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Degree of Environmental Stringency and Impact on Trade Patterns

Selim Cagatay and Hakan Mihci*

1. Introduction

The literature on the relationship between trade liberalization and the environment is rapidly growing since the beginning of the 1970s. International trade is becoming an increasingly critical driver of economic development, and a growing number of developing countries consider trade and investment as a central part of their development strategies. The links between trade and environment are multiple, complex and important. The extent to which environmental problems might affect many facets of trade, or vice versa, has been the subject of considerable debate over these years. At the most fundamental level, trade and environment are related because economic activities and particularly production is based on environment, as such: the environment provides the basis for all essential inputs and the energy needed to process them as well as the capacity to absorb the produced waste. At another level, environment and trade represent two distinct bodies of international law. While international environmental law increasingly defines how countries will structure their economic activities, international trade law increasingly determines how countries should make their domestic laws and policies in areas such as intellectual property rights, investment policy and environmental protection.

In a world of augmenting economic activity induced by international trade, it is argued that environmental degradation will be accelerated unless environment is protected taking the necessary measures both at domestic and international borders. Since the early 1990s, after the implementation of various regulatory multinational agreements, discussions concerning the effects of changing environmental policies on production technology, international trade patterns and investment flows have been increasingly growing. One particular focus of attention has been the issue of whether

* Both authors are in the Department of Economics of Hacettepe University, Ankara, Turkey. Contact e-mails are: selim@hacettepe.edu.tr; hakan@hacettepe.edu.tr.

environmental regulations are influencing patterns of international trade. If the degree of stringency of environmental regulations vary across countries, then the differences in the environment-related costs for firms may be sufficient to have an effect on international competitiveness and on countries' export and import patterns.

The differences in the degree of stringency in a wide variety of countries from various development categories, have brought the hypotheses of "pollution havens", "industrial flight" and "race to the bottom" again into the research agenda. For instance, there has been speculation that developing countries may possess a comparative advantage in pollution intensive production as the stringency of such regulations increase with economic development. This 'pollution haven hypothesis' may also manifest itself in the form of dirty industries relocating from developed to developing countries (industrial flight hypothesis). These hypotheses suggest that, with the trade liberalization, the activities of the countries seeking to increase their share in the global markets cause a race to the bottom in the environmental standards which they consider to be incentive-creating for international capital flows and to change investment patterns. Nevertheless, both theoretical and quantitative analyses regarding the effects of environmental regulations on competitiveness and location decision are needed in order to be able to derive some policy recommendations.

The theoretical analyses of these linkages were presented in the context of traditional and new trade theories and also in the context of Kuznets effect. However, empirical evidence of the linkages between trade, environment and development is less convincing. Overall, the results from the empirical research are mixed which is mostly due to the intensity and type of environmental measures that vary across issues and countries. Furthermore, data availability and the absence of direct measures of environmental stringency appear to be the other major factors behind the lack of empirical information on the trade, development and environment linkages. In this respect, the literature on the measurement of environmental pollution and efforts of economic agents to improve environmental quality, and also on the analyses of economic linkages between environmental sensitivity levels and international trade and development patterns, does not seem to provide sufficient information on a cross-country single quantitative tool that can be employed in empirical models.

Based on these considerations, the aim of this paper is twofold. Firstly, an index (Index of Environmental Sensitivity Performance-IESP) which is constructed depending on the pressure, state and response environmental indicator framework of

the OECD and which is used to measure the environmental stringency of various developing and developed countries is introduced. Secondly, the index is used in a cross-country trade model in order to analyze the effect of various degrees of environmental stringency on the trade patterns, and especially on the export performance of developed and developing countries. The main focus of the IESP is industry based environmental pollution and the econometric analysis concentrates on the most polluting industries.

The remainder of this paper is organized as follows. The following section analyzes the linkages between environmental regulations, international trade and development. After reviewing the previous approaches attempting to measure environmental stringency performance of the countries, section 3 presents IESP which will be used to investigate the effects of various degrees of environmental stringency on the export performance of the developed and developing countries in section 4. As usual, the last section elaborates the main findings of the current study.

2. Environmental Regulations, International Trade and Development

With the integrating world economy and associated reduction in the tariff barriers to trade, environmental concerns have become one way of restricting trade with either 'real' environmentalist or protectionist purposes. Therefore, it can be argued that countries may use environmental policies for protectionist purposes rather than targeting environmental objectives (Panayotou, 1999). In other words, countries may hide behind environmental concerns to protect domestic industries and the environment-related trade barriers, in that case, may not reflect true motives.

Low and Safadi (1992) indicate that the satisfaction of protectionist economic demands on environmental grounds never guarantees effective action to protect environment and welfare costs of restricting trade represents a net national loss. Frankel (2002) also argues that putting trade barriers in such a manner will result in lower levels of growth in trade and income without a better environmental quality.

However, it is difficult to assess whether specific trade restrictions have protectionist purposes behind. One country may restrict trade on real environmental grounds, while another country may interpret this restriction as "green protectionism". To make a meaningful assessment, Fontagné et al. (2001) suggest that when a sizeable proportion of international trade is affected by such regulations, it implies a wide consensus on the negative environmental impacts of the product that is subject

to regulation. If a single country or a limited number of countries enforce barriers to trade on environmental grounds, it is more likely that this is non-tariff barrier to trade.

In fact, trade has broad implications not only for environment, but also for real income, output, employment, economic growth and development, which in turn have bearings on structural change and adjustment. The complex interactions between economic development, international trade and environment address various issues such as: economic development and its environmental consequences; effects of international trade on economic development and related environmental impact; and impacts of environmental regulations on economic development and patterns of trade. In this section, the linkages between environmental regulations, trade and economic development is investigated both from theoretical and empirical perspectives.

