Trade and Sustainable Development: Should "transition countries"* open their markets to environmental goods?

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Abstract

Considering that environmental goods play an essential role in sustainable development and in achievement of specific targets set out in the United Nations Millennium Declaration at the World Summit on Sustainable Development, the Paragraph 31(iii) of the Doha mandate, agreed by all WTO Members in 2001, calls for a reduction or, as appropriate, elimination of tariffs and non-tariff barriers on environmental goods and services. This mandate offers a good opportunity to put climate-friendly goods and services on a fast track to liberalization, although, as the negotiations to date have shown, this is not a simple proposition. This study treats trade, environmental policy and income as endogenous and estimates the overall impact of environmental goods' (EGs) trade intensity on the environment using the technique of instrumental variables and three stage least squares estimation method on panel data. We analyze the causal (direct and indirect) effects of EGs trade liberalization on SO_2 and CO_2 emissions by using extensive annual data for "transition countries". Our empirical results show that EGs trade intensity has a negative net impact on pollution, the negative technique (indirect) effect compensating the positive scale-composition (direct) effect. Nevertheless, this finding can be misleading if no distinction is made between different EGs classifications. Finally, in order to increase EGs trade flows, attention must be paid not only to liberalization issues, but also to cross-country harmonization of institutional quality, and especially, of environmental regulation.

Keywords: trade liberalization; environmental goods; transition countries; pollution.

JEL classification: F14, F18, Q56.

1 Introduction

At the beginning of the 21^{st} century, one could not dismount the double profit: economic and environmental, of the countries' economic openness. Today, this can always be possible for the environmental goods (EGs) trade liberalization. Trade can play an important role in the diffusion of ecological technologies. In particular, all increase in the availability of environmental goods and services (EGS) through trade openness represents an opportunity for a mutually beneficial relationship between trade and environment.

*In this study, we mean by "transition countries", the countries of Central and Eastern Europe having emerged from a socialist-type command economy towards a market-based economy, during the last decade of the 20^{th} century (see Appendix B).

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Most of the discussion on trade and environment turned up to now around the Processes and Production Methods (PPM). That is, naturally, very important. However, it is now time for debate to get wider in order to encompass the entire life cycle of the product, which does not include only externalities coming from the production of goods, but also from their consumption and disposal. The excessive attention to PPM often designates unjustly the "transition countries" as criminals responsible for environmental degradation, as consequence of the use of out-of-date production methods, without estimation of the externalities coming from consumption and waste disposal. In the current debates, it is also necessary to consider that some environmental effects, often among the most serious, are not related to PPM, but to the product consumption and waste disposal.

An international engagement in favour of EGS trade liberalization shaped when the WTO Ministers asked, in the paragraph 31(iii) of their declaration of November 14, 2001, during the ministerial Conference held at Doha (Qatar), that negotiations are led on the reduction or, if it is suitable, the elimination of the tariffs and non-tariff barriers aiming EGS.

According to the WTO, the environmental goods (EGs) trade liberalization would benefit to developed countries as well as to developing countries; it would allow simultaneously environmental protection improvement and economic development. On the one hand, polluting firms in the developing countries, mainly EGs importers, will probably increase their pollution abatement efforts because of the reduced prices resulting from import tariffs cut. Alternatively, this reduction in environmental compliance costs would encourage the local governments to set more ambitious environmental standards. On the other hand, the developed countries, EGs exporters, would draw benefit from getting new markets because of tariff reductions; that would contribute to economic development through creating more employment and income in eco-industrial activities.

