percentage of Total Costs
	Mining		
5	281	Iron ore, concentrates	2.03
6	283	Ores of nonferrous base metals	1.92
	Primary Nonferrous Metals		
38	681	Silver, platinum, etc.	2.05
38	682	Copper	2.05
38	683	Nickel	2.05
38	685	Lead	2.05
38	686	Zinc	2.05
38	687	Tin	2.05
38	689	Nonferrous base metals, n.e.s.	2.05
	Paper and Pulp		
24	251	Pulp and waste paper	2.40
24	641	Paper and paperboard	2.40
24	642	Articles of paper	2.40
	Primary Iron and Steel		
37	671	Pig iron	2.38
37	672	Ingots	2.38
37	673	Iron and steel bars	2.38
37	674	Universals, plates	2.38
37	675	Hoops and strips	2.38
37	676	Railway material	2.38
37	677	Iron and steel wire	2.38
37	678	Tubes and fittings	2.38
37	679	Iron, steel castings	2.38
	Chemicals		
27	513	Inorganic elements	2.89
27	514	Other inorganic chemicals	2.89
28	581	Plastic materials	2.36

United States. Such costs are reported by the U.S. Department of Commerce [1975] and the Environmental Protection Agency [1984]. KALT [1985] has taken these data for 1977 and matched them to sixty-four agricultural and manufacturing 2-digit I-O industries. These direct pollution abatement costs are then multiplied by the 1977 total expenditures I-O table to generate an estimate of total (direct and indirect) PACs per dollar of industrial output.

Commodities termed pollution-intensive are defined as the products of those industries whose direct and indirect abatement costs in the U.S. are equal to or greater than 1.85 percent of total costs. The cut-off of 1.85 percent is chosen because it results in a set of industries that are generally considered the most polluting (metals, chemicals, and paper industries) throughout the world[2]. Moreover, there is a considerable difference between the pollution-abatement costs in these industries and in those of the remaining group of industries.

In *Table 1*, these input-output industries which I have defined as pollution-intensive are matched to 3-digit SITC commodities and aggregated into five commodity groups including paper and pulp products (paper), mining of ores (mining), primary iron and steel (steel), primary nonferrous metals (nfmetals), and chemicals (chems). It is interesting to note at the outset the relatively small size of pollution abatement costs as a percentage of total costs in even the most highly regulated industries.

III. HECKSCHER-OHLIN-VANEK MODEL OF INTERNATIONAL TRADE

The HOV equations are a multi-factor, multi-commodity extension of the Heckscher-Ohlin (H-O) model of international trade. They have been used in three different ways. The factor content studies and cross-commodity regressions use measures of factor intensities and trade to infer factor endowments. The third methodology and the approach taken in this study, regresses trade in a specific commodity across countries on country characteristics, i.e., resource endow-

2. This cut-off does not include the petroleum industry. Petroleum is excluded because it is believed that the dynamics of this industry during this time (1975) were heavily influenced by extraordinary circumstances affecting the availability and processing of crude oil. LEONARD [1988] supports this view.

ments. In that resource endowments are the explanatory variables, such regressions reveal the direct influence of resources on trade in a specific commodity. Since this study seeks to reveal information on the most pollution-intensive commodities across countries, the cross-country analysis is chosen as the most appropriate approach.

A set of eleven resource endowments for the year 1975 is used to explain net exports of the most polluting industries under the HOV model[3]. These endowments are provided by LEAMER [1984] and include:

1. CAPITAL (CAP) Accumulated and discounted gross domestic investment flows since 1948, assuming an average life of 15 years.
2. LABOR 1 (LAB1) Number of workers classified as professional or technical.
3. LABOR 2 (LAB2) Number of literate nonprofessional workers.
4. LABOR 3 (LAB3) Number of illiterate workers.
5. LAND 1 (LND1) Land area in tropical rainy climate zone.
6. LAND 2 (LND2) Land area in dry climate zone.
7. LAND 3 (LND3) Land area in humid mesothermal climate zone (for example, California).
8. LAND 4 (LND4) Land area in humid microthermal climate (for example, Michigan).
9. COAL (COAL) Value of production of primary solid fuels (coal, lignite, and brown coal).
10. MINERALS (MINLS) Value of production of minerals: bauxite, copper, flourspar, ironore, lead, manganese, nickel, potash, pyrite, salt, tin, and zinc.
11. OIL (OIL) Value of oil and gas production.