2.1. Environmental Regulations and Competitiveness

The theory of comparative advantage states that with trade liberalization, countries specialize in the production and export of goods in which they have comparative advantage (i.e. the goods they make relatively well due to resource endowments or other factors). In theoretical trade models, the environment is usually treated as a third factor of production besides labor and capital, and a country is said to have comparative advantage in pollution-intensive goods if it is relatively well-endowed in terms of environmental resources.¹ Obviously, this country will specialize more in the production of pollution-intensive goods compared to other countries having identical production, pollution and abatement functions for these goods, because it will have price advantage to do so (Dean, 1992).

Depending on this theoretical background, it has been argued that, the environmental regulations impose costs on the producers removing their price advantage and putting them at a disadvantageous position in international competition especially when competitors from other countries do not face with similar regulations or if they receive government help to compensate their rising costs (Palmer et al., 1995; Pearson, 1982; U.S. Congress, OTA, 1992). A decrease in the productivity growth of regulated sectors can also be expected with the deterioration of the comparative advantage in the long run (Jaffe et al., 1995).

¹ For example, the country may have relatively large absorption capacity that is more able to tolerate pollutants than other countries.

To be more specific, the emphasis can be given to different types of environmental regulations. Product standards and process and production methods imply trade restriction when the producers are not met the necessary requirements. If, for example, a foreign supplier faces with an additional tax or tariff in the export market because it has been determined by the importing country that the production process is polluting or that the product itself does not meet the requirements to be an “environment-friendly product”; it will be costly to shift to a less polluting process as it necessitates financial and technological resources to do so (Eglin, 1995). The higher costs associated with production will be reflected by higher prices and foreign supplier will be in a disadvantageous position in international competition.

Eco-labeling and certification schemes are also potential sources of trade friction as they increase cost of production by imposing fees and standards especially in developing countries (Beghin, 2000). Labels can be regarded as causing non-tariff barriers to trade if i) the criteria on which they are given are not based on objective considerations or do not take into account the production processes in other countries; ii) procedures are so strict for an outsider making practically impossible to obtain the label; iii) the system is adopted for a product that is imported and the right to grant a label rests with the importing country (Markandya, 1999).

For intellectual property rights, complying with TRIPS imposes significant social and financial costs through higher prices due to payments of royalties and industry concentration (Panayotou, 1999).

On the other hand, Porter Hypothesis states that environmental regulations may lead to increased competitiveness. This hypothesis predicts that tightening of environmental regulations stimulates technological innovation having positive effects on the economy and environment. In some cases, a firm may be unaware of production strategies to lower costs, and environmental regulations may push the firm to adopt such strategies and reduce the costs increasing its competitiveness (Margolis, 2002).

In an attempt to clarify this hypothesis, Frankel (2002) indicates that if the world is moving toward more environment-friendly products in the future, then the countries innovating technologies of this sort will be in an advantageous position among other countries. Similarly, Johnstone (1999) mentions two cases that the Porter hypothesis may arise: the first is that regulations may allow firms to make investments considering their long-run returns without losing the domestic share,

since investments may involve high initial costs but have cost-reducing opportunities in the long-run, and the second case is that adherence to some regulations may allow firms to differentiate their products and capture the market.

Empirical literature on the international competitiveness effects of environmental regulations is quite large and mixed. Siebert (1977, 1974), Pethig (1976), McGuire (1982), Kalt (1988), Krutilla (1991), OECD (1993) and Ratnayake (1999) found that environmental stringency weakens a country's competitive position in pollution intensive industries and diminish exports. However, Robison (1988) showed that a 1 per cent increase in environmental cost would reduce the US balance of trade by \$6.5 billion during 1982. As to Tobey (1990), stringency of environmental controls fails to contribute net exports of the five most pollution intensive commodities in 23 countries. Similarly, Walter (1974) and Leonard (1988) found no quantitative evidence for the claim that pollution costs have influenced the location decisions of multinational firms. Also, Markusen (1997) showed that stringent environmental regulations do not give the multinational companies significant incentive either to increase production or to relocate. Ulph and Valentini (1997), however, demonstrated that under certain circumstances, environmental regulations might affect relocation of industries between countries.

2.2. Migration of 'Dirty' Industries

The change in comparative advantage suggests variations in potential trade flows and industrial location (Duerkson and Leonard, 1980; Walter, 1982; Siebert, 1992; Levinson, 1996). The question is how differences in environmental regulations influence "industrial flight" of dirty industries. Some researchers argue that under certain circumstances dirty industries shift their operations to developing countries where the environmental standards are laxer compared to developed countries (Dean, 1992; Copeland and Taylor, 1995).

The main motive underlying the relocation decision is related to production costs. Tightening of environmental standards will raise the cost of using the environment as an input to the production and the laxer controls in developing world will attract these pollution intensive industries by creating cost advantages.

Empirical findings, however, are unable to support this claim. Birdsall and Wheeler (1992) found that dirty industries developed faster in relatively closed economies than in the open ones. Low and Yeats (1992) showed that developed

countries have a stronger tendency to develop revealed comparative advantage in polluting, as opposed to non-polluting industries. Beghin and Potier (1997) used empirical results to argue that trade liberalization will not cause the developing countries to specialize in dirty industries. Lucas et al. (1992) showed that stricter environmental regulations did not discourage investment given their insignificant contribution to the production cost. Similarly, Ulph (1999) indicated that the impact of environmental regulations in determining the location of polluting industries has been small due to the fact that costs of meeting environmental regulations do not constitute a significant part of total costs of production. Other industrial location studies (Walter, 1975; Pearson, 1985, 1987; Leonard, 1988) found little evidence that pollution control measures had an impact on trade and investment.

Therefore, in choosing where to locate production, it can be argued that firms consider many factors besides environmental regulations, such as size of the local market, the quality of the labor force, the available infrastructure and political instability.

2.3. Eco-dumping and Race to the Bottom Hypotheses

Environmentalists ardently argue that trade liberalization brings together the expansion of production, consumption and transport of goods causing further environmental degradation, and then makes governments more concerned about their market share leading them not to give environmental issues the required priority (Sturm and Ulph, 2002).

