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The Relationship between Environmental Stringency and the Polluting Industry Exports: Evidence for the Pollution Haven Hypothesis

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ABSTRACT

The purpose of this study was to investigate the relationship between the environmental stringency and pollution intensive manufacturing industry exports in order to find evidence for the Pollution Haven Hypothesis. Further, this study aimed to find how exports of these polluting industries take place when the exporting country belongs to a certain trading group. An augmented gravity model was estimated separately for the six pollution intensive manufacturing industries using panel data of 100 countries representing the whole world, during the period 2000-2004. The estimated gravity model showed evidence in support for the pollution haven hypothesis for three polluting industries which are Industrial Chemicals, Refined Petroleum Products and Nonmetallic Mineral Products, during the period and also showed that these exports are high for the countries belong to some of the trading groups.

KEYWORDS: Environmental stringency, Gravity model, Pollution haven hypothesis

INTRODUCTION

The world economy in last two decades has been characterized by liberalization of trade, which question consequences on the world environment. At present, trade and the environment has become one of the most debatable issues. In this regard, one of the most common opinions is that differences between countries in terms of environmental standards lead to a relocation of polluting industries from those with strict environmental regulations to those with less strict regulations, which is known as the "Pollution Haven Hypothesis (PHH)" (Caporale *et al.*, 2010).

It is argued that the environmental concerns of the developed economies caused them to enact strict environmental regulations to reduce the pollution that occurs from the manufacturing process from some dirty industries, which have increased the cost of production in the home country. On the other hand, developing countries with their low wages and lax environmental regulations have been attractive alternative producers in these sectors. At the same time this migration is also beneficial for developing countries that are in need of financial resources for industrial development. Thus, countries with weak environmental policies (generally developing countries) become a pollution haven for those with strong environmental stringency, exporting the "dirty" goods and importing the "clean" ones. In contrast, developed countries improve the quality of their environment by developing a comparative advantage in the clean goods. A wide variety of findings exists related to trade and the environment. Early empirical studies suggested that the stringency of environmental regulations had little or no impact on trade patterns (Tobey, 1990). But in the case where exporting countries are Central and Eastern European, a negative effect of environmental stringency is seen, explaining that more stringent environmental regulations reduce polluting exports (Jug and Mirza, 2005).

To analyze the relationship between environmental stringency and trade flows empirically and in particular to test for the existence of PHH the gravity model of trade is often used as the theoretical framework. Related research contributions are Harris *et al.*, (2002), Grether and De Melo (2003), Van Beers and Van den Bergh (1997) who tests for the existence of PHH using panel data and only week evidence in favor of the hypothesis were reported.

Among the other studies, Mani and Wheeler (1997) examined the PHH using international data on industrial production, trade and environmental regulation for the period 1960-1995. Their cross-country analysis showed a result that is consistent with the hypothesis and showed that pollution-intensive output as a percentage of manufacturing has fallen consistently in the developed countries with high environmental regulations and risen steadily in the developing world.

Again existence of a pollution haven effect in the European Union (EU) in the period 1999-2008 for exports of polluting industry products from Central East European Countries to EU were seen through the study of the relationship between environmental

stringency and intra-EU trade flows (Martinez *et al.*, 2012).

The aim of this paper was to investigate the relationship between environmental stringency and bilateral exports of 100 countries, separately for six pollution intensive manufacturing industries in order to find evidence for the existence of pollution haven effect. In addition, the study discovers how these exports takes place when the exporting country belongs to a certain trading group. The innovative feature of this study was its focus on bilateral polluting industry exports of 100 countries, in industry wise, which has not been covered by existing studies.

METHODOLOGY

Theoretical Framework

The gravity model was first used by Tinbergen (1962) and Poyhonen (1963) to explain bilateral trade flows, and later the first theoretical economic basis for the equation was provided by Anderson (1979). Based on the Newton's 'Law of Universal Gravitation' suggested the bilateral trade flows between two countries are positively related to the economic size of the country represented by Gross Domestic Product (GDP), and inversely related to the geographical distance between them. This basic model has been further expanded by adding variables in empirical studies introducing population, language, common border etc. (Yue *et al.*, 2010).

