Globalization and Environment: Can Pollution Haven Hypothesis alone explain the impact of Globalization on Environment?

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Abstract

The economic literature on trade and environment seeks empirically test hypotheses about how trade affects the environment that is crucial for resolving current policy debates. Applying panel data technique we examine the impacts of globalization on pollution level, pollution intensity and relative change of pollution for the developed (OECD) and developing (Non-OECD) country groups and the world as a whole. This paper examines the factor endowment and pollution haven hypotheses that predict how trade affects the environment. Interaction effects also play a crucial role to determine the impact of globalization on environment. In this study we use CO_2 emission and observe that the impact of globalization on environment heavily depends on the basic characteristics of a country and its dominating comparative advantage. The empirical results suggest that globalization increases CO_2 emission, which is the main culprit of the global warming.

JEL *Classification Number*: Q00, F1

Key Words: Globalization, pollution haven hypothesis, factor endowment hypothesis, and interaction effect.

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1. Introduction

Economic development through rapid industrialization and growing environmental consciousness together have generated a heated debate on how economic development (or growth) is linked with environment. The linkage of environmental quality with economic development evoked much discussion in the last decade (i.e., 1990s). The World Development Report (World Bank 1992) presented cross-sectional evidences on the relationship between different indicators of environmental quality and per capita national income across countries. Other studies (e.g. Grossman and Krueger, 1991; Selden and Song, 1994; Rothman, 1998; Suri and Chapman, 1998; etc) documented an inverted U-shaped relationship between environmental degradation and income. The common point of all these studies is the assertion that environmental degradation increases initially, reaches a maximum level and after that declines as an economy develops. This systematic inverted-U relationship has been termed as the *Environmental Kuznets Curve* (*EKC*) following the work of Kuznets (1955), who postulated a similar relationship between income inequality and economic development. The *EKC* relates to the issue of the impacts of economic growth or development on the environment of a country.

Now automatically one important question arises whether cross border integration (i.e., globalization) helps or hurts this process. This is indeed the primary motivation for this study. The aim of this paper is to explore whether globalization hurts the environment. Applying panel data technique we examine the impacts of globalization on pollution level, pollution intensity and relative change of pollution for the developed (OECD) and developing (Non-OECD) country groups and the world as a whole. In this study we use CO2 emission and observe that the impact of globalization on environment heavily depends on the characteristics of the economy. The basic characteristics of a country and its dominating comparative advantage determine how trade liberalization influences its sectoral composition and consequently environmental outcomes.

This analysis has been done mostly by applying the technique of panel data analysis to a cross-country panel data set on per capita income and CO_2 emission. In what follows, we explain first the background of this study, methodological framework and then present the empirical results of our analysis. The paper is organized as follows: Section 2 presents the background of this study and ideas develop how the globalization links up environmental quality. Section 3 describes the data set. The empirical results are presented in Section 4. Finally, in Section 5 some concluding observations have been drawn.

2. Background of this study

Environmental quality could decline through the *scale effect* as increasing trade volume (especially export) would expand the size of the economy thereby increasing the extent of pollution. Thus, trade might be a cause of environmental degradation, *ceteris paribus*. Many economists have long argued that trade is not the root cause of environmental damage (Birdsall and Wheeler 1993, Lee and Roland-Host 1997, Jones et al. 1995). However, free trade has the contradictory impacts on environment, both increasing pollution and motivating reductions in it. Antweiler et al. (2001) and Liddle (2001) argue that trade may be good for environment. Trade may improve the environmental quality through *technological effect*. As income rises through trade, environmental regulation is tightened that spurs pollution reducing innovation. And as trade relates one country with international communities, one underdeveloped economy may rely on technology transfer through foreign direct investment that may reduce pollution.

However, globalization, by increasing competition for investment, may trigger the environmental *race to bottom* (Wheeler (2000)). Poor economies may be able to improve their environmental quality as investment raise their income levels. Thus, globalization may facilitate pollution reduction. In fact, *the bottom* rises with economic growth. Tisdell (2001) points out that globalization can be a driving force for global economic growth. Yet opinion is divided about the benefits of this process. The global economy raises the issue of potential conflicts between two powerful current trends – viz., the worldwide acceptance of market oriented economic reform process on the one hand, and environmental protection on the other.