Environmental dumping or eco-dumping refers to the case in which governments set weaker environmental standards than what is needed to compensate the environmental damage considering trade and its priorities as important. To put differently, environmental standards are set such that the result does not meet optimality conditions.² That is, environmental dumping occurs when governments set marginal abatement costs below marginal damage costs.

In an open economy, industrialists who are concerned about competition from abroad fear that they will lose their competitiveness against foreign firms when domestic regulations increase their costs resulting in loss of sales, employment and

² In case of local pollution in a closed economy with perfect competition, optimality requires that marginal abatement costs are equal to marginal damage. If the optimal policy in a trading economy is laxer than this requirement, the country is said to engage in environmental dumping (Sturm 2000).

investment. Under these circumstances, domestic producers apply pressure on their governments to weaken the burden of regulation (Frankel, 2002). In such a case, environmental dumping is said to occur as a result of marginal abatement costs being set below the marginal damage costs, without compensating from the damage given to the environment.

Race to the bottom hypothesis states that, if the process described above continues to work, environmental standards will decline over time below socially acceptable levels as countries weaken regulations for competitive purposes and the equilibrium will be a world of little or no regulation under the pressures of international competition (Klevorick, 1996; Wilson, 1996).

However, empirical evidence for such a race is not strong. Bhagwati (2000) explains the reason for empirical evidence not to support this hypothesis by underlying two facts: i) Multinational corporations do not seem to lower environmental standards for a variety of reasons³, and ii) the evidence that poor countries lower environmental regulations to attract these companies is not reasonable when democratic countries are involved. Instead, the competition to attract foreign capital is through taxation. Democratic countries will rarely encourage activities to pollute freely as a way of getting competitive power.

Beghin (2000) considers the emergence of a race to the bottom as theoretically possible particularly when political and regulatory environments are not transparent and can be captured by dirty-industry interests.⁴ Lack of representation of the population in the political process, constraints on tax instruments and lack of transparency are seen among the factors fostering the emergence of a race to the bottom. However, he also notes that there is little evidence for such an emergence.

2.4. Pollution Havens Hypothesis

As it is mentioned earlier, with trade liberalization, industrial structure of a country shifts in line with its comparative advantage causing it producing and trading the goods it makes relatively well in the absence of market and policy failures. Comparative advantage of a country can be determined by its endowments of capital

³ The detailed discussion on the reasons can be found in Bhagwati and Srinivasan (1996).

⁴ Margolis (2002) argues that as the governments in real life are not ideal, imperfections of the governments may also lead a race to the bottom. Politicians, considering only their short-term benefits, may not predict the long-term environmental damage of the imported industries or technologies causing the environmental costs spread among the whole population.

and labor as well as endowments of natural resources. The idea under the pollution havens hypothesis is that comparative advantage can also be determined by differences in environmental regulations among countries which may be created by differences in demand and supply conditions of environmental quality.

When countries open their economies to international trade and investment, the ones with low demand for environmental quality set lax environmental standards while others set tougher standards. The countries with laxer standards –who are mostly the less developed countries engaging in environmental dumping- seek to attract more investments or try to get higher share from the world market by producing and exporting pollution-intensive goods. On the other hand, the countries with tougher standards import the pollution-intensive goods from these countries (Frankel and Rose, 2002).

Besides this specialization pattern induced by different structures of the countries, as it is mentioned earlier, the firms all around the world making pollution-intensive production may also shift their location to those countries with laxer environmental standards to decrease their production cost and these countries will soon become “pollution havens”. This is what pollution haven hypothesis actually predicts.

Following this trend, pollution havens will end up with fewer clean industries. At the same time, it is possible to argue that pollution havens will lead to higher levels of national income, as being havens will make them more productive by allowing them produce the goods they have comparative advantage. However, this argument neglects the impact of environmental pollution on different components of production such as worker productivity.

Furthermore, Frankel (2002) points out to the lack of empirical evidence supporting the hypothesis that the countries -generally the poor ones- with low demand for environmental quality specialize in pollution-intensive products whereas the rich ones take care of their environmental quality preferring cleaner products and leaving the production of dirty goods to the poor countries.

2.5. Environmental Kuznets Curve

Trade creates wealth through economic growth, and increased level of income effects environment in different ways. Firstly, when people become wealthier, their demand for environmental protection will increase because their priorities will change

from employment, income, food or housing to more qualitative measures such as cleaner environment. Through increased level of income, trade can save people from the poverty versus environmental degradation circle which forces the poor people to exploit the environment in order to survive (UNEP, IISD, 2000). Secondly, with rising level of national income, the governments and/or private firms could increase the expenditures targeting environmental development. These changes resulting from wealth increase may also improve environmental rules and regulations.

During the past few years, the relationship between the level of income and environmental degradation started to be explained by the environmental Kuznets curve (EKC). This is an inverted U-shaped relationship implying that at low levels of income, growth leads to higher level of environmental damage until a turning point is reached with an intermediate level of income; and after this point, further growth leads to environmental improvement. EKC is based on the Kuznets curve introduced by Kuznets (1955) to predict income inequality during a country's economic growth and influencing factors.

The idea behind this curve is that at the initial stages of economic development and industrialization, growth is harmful for the environment, but as countries become wealthier the demand for environmental quality rises calling for environmental protection through regulations.

The relationship suggested by the EKC has been criticized by many studies. Panayotou (1999) argues that this relationship does not have any significant policy implications because it ignores the role of market and policy failures in determining the level of environmental damage cost per additional unit of GDP and the reforms to reduce it⁵; it neglects effects and the risk of irreversible environmental damage caused by economic growth till the turning point is reached; and as the current income levels of countries are not close to turning point, environmental damage of growth will continue for a long time which may result in significant and irreversible environmental damage.

Furthermore, Johnstone (1999) argues that the relations between environmental effects and demand-side issues, such as increase in the demand for higher environmental quality with higher level of income, are mostly incidental. The rational of his argument depends on the fact that while the pollutants which are local

⁵ In case of such failures, it would be impossible to achieve environmental improvement with the increased level of income as the appropriate policies and regulations could not be implemented.

in nature and immediate in effect, such as air pollutants, exhibit significant downward trends with higher income levels; the pollutants whose effects are delayed or diffused, such as carbon dioxide, exhibit no such relationship at all.