The HOV model can be summarized by the following equations which explicitly incorporate this list of endowments:

$$N_{it} = CST_{i0} + b_{i1}V_{1t} + b_{i2}V_{2t} + \dots + b_{i11}V_{11t} + \mu_{it} \qquad (1)$$

where N_{it} are net exports of commodity i by country t; V_{kt} are endowments of resource k (k = 1...11) in country t; b_{ik} are the coefficients which indicate the total effect (production and consump-

3. Trade data for 1975 comes from United Nations' trade tapes.

tion) of an increase in a resource on net trade of a specific commodity; μ_{it} is the disturbance term, and; CST_{i0} is the equation's constant term. The constant term embodies one resource endowment or country characteristic, which all countries are assumed to possess identically and which has a non-zero mean value.

If the environmental endowment, measured by the stringency of environmental regulations[4], has an effect on trade patterns then the set of eleven endowments in equation (1) is incomplete. In this case, estimation of the HOV trade equations implies a specification error involving an omitted variable. Two approaches are taken to test the effect of the environmental endowment on trade patterns under the HOV model when cross-country quantitative data on the environmental endowment are not available. In the first, a qualitative variable is included in equation (1) to represent the omitted variable, and, in the second an omitted variable test is conducted.

IV.

1. The HOV Model with Environmental Stringency

To test the pollution-haven hypothesis under the first approach, the following equation is estimated under ordinary least squares (OLS):

$$N_{it} = CST_{i0} + b_{i1}V_{1t} + b_{i2}V_{2t} + \ldots + b_{i11}V_{11t} + b_{iE}D_{Et} + \mu_{it} \qquad (2)$$

where D_{Et} is a qualitative variable measuring the stringency of pollution control measures in country t based on a 1976 UNCTAD survey [WALTER and UGELOW, 1979].

The degree of environmental stringency is measured on a scale from one (tolerant) to seven (strict); the mean score for developed

4. Although pollution emissions are a joint product of the production process, they can also be interpreted as an input in the production function because they can be viewed as one of the various uses of the environment [BAUMOL and OATES, 1988]. Since use of the environment is typically a public good, the environmental endowment has no price attached to it and will be used freely by industries until pollution control measures are instituted. Thus, in this study, a country's environmental endowment is measured by their stringency of pollution control measures.

Table 2

Index of the degree of Stringency of Environmental Policy
(7 = strict, 1 = tolerant)

Group A	Index	Group B	Index	Group C	Index
1 Austria	4	1 Chile	4	1 Colombia	5
2 Australia	5	2 Cyprus	1	2 Liberia	1
3 Belux	3	3 Israel	4	3 Nigeria	2
4 Denmark	5	4 Malta	1		
5 Finland	6	5 Singapore	6		
6 Germany	5	6 Spain	4		
7 Japan	7	7 Panama	4		
8 New Zeal.	5				
9 Nether.	5				
10 Norway	6				
11 Sweden	7				
12 UK	4				
13 USA	7				

Source: Walter and Ugelow [1979].

countries is 6.1, while for developing countries it is 3.1. There are observations for 23 countries: 13 industrialized and 10 developing countries (see *Table 2*).

The results are presented in *Table 3* (absolute value of the t radio shown in parentheses beside the estimated regression coefficient). In no instance is the t ratio found to be statistically significant on the measure for the stringency of environmental policy in the five regressions of net exports of polluting industries.