However, the debate concerning potential advantages of EGs trade liberalization lacks a consensus. For example, since tariffs applied to EGs are lower in the developed countries than in the developing countries, one can suppose that this trade liberalization could benefit economically especially to the first country group. A note of Hamwey *et al.* (2003) on the liberalization of EGS international trade illustrates well this intuition. The authors affirm that direct commercial profits of EGS trade liberalization return mainly to the most advanced WTO member countries, which benefit from a better access to EGS markets in the developing countries. On the other hand, the EGs import tariffs can play at least two roles in the EGs non-manufacturing countries or non-competitive producers. First, according to the literature on foreign direct investments (FDI) determinants (Corden, 1974; Svedberg, 1979), the tariffs can lead to technology transfer via FDI aiming eco-industrial activities. Secondly, even in the absence of FDI, if the EGs exporters benefit from an underperforming environment, the import tariffs can contribute to welfare improvement while they permit to the importing country to retain a part of the international eco-industrial firms revenue (particularly specific to a number of "transition countries").

In order to understand the debate on these contradictory effects of the EGs trade liberalization, it should be noted that the firms of OECD Member States currently count for approximately 90% of the EGS market. However, the excessive capacity of EGs produced in the OECD countries slowed down this market growth and the fastest growth rates currently occur in the developing and "transition countries" (Kennett and Steenblik, 2005). Studying economic and environmental consequences of this phenomenon becomes of strategic importance for the last group of countries. With the adhesion of a number of "transition countries" to the European Union, the trade became increasingly intense on the West part of the European continent. Trade is liberalized while major differences exist between environmental regulations of trade partners, from which the concern about pollution havens. The environmental impact of polluting goods' trade liberalization was intensively studied in the literature on trade and environment. Nevertheless, to our knowledge, there is no empirical study on the economic and environmental simultaneous effects of EGs trade liberalization. Authors of some recent papers, such as: Feess and Muehlheusser (1999, 2002), Copeland (2005), Canton (2007), Greaker and Rosendahl (2006) study the impact of the EGS international trade on the environmental policy design. However, they do not approach any problems related to the impact on sustainable development of the EGS trade liberalization. Consequently, the distinction of our paper lies on the empirical estimation of the simultaneous effects of EGS trade intensity on the economic development and environmental quality improvement, after having identified the factors determining trade intensity of these products.

In order to evaluate the net impact of EGs trade openness in the "transition countries", it is not sufficient to estimate only effects of opening EGs markets on the environmental quality and policy. The impact on the economic development must be also taken into account, because it is supposed to induce, together with the environmental regulation, a technical effect (via consumers' richness and their willingness to pay for environment, to require more environmental protection) and to contribute thereafter to the environmental quality improvement. On the contrary, removal of tariff barriers in a EGs Net importing country can lead to a loss of income and thus to a lower demand for the environmental quality. The scope of this study is the estimation of the EGs trade liberalization Net impact with simultaneous identification of different canals through which this trade influences the environmental quality. Hence, our study highlights some political implications as it permits to see the good (or bad) of EGs trade openness by investigating the overall effect of trade liberalization on the environment, as well as each of the scale-composition (direct) effect and the technique (indirect) effects.

First, we start our empirical analysis with the assessment of factors explaining the existence and the scale of EGs trade between pairs of countries, supposing that besides tariffs and non-tariff barriers, other factors, such as: country size, severity of the environmental policy and consumers' choices concerning clean products, sociocultural relations and geographical aspects, can have a significant impact on EGs trade. In our system of simultaneous equations, we use instrumental variables for EGs trade intensity following Frankel and Rose (2005), i.e. we predict trade using gravity model estimations. Besides endogeneity control and supply with exogenous instrumental variables for trade, the empirical results of the gravity model estimations give us some political implications in terms of EGs liberalization. We show that liberalization is not the only determinant factor of the EGs trade intensity. Our empirical results underscore the importance of the institutional quality and, particularly, the role of stringency of the environmental policy (SEP) in determining the volume of EGs trade.