Similarly, as to Frankel (2002), it is misleading to portray the EKC as claiming that if countries promote growth, the environment will eventually take care of itself. The reason behind his point is that most pollution is external to home country or domestic firm and for such externalities, effective government regulation as well as rule of law is needed besides higher income levels and public demand.

Jayadevappa and Chhatre (2000) summarizes the findings of different studies showing that the relationship may not be as the EKC predicts all the time, and conclude that although this relationship has some statistical support, it is subject to sufficient doubt to make it unreliable. Additionally, Dunkley (1999) argues that if correct policy making governments and appropriate climate exist, environment awareness can occur even at low-income levels.

3. Measuring Environmental Stringency

This section firstly reviews previous attempts to measure environmental stringency, and then presents an index, which is called as Index of Environmental Sensitivity Performance-IESP, constructed depending on the pressure, state and response environmental framework of the OECD. This index will be employed in the following section in a cross-country trade model to investigate the impact of various degrees of environmental stringency on the trade patterns of the countries.

3.1. Literature Review on the Measurement of Environmental Stringency

One of the earliest works that attempts to measure the environmental stringency of countries is Walter and Ugelow (1979). Basically, they gather the information obtained from a questionnaire prepared by UNCTAD, which looks for environmental problems and associated domestic regulations in countries of various development levels. The national replies are evaluated individually and in relation to the benchmark of the USA where it stands for “strict” environmental policies. Consequently, they build an “environmental stringency index” which measures countries’ environmental policy strictness and which ranks countries from 1 (strict) to 7 (tolerant).

In another study, Dasgupta et al. (1995) develop comparative indices of

environmental policy and performance for 31 countries by using a quantified analysis of reports prepared for the UNCED (United Nations Conference on Environment and Development). The countries covered in the indices range from highly industrialized to extremely poor. Dasgupta et al. categorize the state of environmental awareness, scope of policies adopted, scope of legislation enacted, control mechanisms in place and the degree of success in implementation for each environmental dimension, and they grade the status in each category as high, medium and low.

Van Beers and Van den Bergh (1997) construct the environmental regulations' strictness measure, which is consistent with "polluter pays principle". Their main emphasis is on the societal responses and they distinguish these responses into input and output oriented categories. Based on a combination of output-oriented indicators, they introduce a broad and a narrow measures. Environmental regulations' strictness measure is created for all the indicators first by ranking the countries in ascending order from the worst performer to the best; and by assigning scores to corresponding levels in ascending order starting from 1. At the second step, for each country these scores are summed up and the result is ranked again. Finally, the outcomes are divided to the total number of countries in order to index the measure between 0 (no environmental policy) and 1 (strict environmental policy).

Apart from the above measures which consider both the states of various environmental problems and their societal responses, there are other measures which quantify the various types of pollution into an aggregate index. Birdsall and Wheeler (1992), for example, concentrate on different types of industrial pollution. In order to examine both the productive sources and international distribution of industrial pollution, they create an aggregate index of output-based industrial pollution, which is comparable across countries. At the same time, their measure provides information on changing shares of different industries and impacts of various development levels on the aggregate index.

In another study, Dessus et al. (1994) provide econometric estimates of the linkages between input use and the effluent intensity of final output and they introduce an effluent intensity of output index for USA. Their model explains the production of each effluent type by the level and composition of intermediate demand, which is aggregated into 16 items that make significant contributions to industrial pollution. There are 13 types of effluents, which represent most major categories of air, water and soil pollutants. The emissions directly depend on the

absolute level of intermediate consumption of pollutants. Dessus et al.'s index is an input-based measure and can be disaggregated into various sectors; and can also be applied to other countries with the necessary adjustments.

In a recent study done by Cagatay and Mihci (2003), an index of environmental sensitivity performance is constructed to measure and quantify the comparative environmental sensitivity of countries. The main emphasis of their index is to obtain an overall measure of stringency instead of focusing on various indicators designed for particular environmental issues. The index is built to investigate empirically certain economic relationships that appeared firstly in the emergence of environmental regulations in industrial nations, and secondly, in the debate over recent international agreements.

Also, there is a wide range of empirical studies evaluating certain environment-economic linkages through explicitly using or by implicitly referring to the environmental stringency levels of countries. The recent applied economics literature provides only limited number of studies that employ explicitly a measure of cross-country environmental stringency. These studies mainly focus on analyzing the impacts of different stringency levels of countries on the changing world trade patterns and/or on exports, imports, trade balance and comparative advantage of countries and/or industries (Chapman, 1991; Kalt 1988; Larson 2000; Larson et al., 2002; Ratnayake, 1999; Robison, 1988; Siebert, 1992; Tobey, 1990; Van Beers and Van den Bergh, 1997; Xu, 2000; Xu, 1999). By employing single equation estimation techniques on cross-country samples, the studies make use of the extended versions of Heckscher-Ohlin theorem; and also the findings of new trade theories.

One of the earliest studies in this area is Kalt's (1988) empirical work investigating the effect of direct factor input levels on the net exports of industrial outputs. Kalt explains the variation in the net export level depending on the labor and capital endowments, industrial research and development inputs; and also on pollution abatement expenditures incurred in each industry. Pollution abatement expenditures in Kalt's model resemble the environmental stringency of countries as they reflect both the relative size of industry-based pollution among all the industries and the amount of extra costs that the industry has to suffer for abatement. This variable is expected to have deteriorating impacts on comparative advantage of the industries as it generates extra costs of production. Therefore, a negative sign is expected for the estimated coefficient.

In a similar model, Ratnayake (1999) examines the role of environmental stringency in determining a country's revealed comparative advantage and the resulting impacts on net exports. By utilizing Chamberline-Heckscher-Ohlin theorem, which is introduced by Helpman (1981), he analyzes the changes in New Zealand's net exports classified as environmentally sensitive and non-sensitive goods. His model employs a dummy variable to reflect the environmentally sensitive industries and a negative effect on exports is expected if the industry is environmentally sensitive.