The gravity model of trade is often been used as theoretical framework to empirically analyze the relationship between environmental regulations and trade flows and in particular to test for the existence of PHH. Consistent with this approach and in order to investigate the above mentioned effects, the traditional gravity model was augmented with proxies for environmental regulations on dirty exports.

Usually the model is estimated in log-linear form. The model includes Environmental Performance Index (EPI) as a measure of environmental stringency and other traditional gravity variables such as country's GDP and population, distance between trading partners. In addition, dummy variables for common border, exporting country's income level and trading groups were included in the model (Equation 1).

$$\ln Q_{ijk} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln POP_i + \beta_4 \ln POP_j + \beta_5 \ln DIS_{ij} + \beta_6 \ln EPI_i + \beta_7 BOR_{ij} + \beta_8 INC1_i + \beta_9 INC2_i + \beta_{10} INC4_i + \beta_{11} INC5_i + \beta_{12} AFTA_i + \beta_{13} APTA_i + \beta_{14} SICA_i + \beta_{15} CEFTA_i + \beta_{16} COESA_i + \beta_{17} NAFTA_i + \beta_{18} SAFTA_i + \beta_{19} EU_i + \beta_{20} GAFTA_i + \varepsilon_{ij} \quad (1)$$

Where, β terms are coefficients, i is the exporting country j is the importing country k is the industry. The model variables are described in Table 1.

A higher GDP value in the exporting country indicated high level of production which increases the availability of goods for exports. Therefore, the value for β_1 was expected to be positive. The coefficient of GDP_j (β_2) was also expected to be positive since high GDP value in the importing country suggests higher demand for imports. The signs expected for exporter (β_3) and importer (β_4) population coefficients were ambiguous, as literature has found both positive and negative signs. Typically population is associated with market size in literature, and therefore β_3 and β_4 were expected to be positive. However, import substitution effect can also take place. Therefore, β_4 can become negative in empirical analysis. According to the PHH, a negative sign for the coefficient of EPI was expected.

Collection of Data

Trade, Production and Protection data base provided the dirty industry export values (kilograms per year), the GDP data of the countries, shared border and bilateral distance (kilometers) by country pair, geographic region by country and polluting industry codes according to Industrial Standard Industry Classification (ISIC) revision 2, for the period of 2000-2004 (Nicita and Olarreaga, 2006). Following Grether and De Melo (2003), 6 industries were selected as polluting industries: ISIC 341(Paper and paper products), ISIC 351(Industrial chemicals), ISIC 353 (Refined petroleum products), ISIC 369 (Non metallic mineral products), ISIC 371 (Iron and steel), ISIC 372 (Non ferrous metals).

The World Bank data provided the country's population in million persons for years 2000-2004. For the environmental stringency variable, the Environmental Performance Index (EPI), prepared by Yale Center for Environmental Law and Policy of the Yale University and the Center for International Earth Science Information Network of the Columbia University was used. This index has formed by considering both environmental health and ecosystem validity in each country. The EPI was used based on the assumption that if the EPI is high in a country, their environmental stringency is also high (Emerson *et al.*, 2012).

According to the data availability, bilateral exports of 100 countries related to six pollution intensive manufacturing industries were selected to represent the dirty industry exports of the whole world.

Table 1. Model Variables

Variable	Description
Q_{ij}	Export quantity of industry k from the exporting country i to the importing country j
GDP_i, GDP_j	Gross Domestic Product of the country i and j respectively
POP_i, POP_j	Population of the country i and j respectively
DIS_{ij}	Geographical distance between country i and j
EPI_i	Environmental Performance Index of the exporting country
BOR_{ij}	1 if country i and j shares a common border
$INC1_i$ (HOECD)	1 when the i^{th} exporter is a high income OECD country
$INC2_i$ (HOTHR)	1 when the i^{th} exporter is a high income other country
$INC\ 4_i$ (MID LW)	1 when the i^{th} exporter is a lower mid income country
$INC\ 5_i$ (MID UP)	1 when the i^{th} exporter is an upper mid income country
$AFTA_i$	1 when the i^{th} exporter belongs to AFTA trade group
$APTA_i$	1 when the i^{th} exporter belongs to APTA trade group
$SICA_i$	1 when the i^{th} exporter belongs to SICA trade group
$CEFTA_i$	1 when the i^{th} exporter belongs to CEFTA trade group
$COMESA_i$	1 when the i^{th} exporter belongs to COMESA trade group
$NAFTA_i$	1 when the i^{th} exporter belongs to NAFTA trade group
$SAFTA_i$	1 when the i^{th} exporter belongs to SAFTA trade group
EU_i	1 when the i^{th} exporter belongs to EU trade group
$GAFTA_i$	1 when the i^{th} exporter belongs to GAFTA trade group
ϵ_{ij}	Error term