It should be mentioned that a polluting activity in a high-income country normally faces higher regulatory costs[1] than its counterpart in a developing country (Mani and Wheeler (1998)). Under these circumstances the pollution intensive industries will have a natural tendency to migrate to countries with weaker environmental regulations (Copeland and Taylor (1995)). This is referred to as the *Pollution Haven Hypothesis (PHH)* (See, Bommer (1999), Cole (2003, 2004)). The *PHH* refers to the possibility that polluting industries concentrate in developing countries with low environmental standards. The *pollution haven hypothesis* (*PHH*) predicts that, under free trade, multinational firms will relocate the production of their polluting goods to developing

[1]This creates an incentive for at least some highly polluting industries to relocate. The firms are relocated to low-income countries with weak environmental regulation. Rising capital outflows force governments in high-income countries to begin relaxing environmental standards.

countries, taking advantage of the low environment monitoring in these countries. Developing countries will develop a comparative advantage in pollution-intensive industries and become ‘haven’ for the world’s polluting industries. Thus, developed countries are expected to benefit in terms of environmental quality from trade, while developing countries will lose (See Figure 1). In other words, the *PHH* basically suggests that countries having stricter environmental standard will lose all the *dirty industries* and poor countries (i.e., those having poorer environmental standard) will get them all. It is also true that the differences in the consumer preferences for a cleaner environment in rich and poor countries also induce the displacement hypothesis and/or *PHH*.

It is observed that changes in the structure of production in developed economies are not accompanied by equivalent changes in the structure of consumption. This could be explained by the *EKC,* which actually record the shifting of dirty industries to less developed economies. As Rothman (1998) speculates, what appears to be an improvement in environmental quality may in reality be an indicator of increased ability of consumers in wealthy nations to distance themselves from the environmental degradation associated with their consumption. The mechanisms through which such distancing take place may include both moving sources of pollution away from the people and moving people away from pollution sources[2]. Thus, in general, the phenomenon of *distancing* may be a possible source of *EKC* results. Hettige et al (1992) observe that toxic intensity grew rapidly in high-income countries during the 1960s and this pattern was sharply reversed during the 1970s and 1980s, after the advent of stricter

[2] Gawande et al. (2000, 2001) provide evidence that migration is a contributing factor behind the *EKC* especially for US hazardous waste (See also Berrens et al. 1997).

environmental regulations in the OECD countries. Concurrently, toxic intensity in LDC manufacturing grew quickly. Lucas et al (1992), Low and Yeats (1992) also confirm this displacement hypothesis.

Agras and Chapman (1999) and Suri and Chapman (1998) analyse the composition of international trade and observe that manufacturing goods exporting countries tend to have higher energy consumption. They find the poor and rich countries to be net exporters and net importers of pollution-intensive goods, respectively. Therefore, the inverted U-shaped *EKC* curve might partly be the result of changes in international specialization under which poor countries engage in *dirty* and energy intensive production while rich countries specialize in *clean* and service intensive production, without effectively any change in the consumption patterns.

On the contrary the *PHH*, the *factor endowment hypothesis* (*FEH*) asserts that in free trade the differences in endowments (or *technology*) determine trade between two countries. The *FEH* suggests that the capital abundant country exports the capital-intensive goods that stimulate its production and thereby raising pollution in the capital abundant country. The effects of trade on the environment depend on the comparative advantages enjoying a country. Under this view capital-abundant countries tend to export capital-intensive goods, regardless of differences in environmental policy (Copeland and Taylor 2004). According to the FEH[3] polluting industries will concentrate in affluent countries, which also tend to be capital abundant. This is because polluting industries are

[3] Under free trade the capital abundant country exports the capital-intensive (dirty) goods, which stimulates its production, thus raising pollution in the capital abundant country. Conversely, pollution falls in the capital-scarce country as a result of contraction of the production of pollution-intensive goods, since there is no comparative advantage of producing polluting goods in the developing world (Temurshoev 2006, Liang 2006, Mukhopadhyay et al 2005).

typically also capital intensive, and thus affluent capital-abundant countries have a comparative advantage in these industries (Copeland and Taylor 2004). In this context, it should be noted that the differences in environmental policy and differences in factor endowments might jointly determine the comparative advantage in trade. It is clear that effects of trade liberalization on environmental quality depend on, among other factors, jointly by differences in pollution policy and differences in factor endowments, which leads to two competing theories in question.