In another study, Tobey (1990) investigates the impacts of environmental stringency levels on world trade patterns by employing Walter and Ugelow's (1979) environmental stringency index. This study 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. He uses Heckscher-Ohlin-Vanek model of international trade. The model is also extended to allow for non-homothetic preferences, scale economies, product differentiation. His first approach involves inclusion of a qualitative variable in the estimated equation to represent stringency of pollution control measures. The second approach examines the signs of the estimated error terms when the variable that measures the stringency of a country's environmental policy is not included in the estimated equation. According to his model, the variations in net exports are explained by the factor and resource endowments, and environmental stringency of countries.

Van Beers and Van den Bergh (1997) use a gravity/trade flow model to examine how the differences in strictness of environmental regulations among countries influence foreign trade flows.

The other group of studies that use single equation methods consist of the models, which search the impacts of regulations on industrial output and price, particularly in the dirty industries of developed countries (OECD, 1978; Ugelow, 1982; U.S. DOC, 1975 and Yezer and Philipson, 1974). The regulations in these models are generally reflected by environmental control costs.

Besides the single equation approaches, there is also a growing empirical literature, both in general and partial equilibrium frameworks, which aims to evaluate the linkages between environmental stringency levels and production costs, international trade and direct foreign investment patterns. These empirical models are built in a single or multi-country structure and they seek to find the impacts of

environmental/economic policies on domestic-international markets/environment. The ones that focus on the effects of environmental policies incorporate environment mostly in terms of changing regulatory policies (taxes) and limitations on effluent emissions. Furthermore, these models measure the country and industry-based pollution levels by pollution abatement costs incurred to the particular industries. However, neither the range of regulatory policies nor the amount of abatement costs provides a comparative measure of environmental sensitiveness across countries. This is mainly due to the absolute measurement of those variables at country level without considering the country's relative situation. In addition, this is also due to the coverage of these environmental measures as they only emphasize either state of the pollution or related response variable instead of considering those together.

Having reviewed the previous approaches attempting to measure environmental stringency and their applications to empirical studies, the paper will focus on the index of environmental sensitivity performance (IESP) in the following sub-section.

3.2. Index of Environmental Sensitivity Performance (IESP)

The presentation of IESP starts with the definition, coverage and calculation of the index, and proceeds with the main findings.

3.2.1. Definition, Coverage and Calculation of IESP

IESP is built to measure and compare the environmental stringency of countries based on the relative degree of pollution generated during certain industrial activities and related efforts of economic agents to improve environmental quality. There are four main environmental issues, sub-indices, included in IESP classified according to the type of environmental damage caused by various industrial activities. These sub-indices are climate change, acidification, use of water resources and waste management. Two main criteria are employed to determine the coverage of the sub-indices. Firstly, the potential environmental issues or the environmental damages based on these issues have directly to be related to an industrial activity, as IESP is prepared to focus on different types of industrial pollution. Secondly, the available data on these issues must not be too restrictive to limit the country coverage of IESP.

The indicators for each of these sub-indices are chosen based on a conceptual framework, which enables variety of environmental information to be structured in a

cause-effect relationship. This conceptual framework, which is first developed by the Organization of Economic Co-operation and Development (OECD), is mainly depended on environmental pollution and corresponding environmental quality-improving efforts of economic agents included under the pressure-state-response indicator framework (Hammond et al., 1995). In this context, pressure indicators are used to determine the sources of various stresses yielding in environmental changes, while state indicators are used for measuring the environmental quality. Response indicators measure the efforts of certain agents in the economy to improve the environmental quality and/or to protect the environment from different sources of pollution activities either by applying renouncing measures or by decreasing pollution effects of certain activities.

For each sub-index, the list of pressure, state and response indicators is presented in Table 1.⁶ The pollution indicators and environmental quality-improving measures are determined based on the previous works of Bakkes et al. (1994), Hammond et al. (1995), WB (1995) and MENV (1996). According to this matching, while all the state indicators emphasize the level of environmental pollution caused by certain industrial processes, the level of corresponding response indicators emphasizes the efforts of economic agents to improve environmental quality. It is assumed that the higher the level of response indicators in each sub-index, the higher the strictness of public/private agents against the environmental damage.

⁶ The definitions and other details related with the pressure, state and response indicators for each sub-index can be found in Cagatay and Mihci (2003).

Table 1: Pressure, State and Response Indicators for each Sub-Index

Sub-Indices (SI)	Pressure Indicators	State Indicators	Response Indicators
1-Climate Change	-CO ₂ , CH ₄ emissions	-per unit real GDP emissions of CO ₂ and CH ₄ by industrial processes	-commercial energy efficiency
2-Acification	-SO _x , NO _x emissions	-per unit real GDP emissions of SO _x and NO _x by industrial processes	-expenditures on pollution abatement as % of GDP
3-Uses of Water Resources	-intensity of use	-industrial withdrawals as % of total withdrawals	-wastewater treatment as % of population served
4-Waste Management	-waste generation	-per unit real GDP hazardous waste	-treatment and disposal of hazardous waste as % of generated hazardous waste

Source: adopted from Bakkes et al. (1994), Hammond et al. (1995), WB (1995), MENV (1996).

IESP is based on a simple indexing system in which countries are finally ranked between “0” and “100”. The state and response indicators are included in terms of relative values⁷ in order to avoid the impacts of bias on measurement of indicators caused by different economic development and population levels. Taking the indicators in relative terms is also preferred to make the data comparable across countries. Each sub-index value in IESP is included with changing weights determined according to the countries’ relative environmental suffer level from each sub-index. The country performances in IESP are not evaluated separately in pollution and renouncing measures. Instead, they are evaluated based on the joint performance in state and response indicators for each sub-index, where the corresponding joint performance scores are then aggregated with changing weights to make the composite index.