2. *Omitted Variable Test*

A second approach to testing the effect of pollution control measures on trade patterns investigates the bias in the regression residuals when the variable representing countries' environmental endowments are not included in the HOV equations [5].

5. The idea for this methodology is attributable to Ryterman [1988]. Ryterman was able to show that technological flexibility is a significant variable in determining trade patterns between market economies and centrally planned economies.

Table 3

Variable Name	Equations (D.F. = 10) Mining ($R^2=0.99$)	Paper ($R^2=0.96$)	Chems ($R^2=0.93$)	Steel ($R^2=0.89$)	NFMetals ($R^2=0.92$)
CAP	−192 (2.4)	177 (1.6)	583 (5.6)	1537 (2.6)	−89 (1.0)
LAB1	735 (1.9)	−267 (0.5)	981 (1.9)	−1434 (0.5)	−550 (1.2)
LAB2	−111 (3.2)	−25 (0.5)	−154 (3.5)	54 (0.2)	44 (1.1)
LAB3	−15 (0.6)	50 (1.5)	−49 (1.6)	84 (0.5)	69 (2.5)
LND1	385 (1.5)	278 (0.8)	521 (1.6)	237 (0.1)	−254 (0.9)
LND2	−104 (0.7)	−192 (1.0)	−31 (0.2)	503 (0.5)	−247 (1.5)
LND3	1295 (2.8)	100 (0.2)	−268 (0.5)	−2898 (0.9)	−414 (0.8)
LND4	435 (0.9)	6089 (9.2)	−2003 (3.2)	−1374 (0.4)	−589 (1.1)
COAL	−78 (0.6)	−110 (0.6)	−283 (1.6)	−83 (0.1)	88 (0.6)
MINLS	338 (2.0)	330 (1.4)	88 (0.4)	26 (0.1)	715 (3.7)
OIL	−30 (1.6)	−110 (4.3)	−20 (0.8)	−142 (1.0)	17 (0.8)
D	−10314 (0.3)	2454 (0.1)	−1531 (0.1)	98844 0.4)	48658 (1.3)
CST	−5669 (0.1)	−168370 (1.0)	−107110 (0.7)	−697020 (0.8)	−122980 (0.9)

Consider first a simple HOV equation with one known and one unknown independent variable. Let x_{t2} represent a factor endowment for country t. Under the null hypothesis that the environmental factor (x_{t3}) has no effect on the pattern of trade, the equation specifying net exports (N_t) may be written as:

$$N_t = \beta_1 + \beta_2 x_{t2} + \tilde{\mu}_t \qquad (3)$$

The alternative to the null hypothesis is represented by the following equation:

$$N_t = \beta_1 + \beta_2 x_{t2} + \beta_3 x_{t3} + \mu_t \qquad (4)$$

If equation (3) is correct, the least squares estimators of β_1 and β_2 using equation (3) will be unbiased and efficient for all sample sizes. If equation (4) is correct, then estimation of equation (3) will still generate an unbiased estimator of β_2 given the following assumption[6]:

6. KMENTA [1971] shows that while $\hat{\beta}_2$ is unbiased, var($\hat{\beta}_2$) is positively biased. Therefore, the usual tests of significance concerning β_2 are not valid since they will tend to accept the null hypothesis more frequently than is justified by the given level of significance.

A1: The omitted variable is not correlated with any of the included independent variables.

Given assumption A1, estimation of equation (3) when the omitted variable (x_{t3}) does not equal zero will not affect $\hat{\beta}_2$. Its presence will, however, be embodied in the constant and disturbance term. Solving for $\tilde{\mu}_t$, the following equation can be derived:

$$= \beta_3(x_{t3} - \bar{X}_3) + \mu_t \qquad (5)$$

Under the null hypothesis that x_{t3} has no effect on the pattern of trade so that $\beta_3 = 0$, $\tilde{\mu}_t$ is a consistent estimator of μ_t. Under the alternative case where pollution control measures are expected to have an effect on the pattern of trade, so that $\beta_3 \neq 0$, then (given assumption A1) $\tilde{\mu}_t$ provides a consistent estimate of equation (5).