Thereafter, we study the economic and environmental impacts of EGs trade intensity using instrumental variables for EGs trade intensity in a system of three simultaneous equations, explaining pollution, environmental regulation stringency and per capita revenue, respectively. We employ the theoretical framework developed by Antweiler *et al.* (2001) for pollution equation, the endogenous growth literature (see, for example, Mankiw *et al.*, 1992; Frankel and Romer, 1999) for income equation, and the main theoretical assumptions of some recent studies on environmental policy creation (Fredriksson *et al.,* 2005; Damania, Fredriksson and List, 2003, amongst others).

Our empirical 3SLS estimations results show that EGs trade intensity has a negative net impact on pollution: the negative technique (indirect) effect compensating the positive scale-composition (direct) effect, but these results are sensitive to the pollutant (CO_2 or SO_2) and the EGs classification.

This paper is structured as follows. Section 2 defines EGs and section 3 presents some stylized facts. Section 4 specifies the models to be estimated. Section 5 provides estimation strategy and data. Section 6 discusses the results, while the last section concludes.

2 Overall picture of the environmental goods: what to liberalize?

The concept of EGs recovers intellectually *all products and all technologies favorable to the environment*.

But, the lack of a universally accepted definition of EGs has slowed down agreement on product coverage in negotiations on environmental goods. Two broad categories of EGs have featured in the WTO discussions so far: traditional environmental goods, with the main purpose of addressing or remedying an environmental problem (e.g., carbon capture and storage technologies); and environmentally preferable products (EPPs), which include any product with certain environmental benefits arising either during the production, use or disposal stage relative to a substitute or "like" product. Figure below explains distinctions between these categories.

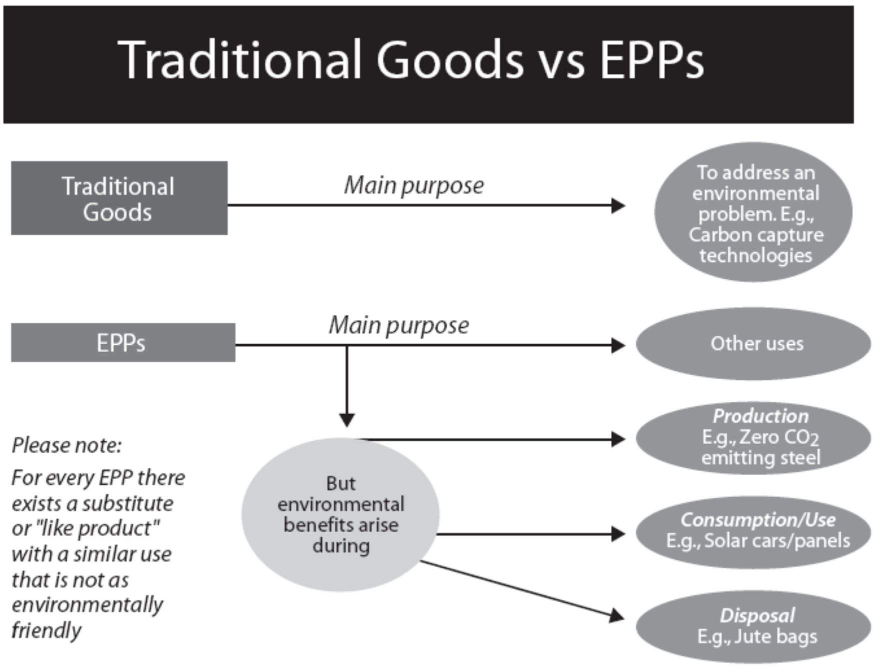


Figure 1: Source: Claro *et al.*, 2007.

In terms of classification, categories and sub-categories of goods are assigned a code within the Harmonized Commodity Description and Coding System (HS), allowing countries to track trade volumes and tariff levels. The more digits are included in a code, the more specific the description of the good is. At the WTO, countries have HS numbers for products only up to the six-digit level. Beyond that, as product descriptions get more specific, different members use different codes and descriptions. This makes it difficult to clearly identify EGs, including climate mitigation goods, at the six-digit level. They are often lumped together with other goods that are unrelated to the environment or climate mitigation. The dual use problem is one of most important challenges facing EGs negotiators. It arises from the fact that most product categories proposed by WTO Members as EGs for rapid liberalization include, at the HS-6 digit level, other products that also have non-environmental uses. Some specific products, such as a pipe, may intrinsically be used for environmental and non-environmental purposes. Pipes, for instance, are used as components of sewage treatment plants as well as for transporting oil and gas.