Note: AFTA = Asean Free Trade Agreement, APTA = Asia-Pacific Trade Agreement, SICA = Central American Integration System, CEFTA = Central European Free Trade Agreement, COMESA = Common Market for Eastern and Southern Africa, NAFTA = North American Free Trade Agreement, SAFTA = South Asian Free Trade Agreement, EU = European Union, GAFTA = Greater Arab Free Trade Area, OECD = Organization for Economic Development and Corporation

In order to test pollution haven effect, the countries were categorized in to five income groups based on the World Bank criterion. And also, dummy variables for trading groups were employed in the model to investigate the impact for these exports when exporting countries belong to a certain trading group.

The variation of the average EPI value with income levels of countries, showed in Figure 1, denoted that high income OECD countries and low income countries are having the highest and the lowest EPI, respectively.

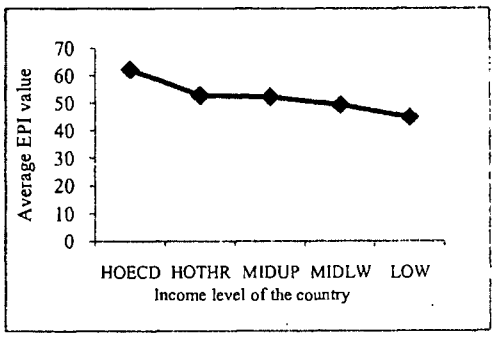

Figure 1. Variation of average EPI with the income level of the countries

Note: HOTHR=High income other countries, MID UP= Upper middle income countries, MIDLW= Lower middle income country, LOW= Low income country

Analysis of Data

Equation (1) was estimated separately for the exports of six polluting industries of the world from 2000-2004. The analysis used Stata 11.2 statistical package. In the analysis of the gravity model, country pair effects were taken into consideration to improve the estimates (UNCTAD virtual institute, 2012). Those country pair effects were incorporated by generating country pair dummies and modeled as random instead of fixed effects, as this approach preserves the possibility of estimating separately the effect of bilateral factors such as distance, common borders etc. that would otherwise be confounded with the fixed effects.

RESULTS AND DISCUSSION

The outcome of the gravity model reported in Table 2, with respect to the six dirty industries. Results revealed that the coefficient sign of the target variable (EPI_i), is negative and significant as expected for three industries, which are 353 (Refined Petroleum Products), 369 (Non Metallic Mineral Products) and 371 (Iron and Steel).

The industries ISIC 351 and 372 also got the expected sign, but the effect was not statistically significant.