A methodology to test the effect of pollution control measures on the pattern of trade may now be presented. Under the alternative hypothesis that equation (4) is correctly specified and assuming it also has all the properties of the classical regression model, then the sign of μ_t is expected to be random. Therefore, the expected sign of $\tilde{\mu}_t$ in equation (5) is the same as that of $\beta_3(x_{t3} - \bar{X}_3)$. β_3 is expected to be negative if pollution control measures reduce net exports of pollution-intensive commodities. To determine the sign of $(x_{t3} - \bar{X}_3)$, consider the distribution of the stringency of environmental regulations, x_{t3}, over the world. Industrialized, high-income countries have environmental endowments greater than the population mean $\bar{X}_3$, and less-developed countries have environmental endowments less than the population mean. Thus, the pattern of signs of $\tilde{\mu}_t$ under the alternative hypothesis depends on the distribution of x_{t3} over countries. Given the distribution above, the proportion of error terms that are postive for developing countries is expected to be significantly greater than the proportion of error terms that are positive for industrialized countries.

Let T_n represent the true proportion of errors for countries in group n (where $n = 1$ corresponds to industrialized countries and $n = 2$ corresponds to developing countries). The null hypothesis (H_0) states that the proportion of errors that are positive is the same for both industrialized and developing countries. The alternative hypothesis (H_1) states that the proportion of such errors is greater for developing countries than for industrialized countries.

$$H_0 : T_2 = T_1$$
$$H_1 : T_2 > T_1$$

A nonparametric statistical procedure was chosen to conduct the statistical test because it requires few assumptions regarding the distribution of the error terms. Under the null hypothesis, the test statistic may be given as[7]:

$$A = \frac{R_2 - R_1}{[\hat{T} \times (1 - \hat{T})[(1/I \times J_2) + (1/I \times J_1)]]^{1/2}}$$

where $R_n = S_n/(i \times J_n)$ represents the proportion of estimated errors that are positive; 'I' equals the total number of commodity groups (= 5), J_n equals the total number of countries in country group n; and S_n equals the number of estimated error terms for countries in group n that are positive.

$\hat{T}$ is an estimate of the true proportion under the null hypothesis. The best estimate of the true population proportion is constructed by combining the observations for both industrialized and developing countries as follows:

$$\hat{T} = (S_1 + S_2)/(I \times (J_1 + J_2))$$

To perform the omitted variable test a set of 58 countries is arranged in three groups (see TAble 4). Group one consists of industrialized, high-income countries. Environmental regulatory costs in this group are predicted to generate a comparative disadvantage in the production of polluting commodities. Group two is composed of upper-income developing countries and semi-industrialized nations without a stringent environmental program in 1975[8]. Group three is composed of middle to low-income developing countries.

A summary of information on the estimated residuals when equation (1) is estimated using this set of 58 countries is shown in Table 5. It is not possible to reject the null hypothesis that $T_2 = T_1$ in the comparison of industrialized countries with any combination of the

7. See YAMANE [1967].

8. A review of international environmental policy [TOBEY, 1989] is used to specify those countries with and without enforced pollution control measures as of the mid 1970s.