3. The Data and Methodology

In the present exercise we have used annual per capita real GDP *(PCGDP),* capital per worker (capital–labour (i.e., *K/L)* ratio), trade intensity and annual per capita CO_2 *(PCCO2)* emission as the measure of the income, *K/L* ratio, openness and the emission variable, respectively. It should be noted that globalization is the proxy measurement in terms of openness, which is measured as export plus import to GDP. This openness is also termed as trade intensity. The basic country-level time series data *PCGDP* (expressed in 1985 international prices, i.e., PPP dollars) for the period 1965-1990 were taken from the RGDPCH series of the Penn World Table (Mark 5.6) available at the web site http://www.nber.org/pwt5.6. As mentioned, for the present exercise we have used cross-country panel data on *Openness (in per centage)*, capital per worker (*K/L*), *PCGDP* and other economic variables compiled by Summers and Heston (viz., the Penn World Table). Corresponding panel data set on *PCCO2* (measured in metric tons) was obtained from the web site of Carbon Dioxide Analysis Information Center (CDAIC), Oak Ridge National Laboratory of the U. S. A. Combining these data sets, we compiled a panel data set of annual observations on income, *K/L* ratio, openness and emission covering 54 countries for the time period 1965 - 1990 (see Coondoo and Dinda (2002)). For the purpose of the exercise, we grouped the countries into 3 major country groups, viz., developed (OECD), less developed (Non-OECD) and the world as whole.

The empirical exercise has been done separately for each of these country groups based on these panel data sets for the individual country groups. Panel data analyses offer different ways to deal with the possibility of country-specific variables. Fixed Effect (FE) model is a suitable estimation approach that treats the level effects as constants, whereas Random Effect (RE) model is suitable to capture the level effect. It should be mentioned that RE model treats the level effects as uncorrelated with other variables, while FE model does not. In this analysis we estimate both FE and RE models. Now the estimating equations are

(1) $E_{it} = \alpha + \beta_1 \ln Y_{it} + \beta_2 (\ln Y_{it})^2 + \beta_3 \ln KL_{it} + \beta_4 (\ln KL_{it})^2 + \beta_5 \ln P_{it} + \lambda OP_{it} + \theta t + u_{it}$

(2) $\ln E_{it} = \alpha + \beta_1 \ln Y_{it} + \beta_2 (\ln Y_{it})^2 + \beta_3 \ln KL_{it} + \beta_4 (\ln KL_{it})^2 + \beta_5 \ln P_{it} + \lambda OP_{it} + \theta t + u'_{it}$

(3) $$\begin{aligned} E_{it} &= \alpha + \beta_1 \ln Y_{it} + \beta_2 (\ln Y_{it})^2 + \beta_3 \ln KL_{it} + \beta_4 (\ln KL_{it})^2 + \beta_5 \ln P_{it} + \lambda OP_{it} + \theta t \\ &+ \eta_1 (RKL_{it} * OP_{it}) + \eta_2 (RKL_{it}^2 * OP_{it}) + \eta_3 (RI_{it} * OP_{it}) + \eta_4 (RI_{it}^2 * OP_{it}) + v_{it} \end{aligned}$$

(4) $$\begin{aligned} \ln E_{it} &= \alpha + \beta_1 \ln Y_{it} + \beta_2 (\ln Y_{it})^2 + \beta_3 \ln KL_{it} + \beta_4 (\ln KL_{it})^2 + \beta_5 \ln P_{it} + \lambda OP_{it} + \theta t \\ &+ \eta_1 (RKL_{it} * OP_{it}) + \eta_2 (RKL_{it}^2 * OP_{it}) + \eta_3 (RI_{it} * OP_{it}) + \eta_4 (RI_{it}^2 * OP_{it}) + v'_{it} \end{aligned}$$

Where E_{it} is the pollution measured in country i at time t; similarly *Y, KL, P, OP, RI, RKL* and *t* denote income per capita, capital labour ratio, population, openness, relative income, relative capital ratio and time trend, respectively.