⁷ It is preferred to include state and response indicators as a ratio of either overall or sectoral economic measures or of population level where necessary.

Calculation of IESP involves three main stages: determination of sub-index weights (countries' degree of relative suffer from each sub-index), calculation of sub-index values and determination of total sensitivity level.⁸

3.2.2. Findings of IESP

The twin criterion of objectivity and unbiasedness has been taken into consideration in the process of constructing IESP. While this consideration can be evaluated as one of the distinguishing features of IESP from alternative measures, it also restricted the coverage of the index to some extent in terms of environmental issues and countries. If it were allowed to relax such kind of limitations, it would be possible to extend the coverage of IESP.

As the coverage of IESP is limited in terms of variety of the economic and social development levels of the included countries, it is not the aim of this paper to interpret the results at the country base. Instead, depending on the theoretical background or assumptions behind the environment/regulation debate, some generalized results were derived from the analysis.

In Table 2, the IESP values are presented for 31 countries of which 8 belong to developing⁹ (or upper/lower middle income) and 23 belong to developed¹⁰ (high income) countries. The values seem to be consistent with the disputes emphasizing the growing sensitiveness of the developed nations towards the industrial pollution relative to the upper/lower middle-income countries. With a very few exceptions, developed countries appear to be stringent in the pursuit of the industrial environmental regulations. This general trend, which is consistent with the theoretical expectations, contributes to the value of the IESP as a quantitative instrument. Although it can appear as an optimistic approach to generalize this result depending on a relatively limited number of developing nations, obtaining this sensitivity differential in the measurements can still be accepted as promising in terms of the applicability of the methodology used in the calculations of IESP.

⁸ The details of calculations for a limited sample of countries can be observed in an earlier work of the authors (Cagatay and Mihci, 2003).

⁹ According to World Development Report (1998), the developing ones are: Czech Republic, Hungary, Korea Republic, Mexico, Poland, Russian Federation, Slovakia Republic and Turkey.

¹⁰ According to World Development Report (1998), the developed ones are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK and USA.

Table 2: Index of Environmental Sensitivity Performance

Japan	83.929
Netherlands	83.929
Denmark	80.357
New Zealand	78.571
Korea Republic	78.571
Switzerland	75.000
UK	75.000
Australia	73.214
Austria	73.214
Germany	73.214
Ireland	73.214
Italy	73.214
Sweden	73.214
Greece	73.214
Belgium	67.857
Finland	67.857
Luxembourg	67.857
Spain	67.857
USA	67.857
Czech Rep.	66.071
France	66.071
Norway	64.286
Turkey	64.286
Iceland	62.500
Mexico	62.500
Canada	58.929
Portugal	58.929
Slovakia Rep.	50.000
Poland	48.214
Hungary	46.429
Russian Fed.	37.500

As it can be seen from the table, IESP values are scattered in a range of 37.5 to 83.9 out of 100. This range of values can be accepted as promising in terms of utilizing the IESP in econometric applications since the index has sufficient variability. According to the theoretical background of the discussion in recent international agreements, the environmental stringency level differential between developing and developed nations is viewed to be a crucial criteria in terms of

explaining both “industrial flight”, “pollution havens” and “race to the bottom” hypotheses, and change in trade patterns and international competitiveness.

Consequently, in the following section, IESP will be employed to investigate the effects of various degrees of environmental stringency on the trade patterns of developed and developing nations.

4. Empirical Analysis

At the beginning of this section, the model is described. Furthermore, the data, variables and the methodology used to conduct the empirical analysis are explained. Finally, the results together with their interpretations are presented.

4.1. The Model

In this paper, the gravity model of trade is used in order to find the effects of environmental stringency on the variation in trade flows. Tinbergen (1962) and Poyhonen (1963) was first introduced the gravity model based on ad hoc, intuitive theory. Tinbergen and Poyhonen explained the bilateral trade between two countries in terms of their GNPs and the distance between them. Later, Linneman (1966) elaborated the model by incorporating population variable in order to reflect the role of scale economies. Aitken (1973) and more recently Matyas (1997) extended the gravity model to incorporate some local and target country effects to analyze their impact on bilateral trade flows. In spite of its dubious theoretical background, gravity models proved to be successful econometric tools in explaining bilateral trade flows (Deardorff, 1984; Van Beers and Van Den Bergh, 1997).

In the gravity model, GNP variable in the exporting and importing countries reflect the productive and absorptive capacities, respectively. Hence, in the bilateral export flow equation, a positive sign is expected on both of the estimated coefficients of GNP. Population is used as a measure of country size. Larger countries are assumed to have more diversified production and tend to be more self-sufficient; therefore, a negative relationship is expected between the exports of the reporting country and the population in both reporter and partner countries. However, larger size may also reflect the possibility of economies of scale promoting the specialization and so, an increase in the exports. It can be concluded that the sign of the estimated coefficient on the population of the reporting country in a bilateral

export flow equation is indeterminate. The other variable that is assumed to explain the potential trade is the distance, which proxies the transportation costs. So, as the distance between reporting and partner country increases, a decrease in the level of exports is expected. Various dummy variables such as; whether countries have a common border, and belong to a trade agreement is important in terms of their trade facilitating effects. Therefore, a positive relationship between these dummies and level of exports is expected.

The gravity model used in this empirical analysis is introduced in equation 1. Accordingly, with the above explanations, the expected signs of the coefficients were given below the equation 1. The variable $IESP_{ij}$ reflects the relative measure of environmental stringency in reporter (exporter) and partner (importer) countries. A rise in the environmental stringency of the exporter country is expected to cause a decrease in the export potential due to the rising production costs and falling production. On the contrary, a rise in the environmental stringency of the partner country is expected to result in an increase in its imports, so in an increase in the exports of the reporter country. Therefore, if the rate of change in the reporter country's environmental stringency is greater than the rate of change in the partner country, a negative relationship is expected between $IESP_{ij}$ and export value.