Table 4

Country Observations

Country	GDP per capita[1]	Country	GDP per capita[1] (1975 constant U.S. $)	Country	GDP per capita[1]
Group One		Group Two		Group Three	
Australia	5919	Argentina	3159	Afghanistan	380
Austria	4994	Brazil	1978	Burma	312
Belux	5569	Chile	1834	Colombia	1596
Canada	6788	Costa Rica	1835	Dom Rep	1443
Denmark	5969	Cyprus	1811	Ecuador	1300
Finland	5192	Greece	3360	Egypt	929
France	5864	Hong Kong	2559	El Salvador	1005
Germany	5758	Ireland	3067	Ghana	952
Iceland	5201	Israel	4154	Honduras	871
Japan	4904	Italy	3870	India	472
Netherlands	5321	Malta	2154	Indonesia	536
New Zealand	4769	Mexico	2276	Jamaica	1763
Norway	5419	Panama	2026	Korea	1530
Sweden	6749	Peru	1860	Liberia	830
Switzerland	6082	Portugal	2397	Lybia	6680[2]
UK	4601	Singapore	2875	Malaysia	1532
USA	7132	Spain	4032	Mauritius	1260
AVERAGE	5661	Turkey	1738	Nigeria	1179
		Yugoslavia	1960[2]	Paraguay	1186
		AVERAGE	2567	Philippines	912
				Sri Lanka	661
				Thailand	930
				AVERAGE	1002[3]

[1] HESTON and SUMMERS [1984].
[2] 1977 GNP per capita, from World Bank [1979], *World Development Report.*
[3] Excluding Libya.

developing country groups. These results reinforce the earlier finding which used a qualitative variable to represent the environmental endowment and which also found no effect of pollution control measures on HOV trade patterns.

IV. EXTENSIONS TO THE HOV MODEL

This section specifies alternative trade models when two of the HOV assumptions are relaxed (see LEAMER s[1984] for a complete list of

Table 5

Positive Residuals

Country Group	Paper	Steel	Chems	NFMetals	Mining	S_n[1]	J_n[2]	R_n[3]	A[4]
One	7	9	5	8	11	40	17	0.47	-
Two	5	10	9	5	6	35	19	0.37	−1.32
Three	10	18	15	5	11	59	22	0.54	0.96
2 + 3	15	28	24	10	17	94	41	0.45	−0.15

[1] S_n is the number of errors for group n that are positive.
[2] J_n is the number of countries in group n.
[3] $R_n = S_n/(I \times J_n)$.
[4] 'A' is the test statistic computed using group one as the sample of industrialized countries compared against groups of developing countries (T = 0.46). An absolute value of 1.65 for the test statistic in the normal distribution corresponds to a probability of 95 percent.

necessary assumptions) and reports the empirical results when the above empirical tests are again performed on these models.

The first exension of the HOV model allows for non-homothetic preferences. The HOV model assumes identical homnothetic tates – meaning that individuals facing identical commodity prices will consume commodities in the same proportions. In this cross-section study, with countries at various levels of development, this assumption may not be completely reasonable. To allow for NHP I assume that consumption across countries is a linear function of population and national income. When the HOV model is modified to incorporate this assumption, per capita net exports (n_{it}) become a linear function of per capita resource endowments (v_{kt}) as given by the following equation:

$$n_{it} = b^*_{i0} + \left(\sum_{k=1}^{K} b_{ik} v_{kt}\right) \tag{6}$$

where $b^*_{i0} = -c_{i0}$, and c_{i0} is a parameter that relates consumption of commodity i in country t to country t's population. As before, b_{ik} indicates the total effect of an increase in a resource on net trade of a specific commodity.

The same set of empirical tests are conducted using this equation.

Without burdening the reader with additional tables, I simply report that WALTER and UGELOW's variable is not significant in any of the OLS regressions. Similarly, the statistical comparison of error terms under the omitted variable test does not support the hypothesis being tested.

The second extension of the HOV model emphasizes scale economies and product differentiation. All of the pollution-intensive commodity groups are associated with what are generally considered very large-scale production processes. Moreover, HUFBAUER [1970] has found the production of paper products to be subject to large economies of scale and the production of nonferrous metals to be subject to diseconomies of scale. Scale economies may therefore be important in determining international comparative advantage for these goods. If this is the case, developing countries, with small economies and limited infrastructure outside of major cities may be at a disadvantage in the production of these commodities. A model which allows for the fact that the production function for polluting commodities exhibits economies of scale is therefore tested.