Some international organizations (OECD, WTO, and UNCTAD) started to analyze this topic beginning with the 90^{th} years. The lists drawn up by OECD and the APEC (see in Appendix A) are the references even if other international organizations work on this subject. The OECD list carried out in 1997 and brought up to date in 2000 is conceptual and illustrative. Established on the base of general categories of goods and services used to measure, prevent and reduce environmental damages and to manage natural resources, it identifies EGs products using six digits codes of the harmonized system. However, as mentioned above, this system does not allow isolating the products used only for an environmental scope. The APEC list, realized between 1998 and 2000, within the framework of traditional tariff negotiations, identifies EGs according to national customs nomenclatures with eight or ten digits. It is more pragmatic and more precise than OECD list. But none is complete or final. Because of technological progress, no list can be exhaustive and each one must rather be conceived in order to be regularly updated. UNCTAD compiled a list of environmentally preferable products (EPPs). These are products that cause less damage to the environment at one of their life cycle stages, because of the manner they are manufactured, collected, used, destroyed or recovered. Thus, this category includes products the physical characteristics of which are similar to ordinary products but that were manufactured according to some environment respectful PPM, such as paintings and varnish without solvents. To identify EPPs, one has, generally, recourse to labeling and certification. However, the PPMs are not recognized by WTO because they lead to differentiate the seemingly similar products. Thus, the majority of delegations do not want to take into account these products in this negotiation.

To resume, there are two broad classes of EGs under discussion in WTO negotiations. Specifically, as presented in Figure 2, these two classes of EGs are:

- **Class A EGs**, which includes manufactured goods and chemicals used directly in the provision of environmental services. Class A EGs include goods, and systems comprised thereof, used to provide an environmental service such as wastewater treatment, solid waste management, air pollution control, etc. These goods, referenced in OECD and/or APEC lists and including a wide variety of basic industrial products such as valves, filters, pumps and compressors, can be specifically employed for environmental purposes.

- **Class B EGs**, which includes industrial and consumer goods not primarily used for environmental purposes but whose production, end-use and/or disposal have positive environmental characteristics relative to similar substitute goods. Class B EGs include items such as chlorine-free paper, energy efficient office machines, clean production and energy technologies, natural fibre clothing, packaging or floor covering materials. Such goods, sometimes referred to as environmentally preferable products (EPPs), have inherent environmentally superior qualities compared to substitute goods..

Could also be considered EGs the less polluting technologies and energy savings, the facilities of electrical production using renewable energy, and recycled materials.