Equation 1 was estimated for identifying the significance of factors behind the bilateral exports of 31 countries in 5 industries. The estimation was carried out using two samples (sub-samples). In the first sub-sample, both the reporter and partner country groups included all countries in the main sample. In the second sub-sample, the reporters consisted of only the developed countries and partners included only the developing ones in the main sample. Therefore, the second sub-sample specifically aimed at finding the effect of environmental stringency differences on the trade flows between these countries. A list of developed and developing countries in the total sample was previously given in section 3.2.2.

$$EX = \alpha_0 TA_{ij}^{\alpha_1} BD_{ij}^{\alpha_2} Y_i^{\alpha_3} Y_j^{\alpha_4} P_i^{\alpha_5} P_j^{\alpha_6} DST_{ij}^{\alpha_7} IESP_{ij}^{\alpha_8} e^u \quad (1) \quad \text{where}^{11};$$

(+ +) (+) (+) (-) (-) (-) (-)

¹¹ Data sources:

EX- United Nations, COMTRADE Database, <http://unstats.un.org/unsd/comtrade/syslogin.aspx?>;

Y and P- United Nations, Human Development Indicators, 2001;

DST <http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html#Gravity>;

TA- http://www.wto.org/english/tratop_e/region_e/region_e.htm;

BD- Map of Europe, <http://www.sitesatlas.com/Maps/Maps/Europe.htm>.

i: reporter country

j: partner country

EX: export value, in million US \$

TA: intercept dummy; 1 if *i* and *j* belong to a trade agreement, 0 otherwise

BD: intercept dummy; 1 if *i* and *j* share a border, 0 otherwise

Y: level of income, in purchasing power parity million US \$

P: population, in millions

DST: distance between *i* and *j*

IESP_{ij}: ratio of the index of environmental sensitivity performance in the reporter country to the partner country

Based on Tobey (1990), Van Beers and Van Den Bergh (1997) and Xu (1999), five industries were determined to be environmentally sensitive with respect to the levels of pollution abatement expenditures incurred to all industries. The description of these environmentally sensitive industries are given with SITC code as in the following:

51: Organic chemicals

52: Inorganic chemicals

66: Non-metal mineral manufactures

67: Iron and steel

68: Non-ferrous Metals

The equations were estimated in double-log form using OLS technique. In order to remove changing variance (heteroscedasticity) problem in some of the equations, White's heteroscedasticity adjusted standard errors were used in obtaining the coefficients. An omitted variable test was also applied to see whether excluding *IESP_{ij}* from equations was statistically supported.

4.2. The Results

Equation 1 was estimated twice for each sector using the two sub-samples defined above. Estimation results are presented in Tables 3 and 4. In these tables, the first column presents the explanatory variables, and estimated coefficients with their calculated t-statistics (in parenthesis) for each industry are provided in the following columns of the tables. The estimated coefficients reflect the elasticities as

Table 3: Estimation Results and Diagnostics

<i>Reporter: all countries</i>		<i>Partner: all countries</i>			
<i>Dependent variable: EX</i>					
<i>Industry code:</i>	51	52	66	67	68
<i>Sample size:</i>	804	765	887	844	847
<i>Regressors-coeff.:</i>					
<i>(t-stat)</i>					
<i>CONST</i>	35.95 (10.31)	21.08 (8.05)	27.00 (12.47)	23.26 (9.36)	33.91 (12.27)
<i>Y_i</i>	3.00 (12.07) ¹	1.94 (10.68) ¹	1.46 (9.15) ¹	1.16 (6.01) ¹	2.27 (11.95) ¹
<i>Y_j</i>	1.18 (4.10) ¹	1.54 (9.18) ¹	1.95 (12.19) ¹	1.40 (7.05) ¹	1.59 (7.10) ¹
<i>P_i</i>	-2.03 (-8.08) ¹	-0.73 (-3.98) ¹	-0.46 (-3.11) ¹	-0.33 (-1.99) ²	-1.39 (-8.54) ¹
<i>P_j</i>	-0.22 (-0.92)*	-0.55 (-3.45) ¹	-0.96 (-6.44) ¹	-0.54 (-3.17) ¹	-0.59 (-3.00) ¹
<i>IESP_{i/j}</i>	-1.25 (-2.79) ¹	-1.10 (-3.14) ¹	0.45 (1.48) ³	-0.18 (-0.50)*	-1.66 (-4.02) ¹
<i>DST_{ij}</i>	-0.96 (-11.26) ¹	-0.81 (-10.87) ¹	-1.02 (-15.61) ¹	-1.05 (-14.56) ¹	-1.08 (-13.94) ¹
<i>TA_{ij}</i>	0.36 (2.02) ²	0.67 (4.71) ¹	0.64 (4.44) ¹	0.88 (5.99) ¹	0.72 (4.72) ¹
<i>B_{dij}</i>		1.14 (5.53) ¹	0.53 (2.25) ²	0.41 (1.14)*	0.45 (1.39) ³
<i>R-Bar²</i>	0.40	0.60	0.60	0.44	0.48
<i>S.E. of Reg.</i>	2.43	1.72	1.76	2.12	2.16
<i>F-test</i>	78.15	145.60	166.32	84.89	99.91
<i>Test for heteroscedasticity:</i>					
χ^2 -test	**	**	0.07	**	**
<i>F-test</i>			0.07		
<i>Omitted variable test for IESP:</i>					
<i>F-test</i>	8.42	11.79	2.20	0.22	19.47

¹: Significant at % 0.01.

²: Significant at % 0.05.

³: Significant at % 0.10.

*: Not significant at % 10.

** : Estimated with White's Heteroscedasticity adjusted standard errors.

equations were estimated in double-log form. The last two rows of the tables provide results for the heteroscedasticity and omitted variable tests.

The explanatory power of the independent variables changes from 40% to 71%. In these tables, the variables with insignificant coefficient or which had the wrong direction (based on a priori expected sign) were left out unless these were of the fundamental explanatory variables (*Y*, *P*, *DST*) of the gravity model. Except in one case (under sub-sample 1 for non-metal mineral manufactures-Table 3) all the

estimated coefficients had the a priori expected signs, and only in four cases the estimated coefficients were statistically insignificant. For most of the cases, t-statistics of the estimated coefficients indicate statistical significance at a 1 per cent level.