Table 2. Outcome of the gravity model

Explanatory Variable	ISIC 341	ISIC 351	ISIC 353	ISIC 369	ISIC 371	ISIC 372
EPI_i	1.06*	-0.38	-1.11*	-1.73*	-1.06*	-0.68
GDP_i	1.88*	1.47*	0.62*	1.14*	1.37*	0.54*
GDP_j	0.87*	1.03*	0.92*	0.89*	1.03*	1.26*
POP_i	0.78*	1.46*	0.87*	1.32*	1.53*	0.95*
POP_j	0.81*	1.03*	0.60	0.66*	0.87*	1.07*
DIS_{ij}	-1.56*	-1.62*	-1.56	-1.74*	-1.51*	-1.43*
BOR_{ij}	1.54*	1.87*	1.30*	2.45*	1.92*	1.23*
$INC1_i$(HOECD)	-1.06*	0.44	-0.60	-0.33*	-0.41*	1.53*
$INC2_i$ (HOTHR)	-1.19*	2.09*	-1.21*	0.16	-0.05	1.15*
INC 4_i (MID LOW)	-0.64*	0.65*	-0.31	-0.22	0.50	0.56*
INC 5_i (MID UP)	-1.01*	0.57*	-0.37	-0.20	0.88*	1.26*
$AFTA_i$	1.72*	0.92*	0.99	2.29*	-0.81*	-0.80*
$APTA_i$	-0.50*	-0.88*	-0.50*	-1.06*	1.51*	-0.35
$SICA_i$	1.31*	0.21*	0.15	2.01*	-0.16	0.30*
$CEFTA_i$	-0.18	-2.01*	0.24	2.46*	0.89	-1.56*
$COMESA_i$	0.71	-1.37*	0.92*	0.36	1.41	0.24
$NAFTA_i$	0.56*	-0.43*	-1.29*	-1.53*	-1.93*	-1.10*
$SAFTA_i$	-0.29	-0.52*	-3.20	-0.39	-1.05*	-2.24*
EU_i	0.41*	-0.22*	-0.12*	1.35*	0.46*	-0.91*
$GAFTA_i$	0.07	0.98*	-0.78*	1.69*	-1.53*	-0.44*
Cons	-30.52*	-36.59*	-7.96*	-19.59*	-32.64*	-24.67*
R^2	0.40	0.47	0.28	0.41	0.42	0.41
No of Observations	14298	17691	14896	12707	13510	12461

**significant at 5% level*

Significant positive coefficient value was seen for the industry ISIC 341 which is contrary to the expectation.

The negative sign for the coefficient with significant effects of the industries ISIC 353, 369 and 371 indicated that when the value of the EPI_i increased, the exports of the products of each industry decreases in all countries. It explained that the exports of those three dirty industries are lower in countries with high EPI value than the countries with low EPI value. Further, when the exports across the countries of each income group were considered, results showed that the exports of refined petroleum products, nonmetallic mineral products and iron and steel are significantly lower in high income countries with compared to low income countries, which give some evidence for a relocation of these pollution intensive manufacturing industries in countries with lax environmental regulations.

When the exports of the different trading country groups were considered, it showed that the exports of refined petroleum products are high when the exports take place in a COMESA country, while the highest exports of non metallic mineral products are in CEFTA country. APTA countries showed the highest exports for iron and steel products. It is important to note that in all these three industries, the exports of the countries related to NAFTA trade group were the lowest.

The geographical distance coefficient was negative implying reduced trade due the increase of transportation costs as the distance increases. The coefficient values obtained for the all six dirty industries proved that the distance has a significant impact on dirty industry exports.

In pollution intensive manufacturing industry exports, country's population plays a vital role. This was proved by both exporter and importer population being significant. Population of the exporting country showed a positive impact on bilateral trade flows which indicate that, higher the population, higher the production and exports as a result. The coefficient for the importing country's population was positive, implying that higher demand will occur as the population increases, which enhance impots. GDP which reflects the country's export or import demand conditions

was positive in both exporter and importer as expected. Results revealed that both exporting and importing country's GDP have a significant impact in polluting industry exports. The common border dummy was positive in all estimations.

CONCLUSIONS

This study examined the impact of environmental regulations in a country on bilateral dirty industry exports in relation to 100 countries of the world from 2000-2004. The relationship between environmental stringency and dirty industry exports were empirically analyzed, by estimating a gravity model augmented with an EPI. Also, the exports of some of the country groups were studied by employing dummy variables.

The research found that environmental stringency variables are important determinants and they are having a negative relationship with the exports of some industries: refined petroleum products (ISIC 353), non metallic mineral products (ISIC 369) and iron and steel (ISIC 371). Further, it highlighted that high income countries export less with compared to low income countries in above industries. Moreover, the countries related to COMESA, CEFTA and APTA trading groups showed significantly high exports of these industries during this period. Therefore, a support for the existence of a pollution haven effect in low income developing countries was identified in the period under study (2000-2004), for the exports of refined petroleum products, non metallic mineral products and iron and steel, when the EPI was used as the proxy for stringent environmental regulations.

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