4. Results

We first estimate equations (1) – (2). Later we estimate equations (3) – (4), which include the openness interaction with country characteristics. The conditioning the impact of openness on country characteristics is the important determining factors through which trade affects the pollution intensity of national output.

Our central focus is in λ, the coefficient of openness (or proxy of globalization). Table 1, Table 2 and Table 3 present the estimated results of the impact of globalization on emission level, emission intensity and relative change of emission, respectively. For per capita CO_2 emission level, Table 1 shows that the coefficient of openness is negative for all three groups and statistically significant except Non-OECD country group. This suggests that globalization help to reduce pollution in developed country not in developing country. In case of CO_2 emission intensity per dollar (Table 2) and relative change of CO_2 emission per capita (Table 3), the coefficients of openness are significantly negative in OECD and the World but positive in Non-OECD country group. Thus, unambiguously globalization helps developed countries to reduce emission (or pollution) while it increases in under developed country. Table 2 and Table 3 point out that globalization promotes to increase emission (pollution) intensity and relative change of emission and thereby liberalization or openness hurts the environment of developing country and improves the environment of developed country. Thus, these empirical findings (Table 1 – 3) support the pollution haven hypothesis (PHH). This finding support the earlier studies (Low and Yeats (1992), Agras and Chapman (1999) and Suri and Chapman (1998) etc.) and suggest that developed countries produce less pollution-intensive goods while less developed countries produce more and more pollution-intensive goods.

However, conventional trade theory suggests that capital abundant countries export the capital-intensive goods, (which is also energy intensive,) which increases pollution in capital abundant country[4]. So, it seems that the PHH and FEH contradict. Actually, the differences in environmental policy (PHH) and differences in factor endowments (FEH) might interact and jointly may determine the comparative advantage in trade. The possible interaction effects are incorporated in our last two equations i.e., eq. (3)-(4). Now we present the estimates from our equations (3) – (4) allowing for the interaction of country characteristics with a measure of openness. Table 4, Table 5 and Table 6 present the estimated results of the impact of comparative advantage (interaction with country characteristics) on emission level, emission intensity and relative change of emission, respectively. The results are dramatically changed. Table 4, Table 5 and Table 6 present that the coefficient of openness is positive and significant for all three measures of pollution for all three groups, except negative and insignificant λ (coeff. Of openness) for emission level in Non-OECD country group. It should be noted that adding the country characteristics show to have made a large difference to the impact openness has on CO_2 emission. The signs of the coefficient of openness change dramatically opposing the previous results (i.e., PHH) with high significant level. This result differs from the findings of Antweiler et al. (2001), and Copeland and Taylor (2004[5]). The interaction terms with country characteristics are also highly significant. The interaction term on

[4] Globalization helps to concentrate on the capital-intensive industry and thereby raising pollution.
[5] Their estimated effect is quite small indicating that the FEH and PHH counteract and potentially tend to offset each other, but negative sign remain same and significant.

openness and relative capital-labour ratio is negative and its square term is positive in most of the cases except in Non-OECD for emission intensity (see Table 4 - 6). Now we observe the interaction terms (on relative capital and openness) are negative and positive for all three measures in the world and OECD. Therefore, if a country has sufficiently high capital-labour ratio relative to the rest of the world, further openness makes this country cleaner. Relatively rich and poor country would be cleaner and dirtier[6], respectively. This implies that rich capital abundant country diverts one part of their capital and labour to produce clean and knowledge-based technology. The results of interaction on openness and relative income are also similar to that of capital-labour ratio. Net impact of globalization on emission depends on the relative strength of the factor endowments and policy regulations. Globalization raises emission in the world while it reduces emission marginally in OECD and increases in Non-OECD countries. These empirical findings suggest that globalization increases the pollution, particularly CO_2 emission, and thereby help to rise the global warming.

