AIR POLLUTION AND IMPORTS OF ENVIRONMENTAL GOODS IN OECD COUNTRIES

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Abstract

The treatment of environmental issues in economics is in two basic spheres, namely, growth and trade. Interest in the relationship between international trade and the environment may be traced back to the Stockholm Conference in 1972. Regarding the relationship between economic growth and the environment, sustainable development became one of the key issues in the agenda of developed and developing countries since the 1992 Rio de Janeiro Summit. The present study concentrates on the impacts of environmental goods imports on environmental degradation and/or improvement. We make use of the Environmental Kuznets Curve (EKC) and some other factors as control variables and explore the effect on air pollution of the changes in the share of environmental goods in total imports. We carry out the empirical study for 34 OECD countries during the period covering 1996-2009. We find that an increase in the ratio of environmental goods imports in the total reduces air pollution significantly.

Introduction

As a result of increased public awareness on actual and potential problems of global and local environmental issues such as climate change, air pollution, and hazardous waste towards the end of the 20th century, environmentalists drew attention to the role of economics as the root cause of these problems. National and international environmental policies towards sustainable development and the role of organizations, international institutions and non-governmental organizations such as UNFCCC (United Nations Framework Convention on Climate Change), US EPA (United States Environmental Protection Agency), EEA (European Environment Agency), UNEP (United Nations Environmental Programme), WWF (World

Wildlife Fund), and WWI (WorldWatch Institute) or Oxfam is keeping this interest at a high level.

Economic literature concerning the interaction between economic and environmental issues broadly developed around two major areas, one concerning the impact of economic growth and the other concerning the impact of trade on the environment. Since economic growth and trade are closely linked, economic literature developed along these two broad issues has many common areas.

The Environmental Kuznets Curve (EKC) is a commonly used framework in the said literature and aims to capture the relationship between per capita income and environmental performance. In its original formulation, the EKG has an inverted U-shape and sums up the effects of different processes which are not totally clear to economists. Among the factors that lead to improved or deteriorating environmental performances are the changes in production and growth, preferences and trade. On the other hand, there is another body of literature on the effects of international trade on the environment. While some studies emphasize the positive effects of trade on the environment, there are studies that draw attention to the trade related issues that have detrimental effects on the environment..

In this paper, we examine the relationship between trade and environmental performances of OECD countries. Our starting premise is that when a country becomes more integrated with the world economy, its exports become more responsive to environmental requirements imposed by importers. The country in concern has to use environmentally friendly inputs for exports which are domestically acquired and/or imported. In the present study we focus on the imports of environmental goods and hypothesize that when a country imports more environmental goods, its environmental outcomes will improve. The impact of emissions related to the production of imports, although significant, is left outside the scope of the present study.

The paper has three parts. In the first part, the study reviews theoretical and some selected empirical studies with respect of the relationship between growth, trade and environmental performances. In the second part, the hypothesis of the negative relationship between imports of environmental goods and environmental performances in OECD countries is tested using some control variables such as population density, agricultural and manufacturing value added as a share of GDP. The model employed allows us to test a certain formulation of the

Environmental Kuznets Curve hypothesis. Finally the last part summarizes and draws conclusions from the empirical analysis.

1. International Trade, Growth and the Environment

1.1 Overview of the Linkages among Growth, Trade and the Environment

On the relationship between economic growth and the environment, the large literature is divided into two approaches. One approach presents the positive effects of economic growth on the environment while the other shows the negative effects, both using theoretical and empirical evidences. Despite this large literature, this relationship as a whole remains in question as there are still some evidences which show opposite results of previous studies. In general, the literature on this relationship has centered on the Environmental Kuznets Curve (EKC). After Simon Kuznets who first observed that there is an inverse U-shaped relationship between income and inequality a large number of studies have started to find evidence in favor of a similar relationship between income and environmental degradation (Cole et al., 1997; Frankel & Rose, 2002; Stern, 2003; He, 2003; Muhammad et al., 2010). They argue that growth increases the environmental degradation at low levels of income, but when income grows, environmental awareness and the demand for better environment increase. Higher income levels encourage the production of less polluting environmental goods, services and technologies. Therefore, an inverse U-shaped relationship between income and environmental performances is observed during the development period of a country. Within the EKC framework, a number of studies have emphasized different parameters such as income elasticity of demand, technological constraints of production, consumer preferences and circumstances, etc.