I use a model which MURRELL [1990] derives and which follows HELPMAN and KRUGMAN [1985] closely. The set of assumptions used to generate this model are essentially the same as those of the previous HOV model except that product differentiation and economies of scale are introduced. Specifically, it is assumed that each good can be produced in an infinite nujmber of varieties. Each variety of a single good has the same production function, but such functions vary between goods. Furthermore, the production function for each variety exhibits economies of scale, at least at low levels of output.

With the introduction of economies of scale and product differentiation, the export of good i by country t, x_{it}, are specified as follows [MURRELL, 1990]:

$$x_{it} = \sum_{k=1}^{K} b^{*}_{ik} V_{kt}(1 - G_t/G_w) \qquad (7)$$

where G_t is the national income of country t and G_w is total world income.

Equation (7) cannot be derived from the H-O theory and and the asterisks on the coefficients of the equation are a reminder that these coefficients are not equivalent to b_{ik} in the previous two models.

Again, the same set of empirical tests are conducted, this time using equation (7). Once again, WALTER and UGELOW's 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 percent level of confidence, but, because they are negative, they also fail to support the hypothesis being tested.

V. A FIXED-EFFECTS EMPIRICAL TEST

A reasonable explanation for the empirical results above may be that the magnitude of environmental expenditures incurred by the industrialized countries in the late 1960s and early 1970s were not sufficiently large to cause a noticeable effect on trade patterns between countries with and without environmental protection programs. The cross-section HOV model may not be sufficiently precise to identify these small changes in factor abundances and comparative advantage. Thus, the effect of domestic environmental policy on trade may be getting lost in the 'noise'. By examining the change in trade patterns before and after te introduction of environmental measures in the industrialized countries, one might be able to detect the hypothesized shifts in trade patterns in response to environmental policies that don't show up in the equations using data from a specific point in time. Such a methodology would also be effective in capturing the effect of environmental policy even if there was a significant lag in the impact of pollution controls on international competitiveness.

Although endowment data are only available fo the year 1975, most resource endowments change little over time. At least for the most polluting industries, one might argue that the most important endowment change over the period 1970 to 1984 was the increase in environmental regulations. Consider then a HOV model where the change in net exports over 1970–84 is linearly related to the change in factor endowments over the same period. Under a 'fixed-effects' specification, assume tht, except for the environmental endowment, the change in factor endowments equals zero. In this case, one is left with the following equations:

$$\Delta N_{it} = E_t + \mu_{it}$$

Table 6

Variable Name	Equations (D. F. = 22) Mining ($R^2=0.03$)	Paper ($R^2=0.0+$)	Chems ($R^2=0.05$)	Steel ($R^2=0.0+$)	NFMetals ($R^2=0.04$)
E	−54155 (1.1)	−2298 (0.1)	78007 (1.9)	49437 (0.4)	−65593 (1.1)

where ΔN_{it} are 1984 minus 1970 net exports of commodity i by country t. E_t is the WALTER and UGELOW [1979] measure of the degree of the stringency of environmental policy in 23 countries in 1977. Since these countries generally did not have enforced environmental programs in place by 1970, the level of environmental policy given by this index is a reasonable proxy for the change in environmental policy. Finally, μ_{it} are the random error terms.

The results of the OLS estimation of this model are shown in *Table 6*. If environmental policies reduce countries' international comparative advantage in the most pollution-intensive commodities, then the sign on the environmental endowment coefficient should be negative and significant. Only in the chemicals group does the significance of the coefficient approach a conventionally accepted level of confidence. The sign, however, is positive, and once again does not support the hypothesized impact of pollution control measures on trade patterns.

VI. CONCLUDING REMARKS

Several tests are undertaken under a variety of specifications, but in no case is there any evidence that the introduction of environmental control measures has caused trade patterns to deviate from the HOV predictions. This result is important in that it casts serious doubt on the 'balance-of-trade' argument against environmental control which, as mentioned above, can be a strong deterrent to the implementation of new or stronger pollution control measures. the test results also lend support to the less empirically rigorous location-of-industry studies which maintain that the world distribution of 'dirty' industries has not been affected by differing country levels of environmental stringency.