5. Conclusion

The aim of this paper is to explore whether globalization helps or hurts the environment. Using panel data technique we examine the impacts of globalization on pollution level, pollution intensity and relative change of pollution for the developed (OECD) and developing (Non-OECD) country groups and the world as a whole. This paper examines the factor endowment and pollution haven hypotheses that predict how international trade affects the environment. In this study we use CO2 emission, which is

[6] Thus, these results also partially support the PHH.

the mail culprit of the global warming, and observe that the impact of globalization on environment heavily depends on the basic characteristics of a country and its dominating comparative advantage. The empirical results suggest that globalization help developed countries to reduce CO_2 emission while developing countries to rise CO_2 emission. Net impact of globalization increases the global worming.

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Table 1: Globalization and CO2 emission level

	World		Non-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	-3.4619	-2.1088	-1.7862	-1.8786	9.1655	7.0154
t-value	-4.47	-2.95	-9.04	-9.65	1.94	1.57
Log(income)sq.	0.2709	0.1815	0.1382	0.1444	-0.3855	-0.2931
t-value	5.69	4.17	11.09	11.74	-1.47	-1.19
Log(K per labour)	0.7384	1.1140	-0.3204	-0.3030	-3.3488	1.0643
t-value	1.94	3.03	-3.54	-3.40	-1.37	0.48
Log(K per labour)sq.	-0.040	-0.068	0.027	0.024	0.165	-0.071
t-value	-1.82	-3.26	4.86	4.55	1.31	-0.62
Log(population)	0.8584	-0.0994	0.0068	-0.0333	2.3717	-0.4339
t-value	4.81	-1.59	0.10	-1.96	3.61	-3.04
OPEN	**-6.84E-03**	**-7.24E-03**	**-9.75E-05**	**-4.54E-04**	**-0.01983**	**-0.01681**
t-value	**-5.70**	**-6.49**	**-0.29**	**-1.50**	**-6.10**	**-5.84**
Time trend	-0.0247	0.0010	-0.0022	0.0001	-0.0407	-0.0019
t-value	-5.02	3.10	-1.21	0.34	-3.42	-1.57
Constant	-	2.436	-	7.387	-	-34.745
t-value		1.09		10.79		-2.91

Table 2: Globalization and CO2 emission intensity (per dollar)

	World		Non-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	4.1E-04	6.4E-04	2.4E-04	2.3E-04	2.9E-03	2.5E-03
t-value	4.37	7.38	3.87	3.71	5.72	5.19
Log(income)sq.	-2.6E-05	-4.1E-05	-1.7E-05	-1.7E-05	-1.7E-04	-1.5E-04
t-value	-4.49	-7.74	-4.46	-4.29	-5.95	-5.48
Log(K per labour)	1.3E-04	1.9E-04	2.6E-05	2.7E-05	-4.2E-04	-1.3E-05
t-value	2.71	4.22	0.91	0.98	-1.59	-0.05
Log(K per labour)sq.	-5.5E-06	-1.0E-05	7.8E-07	5.0E-07	2.4E-05	2.7E-06
t-value	-2.04	-4.04	0.45	0.29	1.76	0.21
Log(population)	1.5E-04	-7.5E-06	2.6E-05	1.6E-06	1.8E-04	-5.7E-05
t-value	6.83	-1.05	1.26	0.28	2.51	-4.09
OPEN	**-4.5E-07**	**-5.8E-07**	**3.3E-07**	**2.5E-07**	**-3.2E-06**	**-2.5E-06**
t-value	**-3.06**	**-4.25**	**3.14**	**2.58**	**-9.18**	**-8.09**
Time trend	-4.2E-06	1.6E-07	-8.6E-07	-2.8E-08	-1.5E-06	-1.7E-07
t-value	-6.92	4.55	-1.51	-0.46	-1.15	-1.42
Constant	-	-3.1E-03	-	-9.0E-04	-	-9.9E-03
t-value		-11.57		-4.17		-7.63