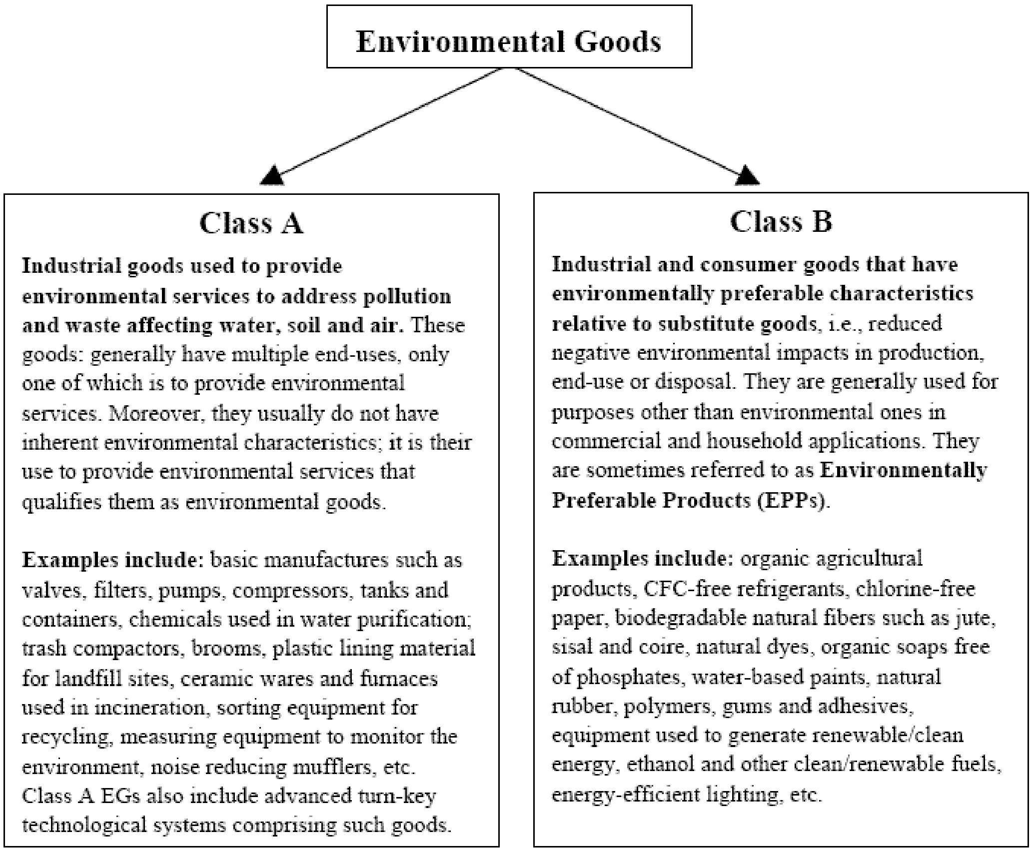


Figure 2: Criteria to identify broad classes of environmental goods and examples of goods meeting these criteria.

Several developing countries claim an EGs list, which should include more products of interest for their exports. For example, Qatar proposed to include some energy efficient technologies, as well as liquid fuels and natural gas used for these technologies. It advanced this proposal compared to the objectives of the multilateral environmental agreements (MEA), in particular the UNFCCC and its Kyoto protocol, and claims that non-tariff barriers (NTB) are serious obstacles for the worldwide trade of these goods. Japan distributed a list which is based on the OECD list and includes energy saving consumables, such as microwave ovens, video refrigerators and projectors, as well as other less-polluting and resources saving products.

Various suggestions were made concerning criteria of EGs identification. Criterion of final use or prevalent final use can be applied to the selection of equipment used in the environmental activities, such as pollution control and waste management. In theory, there is broad support for this criterion. However, other criteria should be applied to also identify the EPPs, in particular products as such favorable to the environment, of great interest for developing countries exports. Criteria of performance were also proposed, such as energy efficiency during the use. However, it can be difficult to apply these last continuous criteria because of the technological progress and innovation. The question of suitable criteria should not have to be solved immediately by validating a starting EGs list. However, such a list should be examined and the mechanism of revision should be based on suitable criteria.

In this study, we focus on three groups of EGs: 1) EGs_A+B - all good referenced in one of the current lists: OECD, APEC, UNCTAD - environmental goods in the broad sense (classes A and B); 2) EG_A - environmental goods referenced in OECD and/or APEC lists (class A); and 3) EG_B – environmentally preferable products