In assessing the environmental effects of NAFTA, Grossman and Krueger (1991, 1995), identify three effects which serve as the basis for the analysis of the effects of economic change on the environment: scale effect, composition effect and technical effect. The scale effect refers to the positive relationship between economic activity and GHG emissions and points to the detrimental effects of growth on the environment. The composition effect explains the impact of changing production or demand structure on emissions and can be in either direction. The technical effect is due to the development and choice of cleaner technologies and lowers GHGs emissions. Although the EKC is empirically observed in many studies, the existing literature shows no certain agreement on the validity of EKC due to the existence of proper data problems, limitations of econometric techniques and characteristics of different environmental indicators (Roberts & Grimes, 1997; Vincent, 1997; de Bruyn et al., 1998).

Regarding the effects of international trade on the environment, some argue that the gains from trade contribute to economic growth and higher income which will in turn increase environmental performance and thus lead sustainable development. Consequently, trade seems to provide an important channel for the diffusion of many goods and technologies which can move economies onto a more sustainable path.

Another strand of literature, however, points to trade liberalization as the most dangerous development towards the environment. Since trade liberalization implies a growing trade volume and hence a higher level of production of goods, one would expect to have higher pollution levels and pressure on natural resources. The environmentalists advocate that trade liberalization accelerates unplanned production and unconscious consumption that cause environmental degradation. They also argue that trade liberalization leads to the international distribution of polluting dirty industries from developed economies to developing countries which is called as the "pollution havens" argument.

The pro-trade community emphasizes the benefits of trade which provides increased funding to improved environmental management and policy reform through enhancing economic development (Daly, 1993; French, 1993; Dean, 1997). In the framework of comparative advantage, specialization brings efficiency and this efficiency contributes to a better environment. The pro-trade argument is one explanation for the shape of the EKC.

Trade liberalization, which is regarded as another complementary part of this discussion, suggests eliminating or reducing trade barriers for the sake of good environment. For example Dean (1997) found that the trade liberalization raises the growth income and it has a negative and significant effect on emissions growth. On the other hand, the study of International Centre for Trade and Sustainable Development (ICTSD) emphasizes the impact of trade liberalization through the trade of environmental goods. According to the organization's 2008 study, "*…trade liberalization and carefully managed market opening in the sector of environmental goods can also be a powerful tool for economic development by generating economic growth and employment and enabling the transfer of valuable skills, technology and knowhow embedded in such goods and services*" (ICTSD, 2008). ICTSD concludes that trade liberalization drives the prices of environmental goods to levels of world market prices, therefore making these goods and services more affordable to economic actors and bringing environmental costs down.

However, in the same framework of standard trade theory, some environmentalist and economists argue that if environmental costs incorporate into the price of goods then exports and imports decrease while the local production of environmentally friendly goods increase (Walter, 1974). On the other hand, trade liberalization by increasing the economic growth rate without environmental provisions causes greater demand for all kind of resources and production of materials therefore this huge demand increases environmental degradation, especially in low-income developing countries. Concerning effects of international competitiveness, it is observed that some developing countries specialize in dirtier activities and the production of environmentally harmful goods in order to achieve competitive advantage. At this point, even some economists from trade community have pointed that "*trade liberalization lowers the pollution level in the North* (mostly it refers OECD countries) *but increases the pollution level in the South and increases worldwide pollution*" (Copeland and Taylor, 1994). In another study, Lopez found that complete trade liberalization causes a reduction of the biomass with the consequent fall of the conventional factors in agriculture and deforestation in Ghana (Lopez, 1997:30). He emphasized that the negative income effect of greater biomass losses is likely to more than off-set the positive income effect of reducing trade distortions (Lopez, 1997:31). Environmental degradation is not resulting only from the production and using resources, at the same time trade liberalization increases transportation of these goods and services thus it is also responsible for air pollution. For instance, according to Environmental Protection Agency of the United States, because of their reliance on petroleum-based fuels, air and sea transport are responsible for significant emissions of greenhouse gases such as sulfur oxides (SO_x), nitrogen oxides (NO_x) and carbon dioxide (CO_2)[1].