Table 3: Globalization and Relative change of CO_2 emission

	World		Non-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	2.3184	3.2181	2.5481	2.4073	10.6059	9.5839
t-value	7.13	10.66	6.46	6.17	8.09	7.72
Log(income)sq.	-0.0893	-0.1474	-0.1139	-0.1052	-0.5402	-0.4873
t-value	-4.47	-8.02	-4.58	-4.27	-7.40	-7.12
Log(K per labour)	0.798	1.031	0.301	0.339	-1.422	0.120
t-value	4.99	6.65	1.67	1.90	-2.09	0.19
Log(K per labour)sq.	-0.0340	-0.0536	0.0006	-0.0046	0.0688	-0.0117
t-value	-3.70	-6.10	0.05	-0.42	1.97	-0.37
Log(population)	0.567	0.016	0.418	-0.006	0.972	-0.069
t-value	7.57	0.57	3.17	-0.17	5.33	-1.76
OPEN	**9.3E-04**	**-7.7E-05**	**3.5E-03**	**2.3E-03**	**-4.4E-03**	**-3.4E-03**
t-value	**1.86**	**-0.16**	**5.27**	**3.77**	**-4.90**	**-4.21**
Time trend	-0.0165	0.0008	-0.0142	-0.0001	-0.0103	-0.0006
t-value	-7.99	4.99	-3.92	-0.35	-3.10	-1.92
Constant		-22.403		-16.068		-44.986
t-value		-23.82		-11.68		-13.56

Table 4:Impact of comparative advantage on CO_2 emission level

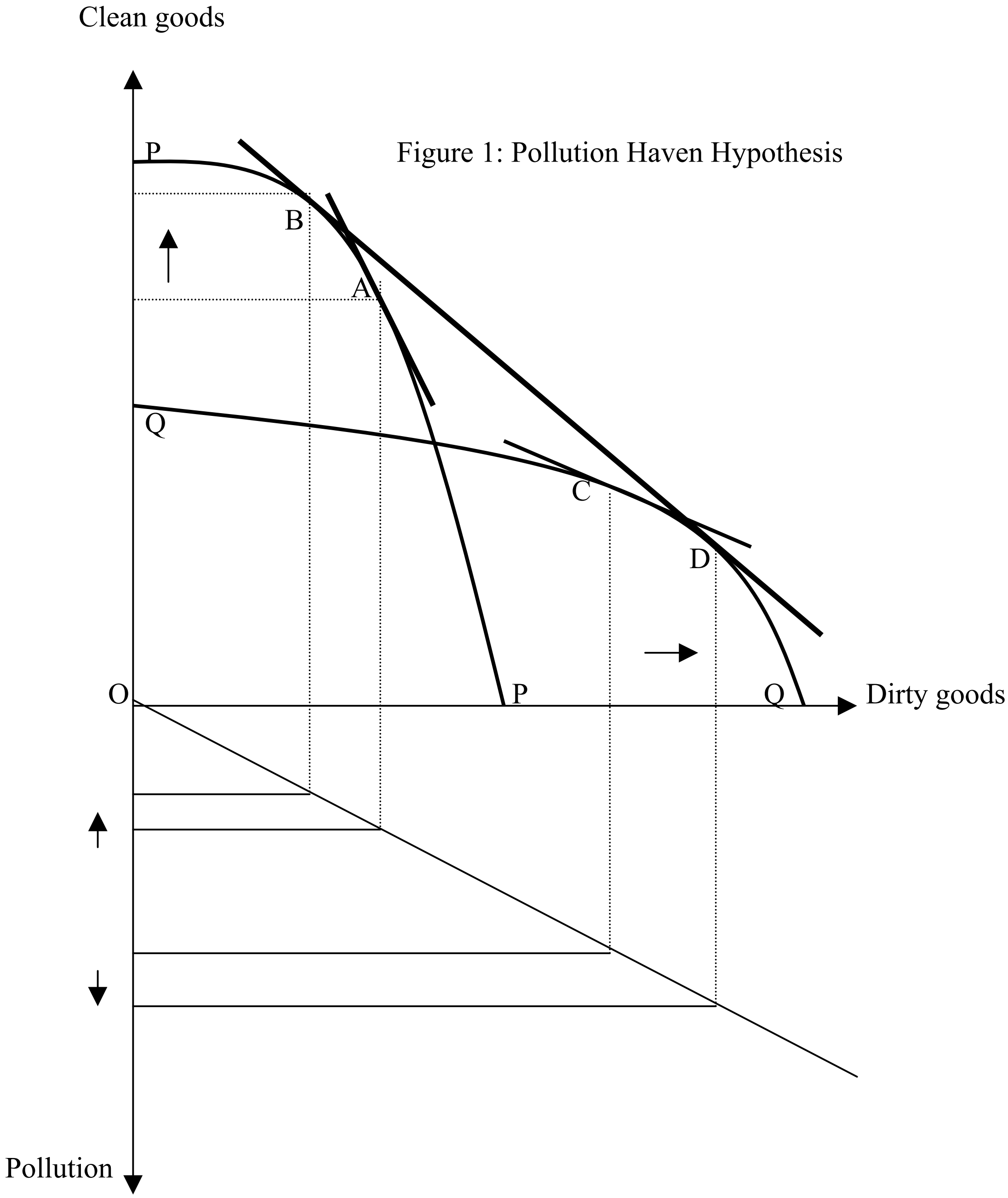
	World		No-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	-5.108	-4.906	-1.748	-1.836	0.879	1.089
t-value	-7.26	-7.41	-7.97	-8.49	0.20	0.26