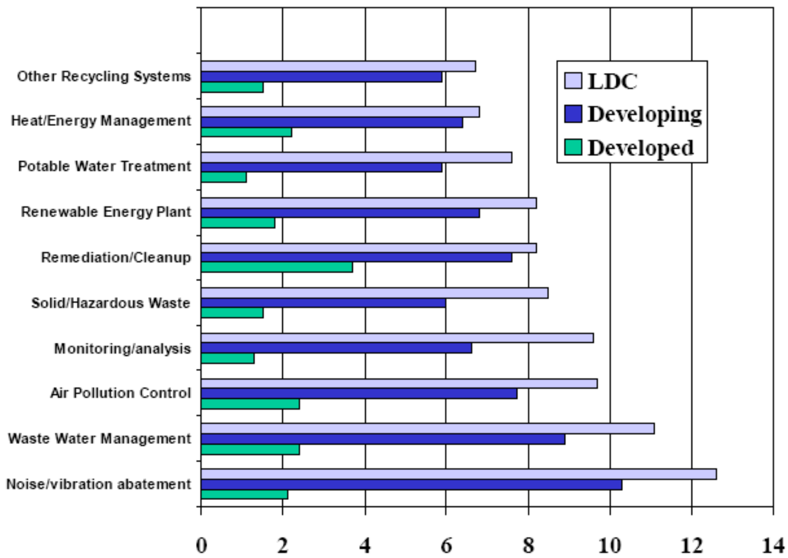


Figure 3: Average Applied Tariffs by EGs Category (UNCTAD, 2003)

specified by UNCTAD (class B).[1]

3 Stylized facts

According to WTO data, total EGs exports, were about USD 238.4 billion in 2002 and it is considered a large expanding market (WTO, 2005). In relative terms, it is not as big as the steel or agriculture markets, but roughly the same size as the pharmaceuticals and information technology markets (UNCTAD, 2003).

There is general consensus that environmental industry in the OECD countries is highly developed, with a rather mature industry in the traditional EGs. The Kyoto protocol's ratification will be simply added to the demand for cleaner energies and fuel saving products, which will widen the market for such goods. The production of biotechnological goods and environmental industry rises potentially. Industrial analysts suggest that the OECD countries will not dominate environmental industry for a longer time. Some countries in Latin America and Asia are already competing in technologies relating to atmospheric pollution control, health and hygiene, water quality management. Even though the definition of EGs is limited to the narrow lists of OECD and APEC, some most advanced developing countries benefit from EGs trade. Nevertheless the most of developing countries do not have yet well developed markets of such products (this make them slow winners from EGs trade), the South-South trade of green products would increase profits within a broader group of developing countries.

As seen in the graph bellow, there are still relatively high import tariffs in developing countries for EGs compared to more advanced economies, the least developed counties (LDC) being even more prohibitive.

EGs trade in the "transition countries"[2]

The EGs trade in the "transition countries" is still at its beginning stage of development, counting in 2005 for only 2.5% in the total exports and approximately 5% in the total imports of these countries. There still