The F-test results, in general, rejected exclusion of the $IESP_{ij}$ from the equations. In other words, omission of the $IESP_{ij}$ would result in misspecification error. This technical finding is consistent with theoretical expectations suggesting the inclusion of an environmental stringency variable into a cross-country trade model.

Furthermore, it can be claimed that the construction procedure of the IESP and its incorporation into the model as a ratio of the index of environmental sensitivity performance in the exporter country to the importer country, to reflect relative environmental stringency of the nations, fit quite well theoretical backgrounds of not only trade models, but also the linkages between international trade, environmental stringency and development level of the countries.

The results related with the $IESP_{ij}$ variable merits further interpretations because with a very few exceptions, they support the argument that environmental stringency has a considerable impact on the patterns of trade flow and especially on the export of the countries. The impact of the degree of environmental stringency on the exports is significantly negative suggesting an inverse relationship between export values and relative environmental sensitivity performance of the nations.

This relation seems to be statistically more strong and valid for the second sub-sample where the reporters consisted of only the developed countries and partners included only the developing ones in the main sample (See Table 4). The estimated coefficients of the $IESP_{ij}$ in Table 4 can be considered as a natural extension of the findings of IESP in sub-section 3.2.2. where the growing sensitiveness of the developed nations towards the industrial pollution relative to the developing countries

Table 4: Estimation Results and Diagnostics

<i>Reporter: developed countries</i>		<i>Partner: developing countries</i>			
<i>Dependent variable: EX</i>					
<i>Industry code:</i>	51	52	66	67	68
<i>Sample size:</i>	151	144	171	161	163
<i>Regressors-coeff.:</i> (<i>t-stat</i>)					
<i>CONST</i>	51.09 (2.81)	25.30 (1.84)	29.25 (4.27)	38.62 (2.73)	66.33 (4.48)
<i>Y_i</i>	3.27 (2.42) ¹	1.72 (1.56) ³	2.21 (4.49) ¹	2.75 (2.65) ¹	3.41 (3.42) ¹
<i>Y_j</i>	3.16 (3.27) ¹	2.36 (3.84) ¹	1.94 (4.00) ¹	2.17 (2.52) ¹	3.89 (3.83) ¹
<i>P_i</i>	-2.14 (-1.56) ³	-0.37 (-0.34)*	-0.84 (-1.77) ²	-1.49 (-1.50) ³	-2.32 (-2.46) ¹
<i>P_j</i>	-1.59 (-1.80) ²	-0.82 (-1.56) ³	-0.51 (-1.21)*	-0.579 (-0.72)*	-2.33 (-2.47) ¹
<i>IESP_{i/j}</i>	-2.15 (-1.99) ²	-3.50 (-4.79) ¹	-2.58 (-5.12) ¹	-2.76 (-2.86) ¹	-2.42 (-2.65) ¹
<i>DST_{ij}</i>	-1.29 (-5.57) ¹	-1.87 (-10.01) ¹	-1.97 (-14.69) ¹	-2.20 (-11.15) ¹	-1.93 (-10.71) ¹
<i>TA_{ij}</i>	1.13 (1.40) ³			0.84 (1.36) ³	1.14 (1.96) ²
<i>BD_{ij}</i>					
<i>R-Bar²</i>	0.40	0.59	0.71	0.52	0.51
<i>S.E. of Reg.</i>	2.11	1.57	1.37	2.01	1.84
<i>F-test</i>	15.07	35.14	70.85	25.32	25.22
<i>Test for heteroscedasticity:</i>					
χ^2 -test	**	**	3.27	**	**
<i>F-test</i>			3.30		
<i>Omitted variable test for IESP:</i>					
<i>F-test</i>	.66	28.89	26.20	9.38	8.21

¹: Significant at % 0.01.

²: Significant at % 0.05.

³: Significant at % 0.10.

*: Not significant at % 10.

** : Estimated with White's Heteroscedasticity adjusted standard errors.

is confirmed with the values of IESP in Table 2. In other words, the results of the present empirical analysis are consistent with the main findings of the IESP.

Additionally, the results of the empirical study and especially the ones presented in Table 4 support the argument that the environmental stringency level differential between developing and developed nations is a crucial criteria in terms of explaining shifts in trade patterns of the countries.

Moreover, it can be argued that the rise in the relative environmental stringency of the countries influence production structure and international competitiveness of the environmentally sensitive manufacturing commodities by rising production costs, and hence, decreasing production activities and reducing export performance.

5. Conclusion

This paper introduced an index which is constructed depending on the pressure, state and response environmental indicator framework of the OECD and which is used to measure the environmental stringency of various developing and developed countries. IESP values are consistent with the disputes emphasizing the growing sensitiveness of the developed nations towards the industrial pollution relative to the developing countries. With a few exceptions, developed countries seem to be stringent in the pursuit of the industrial environmental regulations.

IESP is used in gravity model of trade in order to explore the effects of various degrees of environmental stringency on the trade patterns, and especially on the export performance of developed and developing countries. The main results of the empirical analysis show that environmental stringency has an important impact on the export of the countries. The impact of the degree of environmental stringency on the exports is significantly negative suggesting an inverse relationship between export values and relative environmental sensitivity performance of the nations.

Furthermore, the results of the empirical study support the argument that the environmental stringency level differential between developing and developed nations is a crucial criteria in terms of explaining shifts in trade patterns and international specialization of the countries.

Finally, it should be emphasized that the rise in the relative environmental stringency of the countries affect production structure of the environmentally sensitive commodities by increasing production costs, and therefore, diminishing export performance of the countries.

As a conclusion, it can be stated that the current study contributed to the evidence supporting that the degree of environmental stringency has a significant impact on the change in the trade patterns of the countries. This statement is particularly valid for the export performance of the developed countries.

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