1.2 Definition of Environmental Goods and Services (EGS)

There are several approaches to identify the EGS. Since the Doha meeting called for a reduction or elimination of tariffs and non-tariff barriers on environmental goods and services, the definition of EGS has become more important for trade liberalization. From the beginning of 1990, OECD/Eurostat Informal Working Group has met several times to discuss the definition of the environmental goods and services. In a similar way, in the framework of the

[1] http://www.epa.gov/international/trade/transport.html#growth (20.07.2012)

WTO the Group of Experts on Trade and Environment (GETE) has also worked on it and classified EGS into six broad categories. In 2007, the Friends of Environmental Goods has presented another list which includes 153 products under 12 headings.[2] The discussion is based on whether some environmentally friendly goods are included or not. Especially developing countries are concerned about their import-competitive products and their production pattern which have a loose link to environmental protection. Some environmental standards may not be appropriate for their products or production technologies; therefore they are suspicious of the debates on definition. Today the agreed definition from OECD (Organization for Economic Co-operation and Development) is[3]:

"The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimize pollution and resource use".

On the other hand, APEC (Asia-Pacific Co-operation) has also prepared another list of EGS which serves for using in the negotiations on reduction of tariffs. They identified their list from the above OECD definition of environmental industry. Whatever we choose, OECD and APEC lists are favorable for developed countries which have more ready to compete in EGS market than developing countries.

When we compare these two well-known lists, the OECD list seems a 50% longer than the APEC list. However, at the 6-digit level they have very similar number of codes; the OECD list has 132 HS codes while there are 104 codes in the APEC list. In this study we use OECD list which identify only those goods that could be considered "environmental".[4] The OECD product list of environmental goods is divided into three broad headings: Pollution Management Group (which has 7 sub-parts), Group of Cleaner Technologies and Products (which has 2 sub-parts) and Resource Management Group (which has 10 sub-parts). The first group is the easiest group for collecting and identifying statistics while the last group is still in the development stage.

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[2] See detailed list in appendix 1.

[3] OECD (1999) The Environmental Goods and Services Industry. Manual for Dta Collection and Analysis, http://unstats.un.org/unsd/envaccounting/ceea/archive/EPEA/EnvIndustry_Manual_for_data_collection.PDF (14.07.2012)

[4] Ronald Steenblik (2005) "Environmental Goods: A Comparison of the APEC and OECD Lists", OECD Trade and Environment Working Paper No. 2005-04, p.6 www.ocde.fr/data**oecd**/44/3/35837840.pdf (20.07.2012)

Those products listed in even OECD or APEC list have dual or several uses, in other words they are not exclusively environmental; these goods are used for environmental and non-environmental purposes. This situation is called as “dual use” problem. However, the literature mostly agrees on all related goods under a 6-digit HS codes regardless of non-environmental uses.

2. Methodology and Data

2.1 Econometric Model and Estimation

In order to determine the effectiveness of environmental goods imports on the environment, and capture the scale, composition and technical effects we employ the following structural model:

$$P = f(Y, E, Z) \qquad (1)$$

where, P is the air pollution indicator, Y is income level (scale effect), E is imports of environmental goods (technical effect) and Z is a vector that includes other control variables (composition effect). We hypothesize that the imports of environmental goods reduce air pollution, implying that, everything else equal; we expect a negative coefficient for the technical effect. Following the wide literature on ecological economics, in order to test this hypothesis we begin by defining the following econometric model:

$$(P/N)_{it} = \alpha_i + \gamma_t + \beta_1 (Y/N)_{it} + \beta_2 (Y/N)^2_{it} + \beta_3 (Y/N)^3_{it} + \beta_4 (E/M)_{it} + \sum_{i=5}^{k} \beta_i z_{it} + \varepsilon_{it} \qquad (2)$$

where N is population, M is country’s total imports of goods and services. We employ the panel technique and estimate this equation using both random and fixed effect models. Since a short panel dataset is employed we do not use any time series techniques such as panel unit root and cointegration tests. In equation (1) above, α_i are country specific intercepts, γ_t are time specific intercepts and ε_{it} is the idiosyncratic error term allowed to be heterescedastic and autocorrelated.