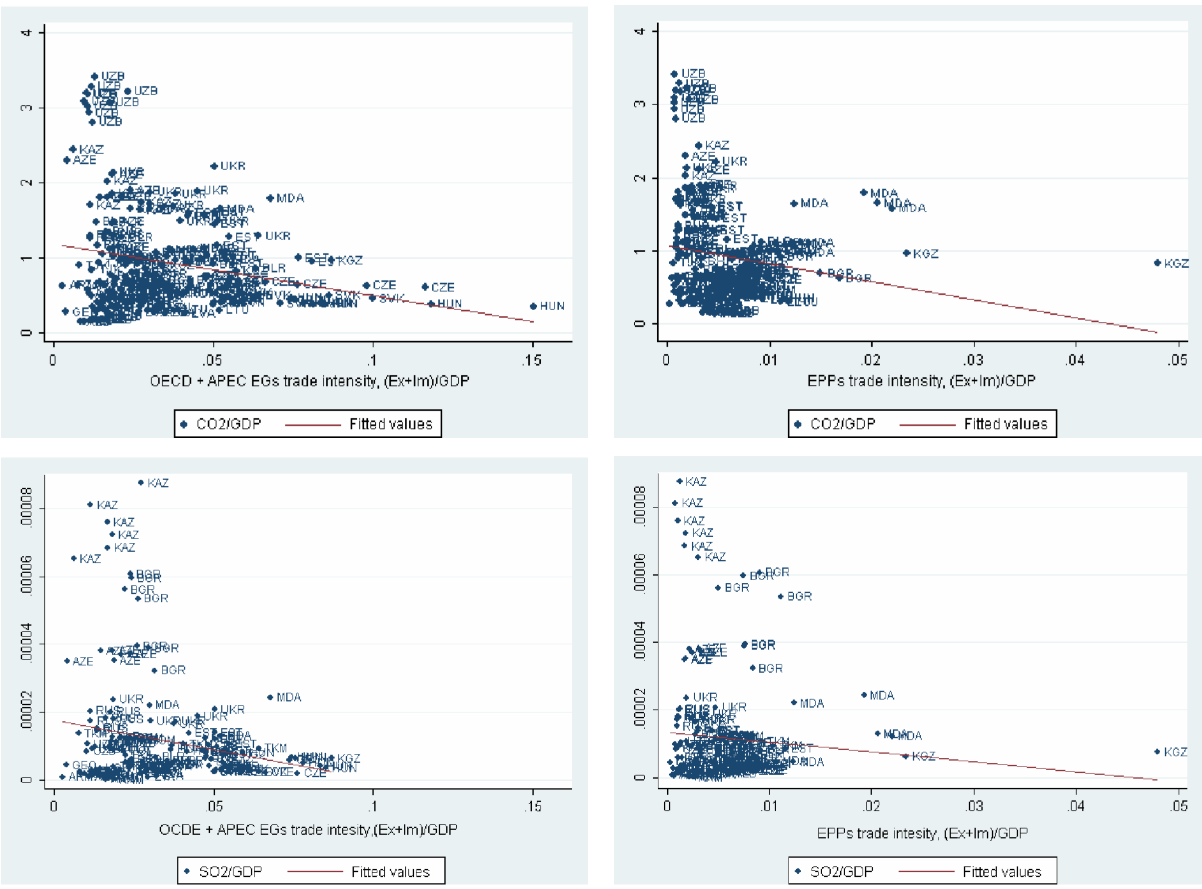
[1] See detailed lists in Appendix A.
[2] Data source: author's database created using CEPI database (*BACI* - for trade flows) and OECD, APEC and UNCTAD lists for EG classifications.