As already noted, a reasonable explanation for these empirical results may simply be that the magnitude of environmental expenditures in countries with stringent environmental policies are not sufficiently large to cause a noticeable effect. This seems like the most likely explanation. Other explanations can, however, be postulated and I offer two possibilities below.

The first relates to the validity of the HOV equations themselves. The accuracy of the cross-section HOV model was recently questioned by BOWEN et al. [1987] who shows that since this model makes no reference to factor input intensities, it is only a weak test of the H-O hypothesis. The stricter H-O hypothesis requires that factor supplies, magnitude of the difference in robustness and accuracy of the weak version vis-à-vis the strict version is not clear.

The second observation relates to the nature of the pollution-intensive commodity groups and violations of the assumptions of the HOV model. this model assumes that commodities move inernationally at zero cost of tansportation, and that there are no other impediments to trade. However, transportation costs, tariffs, and subsidies[9] are important considerations in these industries and may affect a country's composition of trade. These trade impediments are difficult to deal with at an empirical level since they are very difficult to measure for large sets of countries. However, if they are distributed across countries in the same pattern as environmental controls then they would interfere with the ability of the HOV model to pick up the effect of environmental policy.

9. Many countries with stringent pollution control measures have offered various subsidies to polluting industries which lessen the impact of pollution control measures on world trade patterns in these industries.

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SUMMARY

The premise that trade suffers from the imposition of environmental policy has a strong element of a priori plausibility, but, surprisingly, has little empirical support. The present paper provides an empirical test of the hypothesis that stringent environmental policy has caused trade patterns to deviate in commodities produced by the world's 'dirty' industries. The empirical tests are conducted using the cross-section Heckscher-Ohlin-Vanek (HOV) model of international trade. It is not found that the introduction of stringent environmental control measures has caused trade patterns to deviate from the HOV predictions. This result casts serious doubt on the balance of trade argument against the imposition of stronger environmental control.

ZUSAMMENFASSUNG

Die Behauptung, dass der Handel unter umweltpolitischen Auflagen leidet, scheint a priori zwar äusserst plausibel, findet jedoch überraschenderweise wenig empirische Unterstützung. Der vorliegende Artikel liefert einen empirischen Test, in dem die Hypothese aufgestellt wird, dass eine strenge Umweltpolitik eine Verlagerung der Handelsströme zugunsten der Güter bewirkt, welche von den «schmutzigen» Industrien in der Welt produziert werden. Die Tests werden unter Verwendung des Heckscher-Ohlin-Vanek (HOV) Querschnittmodells für den internationalen Handel durchgeführt. Das Ergebnis liefert keine Unterstützung der Hypothese. Dies lässt ernsthaften Zweifel daran aufkommen, ob Argumente gegen die Einführung strengerer Umweltkontrollen aus Gründen des Handelsbilanzgleichgewichts Gültigkeit besitzen.

RÉSUMÉ

Il apparaît plausible qu'une politique gouvernementale vis-à-vis l'environnement ait un impact négatif sur les échanges commerciaux. Mais on n'avait jamais mesuré réellement cet impact. Cet article présente un test empirique de l'hypothèse selon laquelle une politique environnementale contraignante conduit à des déviations dans la structure du commerce international en ce qui concerne les biens produits par les secteurs polluants de l'industrie mondiale. L'auteur a mené ce test grâce au modèle du commerce international de Heckscher-Ohlin-Vanek (HOV). Ce test ne permet pas de prouver que l'introduction de contrôles et de fortes contraintes sur l'environnement ait entraîné la structure du commerce international à dévier des prédictions du modèle HOV. Désormais, grâce à ce test, vouloir s'appuyer sur une soit disant dégradation du commerce international pour freiner la mise en place des contrôles de l'environnement apparaîtra comme de plus en plus difficile.