In the ecological economics literature, several variables are considered to be determinants of air pollution. These include some geographic, demographic and/or sectoral factors, such as human capital, population density and/or urbanization indicators (Grossman and Krueger, 1991; Gangadharan and Valenzuela, 2001), some variables indicating the sectoral specialization of country, namely manufacturing value added of GDP (Suri and Chapman, 1998).

In this paper we first estimate the air pollution equation without any control variables except the per capita income, income squared and income cubed. After that as robustness check we control the effect of other variables. These are population density (*POP*), manufacturing value added as a share of GDP (*MVA*). For complementarity we also add the agriculture value added as a share of GDP (*AVA*). Since we use fixed effects estimators we do not add naturally-time invariant geographic factors to the regressions. We also estimate the models with various human capital indicators (primary and secondary school enrollment ratios) but since they are insignificant, we do not report these results here.

Regarding the relationship between income and pollution, we employ a cubic form to test the existence of an EKC. The cubic form represents N-shaped EKC, meaning per capita pollution first increases at low levels of income and then decreases with rising income, but after a certain level of income it increases again. The expected signs for the estimated coefficients are β_2, $\beta_4 < 0$ and β_1, $\beta_3 > 0$ meanwhile expected signs for the coefficients of our control variables are positive for *POP* and *MVA/Y* but negative for *AVA/Y*.

2.2 Data

Out dataset contains 8 variables for 34 OECD countries between the years 1996 and 2009. Data is collected from several sources. We employ two air pollution indicators, namely 1,000 CO_2 tones per capita and total greenhouse gas emissions (1,000 tones of CO_2 equivalent) per capita. While CO_2 emission is the most used air pollution indicator in the ecological economics literature, total greenhouse gases (GHGs) emission is a more general variable measuring the air pollution. This indicator is the total emission of gases methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and carbon dioxide. These indicators are obtained from OECD database but per capita values are not available in this database. Therefore emissions are divided by the population of the country to obtain per capita emissions. The population data, real per capita income levels ($1,000, with base year 2000), agriculture and manufacturing value added (as a share of GDP) series are collected from World Bank WDI dataset. Finally, environmental goods imports are the total import values of the goods appeared in OECD environmental goods list (Steenblik, 2005: Table A1).

We collected this data from UN Comtrade database and these magnitudes appear in our regressions as a share of total imports of goods and services. This total imports data is again obtained from WDI.

3. Empirical Results

In this section we present estimates from our model using two separate air pollution indicators as dependent variables. In each table the first two columns represent the effects of independent variables on per capita CO_2 emissions and the last two columns represents the same variables' effects on total greenhouse gas emissions per capita. The first and third columns show the fixed effects estimation results while the second and fourth columns show the results of random effects estimation. In the method of fixed effects, each country is assumed to have its own intercept, while the slope coefficients are common to all countries. In many applied papers researchers begin with an assumption of random or fixed effects or use Hausman specification test to choose one of the estimators. Since we use robust standard errors in all regression estimations we do not report the Hausman test statistics. As seen below, random and fixed effects estimation results are very close to each other so we do not report any specification test result.