Log(income)sq.	0.3684	0.3545	0.1320	0.1378	0.1245	0.0967
t-value	8.50	8.75	9.27	9.83	0.50	0.42
Log(K /L)	-1.474	-1.299	-0.477	-0.446	-11.872	-10.873
t-value	-4.02	-3.63	-4.76	-4.55	-5.21	-5.00
Log(K /L)sq.	0.103	0.093	0.038	0.035	0.635	0.579
t-value	4.77	4.41	5.92	5.62	5.41	5.15
Log(population)	-0.0160	-0.1524	0.0686	-0.0583	0.3238	-0.1946
t-value	-0.09	-2.80	1.06	-3.43	0.53	-1.40
OPEN	**6.3E-03**	**5.7E-03**	**-9.8E-05**	**-5.7E-04**	**4.5E-02**	**4.4E-02**
t-value	**4.07**	**3.85**	**-0.18**	**-1.14**	**6.78**	**7.50**
Time trend	-6.0E-04	1.2E-03	-4.3E-03	9.2E-05	-1.6E-02	-2.2E-03
t-value	-0.13	4.21	-2.39	0.59	-1.47	-1.90
Relative (K/L)*OP	-0.0128	-0.0105	-0.0017	-0.0015	-0.0305	-0.0286
t-value	-8.92	-7.44	-1.20	-1.15	-8.99	-9.06
Relative (K/L)^2*OP	3.8E-04	7.4E-06	-2.3E-04	-1.9E-04	2.4E-03	2.1E-03
t-value	1.33	0.03	-0.32	-0.27	4.51	4.16
Relative (Income)*OP	-1.1E-03	-1.7E-03	3.8E-03	3.7E-03	-5.1E-03	-5.5E-03
t-value	-1.10	-1.83	5.65	5.57	-2.96	-3.36
Relative (Income^2)*OP	-6.7E-05	-2.8E-05	-3.1E-04	-3.2E-04	4.2E-05	6.7E-05
t-value	-1.51	-0.65	-1.85	-1.91	0.59	1.01
Constant		22.42		8.14		38.03
t-value		9.76		9.74		3.09