Table 1. Basic Regression Model Results

	CO_2		GHG	
Y/N	0.7553*** (0.1795)	0.7108*** (0.1640)	0.8751*** (0.1802)	0.8708*** (0.1681)
(Y/N)^2	-0.0210*** (0.0051)	-0.0202*** (0.0049)	-0.0272*** (0.0055)	-0.0272*** (0.0055)
(Y/N)^3	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0003*** (0.0000)
E/M	-0.1713** (0.0755)	-0.1706** (0.0757)	-0.1518* (0.0803)	-0.1518* (0.0797)
Constant		3.9068** (1.5799)		5.7632*** (1.5878)
Within R^2	0.35	0.35	0.39	0.39
Between R^2	0.28	0.29	0.25	0.25
Overall R^2	0.24	0.24	0.21	0.21
Year Fixed Effects Test	8.61 (0.00)	108.51 (0.00)	10.30 (0.00)	133.94 (0.00)
N (NT)	34 (447)	34 (447)	34 (447)	34 (447)

Note: Robust standard errors are given in parentheses under parameter estimates. The values in parantheses under the year fixed effects significance test are p-values of F and Chi-square tests for fixed and random effects models respectively. Significance at the 90%, 95% and 99% confidence levels are indicated by *, **, *** respectively. Dependent variables are CO_2 and GHGs emissions (1,000 tones per capita).

Basic regression results can be seen in Table 1. In all regressions the sign of the coefficient *E/M* is negative as expected. Estimated coefficients in fixed and random effects models are quite close to each other in both CO_2 and GHG regressions.

From Table 1 we also observe evidence for the existence of the environmental Kuznets curve. The coefficients of GDP per capita, its square and cube indicate an N-shaped relationship, which is consistent with several other studies. That means as per capita income grows air pollution increases in low levels of income then the relation becomes negative and pollution falls with rising income. Finally the relation becomes positive after a certain level of income again. The existence of an N-shaped EKC, however, is not the essential issue of our study. Our central issue is rather the effect of imports of environmental goods on air pollution. In other words, we investigate whether countries which import more environmental goods, through the technical effect, can reduce environmental degradation or not. In all the regression results reported, the sign of *E/M* is negative and statistically significant which shows the imports of environmental goods reduce the air pollution even represented by CO_2 tones per capita or total greenhouse gas emissions per capita. A one percentage point increase in *E/M* decreases emissions of per capita CO_2 and GHG emissions by approximately 170 and 150 tonnes respectively.

Table 2. Results of Regression Model with Additional Control Variables

	CO_2		GHG	
Y/N	0.6147*** (0.1714)	0.5819*** (0.1635)	0.7182*** (0.1936)	0.7352*** (0.1834)
$(Y/N)^2$	-0.0154*** (0.0048)	-0.0151*** (0.0048)	-0.0211*** (0.0057)	-0.0216*** (0.0056)
$(Y/N)^3$	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)
POP	0.0194* (0.0105)	0.0025 (0.0053)	0.0048 (0.0176)	-0.0046 0.0080
AVA/Y	-0.0981 (0.771)	-0.1077 (0.0756)	-0.1090 (0.1090)	-0.1117 (0.1087)
MVA/Y	0.0703* (0.0367)	0.0612* (0.0369)	0.1145** (0.0477)	0.1072** (0.0491)
E/M	-0.1844**	-0.1847**	-0.1909**	-0.1908**

	(0.0818)	(0.0804)	(0.0892)	(0.0875)
Constant		3.8854** (1.8336)		5.8690 (2.2251)
Within R^2	0.33	0.32	0.38	0.37
Between R^2	0.13	0.27	0.15	0.26
Overall R^2	0.09	0.22	0.12	0.22
Year Fixed Effects Test	13.07 (0.00)	158.36 (0.00)	11.04 (0.00)	154.28 (0.00)
N (NT)	32 (416)	32 (416)	32 (416)	32 (416)

Note: see note under Table 1

Table 2 shows the effects of other control variables. From these results we can also check the validity of the composition effect. All the estimated coefficients have the expected signs. However very few parameters of additional variables are statistically significant. The coefficient of *MVA/Y* is positive and statistically significant, implying that the higher the share of manufacturing, the higher the level of air pollution. The coefficient of *AVA/Y* is negative, as expected, but statistically insignificant in all cases. The estimated coefficient of population density has a positive sign. The fact that the coefficients of all these additional control variables are small, indicates that the inclusion of composition variables and population density does not have a considerable effect on air pollution. This implies either that these proxies are not suitable for composition effects or that the technical effects are relatively strong. We should, however, note that when these additional control variables were taken into consideration, the coefficient of *E/M* increased in absolute terms.

Due to data limitations, Greece and Israel are excluded from the expanded model. For comparison purposes, we also estimate the basic model excluding these countries. The results are presented in Table 3.

Tablo 3. Basic Regression Model Results (Greece and Israel Excluded)

	CO_2		GG	
Y/N	0.7201*** (0.1854)	0.6810*** (0.1665)	0.8505*** (0.1900)	0.8507*** (0.1750)
$(Y/N)^2$	-0.0201*** (0.0051)	-0.0194*** (0.0049)	-0.0266*** (0.0056)	-0.0266*** (0.0056)
$(Y/N)^3$	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)
E/M	-0.1597** (0.0739)	-0.1587** (0.0738)	-0.1437* (0.0799)	-0.1434* (0.0793)

Constant		4.1953*** (1.6091)		6.0508*** (1.6565)
Within R^2	0.35	0.35	0.39	0.39
Between R^2	0.29	0.29	0.25	0.25
Overall R^2	0.24	0.25	0.21	0.22
Year Fixed Effects Test	8.90 (0.00)	113.79 (0.00)	11.12 (0.00)	145.39 (0.00)
N (NT)	32 (427)	32 (427)	32 (427)	32 (427)

Note: see note under Table 1

Our previous interpretation about N-shaped environmental Kuznets curve retains its validity for this sample as well, although the coefficients of *E/M* are lowered in this case but nevertheless statistically significant.

Conclusion

The present study is based on the various aspects on the literature exploring the linkages between growth, trade and environmental outcomes. An EKC framework is set up to explore the effects of per capita income changes on two environmental indicators, namely, CO_2 emissions per capita and GHGs emissions per capita. A cubic functional form is used. The econometric results presented in this study point to the existence of an N-shaped EKC for the 34 OECD countries during 1996-2009. The main thrust of the study is the inclusion of a variable, (*E/M*), representing the imports of environmental goods in total imports. In addition to our basic model, we used additional control variables, namely, agricultural value added as a share of GDP (*AVA/Y*), manufacturing value added as a share of GDP (*MVA/Y*) and population density (*POP*).Our empirical results in both of the estimations support our hypothesis that increased imports of environmental goods and services are accompanied by decreasing levels of per capita emissions.

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Appendix 1. Broad Category of Different Lists of Environmental Goods

OECD List	APEC List	Friends of EGs
A. POLLUTION MANAGEMENT 1. Air pollution control 2. Wastewater management 3. Solid waste management 4. Remediation and cleanup 5. Noise and vibration abatement 6. Environmental monitoring, analysis and assessment B. CLEANER TECHNOLOGIES AND PRODUCTS 1. Cleaner/resource efficient technologies and processes 2. Cleaner/resource efficient products C. RESOURCES MANAGEMENT GROUP 1. Indoor air pollution 2. Water supply 3. Recycle materials 4. Renewable energy plant 5. Heat/energy savings and management 6. Sustainable agriculture and fisheries 7. Sustainable forestry 8. Natural risk management 9. Eco-tourism 10. Other	1. Air pollution control 2. Wastewater management 3. Solid/hazardous waste management 4. Remediation/clean-up of soil 5. Noise/vibration abatement 6. Monitoring, analysis and assessment 7. Potable water treatment 8. Recycling systems 9. Renewable energy plant 10. Heat and energy management	1. Air pollution control 2. Management of solid and hazardous waste and recycling system 3. Clean up or remediation of soil and water 4. Renewable energy plant 5. Heat and energy management 6. Wastewater management and potable water treatment 7. Environmentally preferable products, based on end use or disposable characteristics 8. Cleaner or more resource efficient technologies and products 9. Natural risk management 10. Natural resources protection 11. Noise and vibration abatement 12. Environmental monitoring, analysis and assessment equipment

Source*: WT/CTE/W/228; TN/TE/W/33; WTO 2007*.3 from UNDP (2010) Trade Negotiations on Environmental Goods and Services in the LDC Context, p.20 Table 4