Table 5: Impact of comparative advantage on CO_2 emission intensity (per dollar)

	World		No-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	1.5E-04	2.1E-04	1.7E-04	1.6E-04	1.8E-03	1.7E-03
t-value	1.91	2.75	2.43	2.35	4.07	4.23
Log(income)sq.	-1.06E-05	-1.42E-05	-1.31E-05	-1.26E-05	-9.93E-05	-9.55E-05
t-value	-2.16	-3.07	-2.86	-2.77	-4.03	-4.18
Log(K /L)	-2.17E-04	-1.96E-04	-1.03E-05	-5.55E-06	-1.55E-03	-1.56E-03
t-value	-5.21	-4.80	-0.32	-0.18	-6.89	-7.27
Log(K /L)sq.	1.69E-05	1.54E-05	3.17E-06	2.68E-06	8.63E-05	8.73E-05
t-value	6.87	6.43	1.54	1.34	7.44	7.85
Log(population)	2.43E-05	-1.39E-05	4.21E-05	3.45E-06	-1.05E-04	-2.75E-05
t-value	1.27	-2.16	2.02	0.58	-1.75	-1.97
OPEN	**1.67E-06**	**1.57E-06**	**2.45E-07**	**1.38E-07**	**5.77E-06**	**5.71E-06**
t-value	**9.53**	**9.33**	**1.42**	**0.85**	**8.83**	**9.80**
Time trend	-7.41E-07	1.88E-07	-1.22E-06	-3.20E-08	1.77E-06	-1.90E-07
t-value	-1.40	5.62	-2.12	-0.54	1.68	-1.65
Relative (K/L)*OP	-2.19E-06	-1.95E-06	6.93E-07	7.24E-07	-4.35E-06	-4.08E-06
t-value	-13.40	-12.15	1.56	1.67	-12.97	-13.05
Relative (K/L)^2*OP	1.15E-07	7.01E-08	-7.36E-07	-7.29E-07	3.72E-07	3.43E-07
t-value	3.58	2.26	-3.15	-3.18	7.01	6.80
Relative (Income)*OP	-1.15E-07	-2.02E-07	2.45E-08	-2.02E-09	-6.32E-07	-6.18E-07
t-value	-1.04	-1.88	0.11	-0.01	-3.70	-3.81
Relative (Income^2)*OP	-1.21E-08	-8.30E-09	5.79E-08	5.38E-08	4.35E-09	5.75E-09
t-value	-2.42	-1.69	1.06	0.99	0.62	0.87
Constant		-1.69E-05		-5.44E-04		-4.24E-04
t-value		-0.06		-2.02		-0.35

Table 6: Impact of comparative advantage on relative change of CO_2 emission

	World		Non-OECD		OECD	
	FE	RE	FE	RE	FE	RE
Variable	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient	Estimated Coefficient
Log(income)	1.6156	2.1244	1.8679	1.8599	6.9611	6.8833
t-value	5.15	7.15	4.15	4.16	5.43	5.74
Log(income)sq.	-0.0447	-0.0777	-0.0692	-0.0695	-0.3226	-0.3211
t-value	-2.31	-4.27	-2.37	-2.40	-4.50	-4.84
Log(K /L)	0.014237	0.118808	-0.064421	0.056897	-2.87362	-2.45619
t-value	0.09	0.74	-0.31	0.28	-4.38	-3.93
Log(K /L)sq.	0.01836	7.89E-03	0.026822	0.015461	0.155571	0.133333
t-value	1.90	0.84	2.04	1.21	4.61	4.12
Log(population)	0.362689	7.57E-03	0.526417	-0.014234	0.39951	0.020658
t-value	4.83	0.28	3.96	-0.36	2.29	0.52
OPEN	**6.49E-03**	**5.63E-03**	**5.52E-03**	**3.60E-03**	**0.014684**	**0.015287**
t-value	**9.44**	**8.44**	**5.01**	**3.48**	**7.73**	**9.05**
Time trend	-0.011084	8.36E-04	-0.017536	-1.31E-04	-5.94E-03	-7.68E-04
t-value	-5.33	5.43	-4.79	-0.32	-1.93	-2.37
Relative (K/L)*OP	-5.92E-03	-5.32E-03	-4.77E-03	-2.99E-03	-9.73E-03	-9.70E-03
t-value	-9.22	-8.39	-1.68	-1.08	-9.99	-10.68
Relative (K/L)^2*OP	6.23E-04	4.28E-04	2.88E-04	-2.59E-04	1.08E-03	1.06E-03
t-value	4.96	3.49	0.19	-0.18	7.02	7.21
Relative (Income)*OP	-1.62E-03	-1.88E-03	8.21E-04	5.53E-04	-2.54E-03	-2.72E-03
t-value	-3.71	-4.43	0.60	0.41	-5.11	-5.77
Relative (Income^2)*OP	2.69E-05	3.12E-05	3.24E-04	2.51E-04	5.62E-05	6.64E-05
t-value	1.36	1.61	0.93	0.73	2.77	3.45
Constant		-14.98		-12.98		-23.97
t-value		-14.48		-7.51		-6.77
Hausman test		81.463		37.766		52.641


Clean goods
Figure 1: Pollution Haven Hypothesis
P
B
A
Q
C
D
O
P
Q
Dirty goods
Pollution