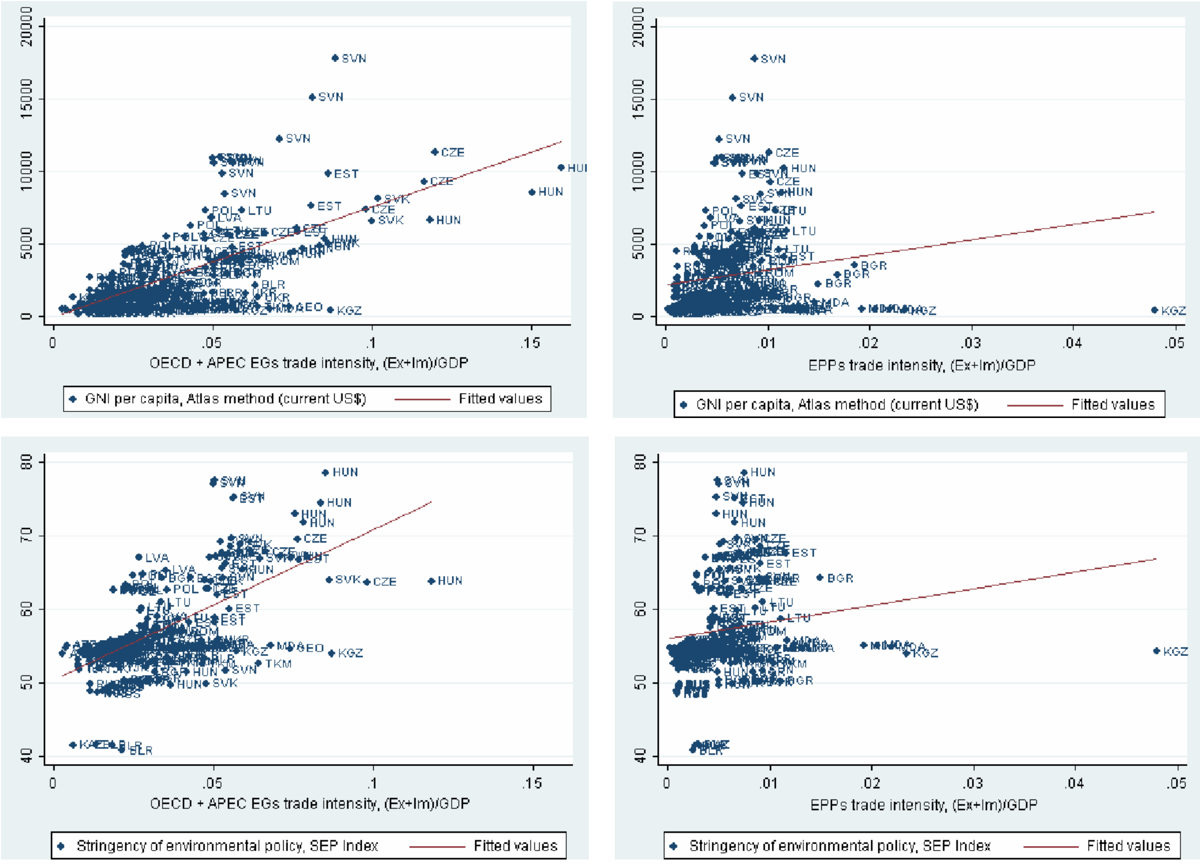
exist big differences across the countries. Concerning imports, the same figure (5%) characterizes the two groups of "transition countries": new EU members (*NEU*) and countries of the Commonwealth of Independent States (*CIS*). As for exports, the first country group has definitely higher advantages: 4% in total exports in 2005, compared to the second group, which counts for only 1% in the total EGs exports.

The "transition countries" are thus Net EGs importers. However, a more detailed analysis of EGs trade in these countries shows that trade balance structure differs across categories of EGs: it is much more overdrawn for the OCDE + APEC EGs list than for the EPPs. If for the first category of goods the imports were 10 times higher than exports in 2005 (2.5 times in 1995), then for the second group of products the same ratio was about 2.9 in 2005 (1.4 in 1995).

In spite of small share of EGs in the total "transition countries'" trade, the volume of this trade increases from year to year. Between 1995 and 2005, the trade intensity ((exports + imports) /GDP) of EGs referenced in OCDE+APEC lists increased by 140% in the *NEU* and by 120% in the *CIS* "transition countries". As for the EPPs, trade intensity increased in the case of *NEU*, whereas falls were recorded for the *CIS*. Most spectacular growth rates were registered for the clean technologies (CT) trade intensity: +170% for the new EU members and +350% for the *CIS*. Trade of this type of products represented 1.4% in the total exports and 3% in the total imports of "transition countries" in 2005.

Before engaging a more complete econometric analysis, it is always of interest to take a look on the primary data and observe the serial correlations. The following graphs show an apparent negative relationship between EGs trade intensity and CO_2 and SO_2 emissions in the "transition countries".





We can also observe a positive correlation between openness to trade in EGs (more obvious relationship for EGs listed by OECD and APEC) and environmental regulation and development level. Does this mean that "transition countries" should liberalize EGs trade, improving thus their environmental quality? Not necessarily. The observed correlations could be due to endogeneity of trade, rather than causality. It's largely proven, through Environmental Kuznets Curve, that income growth has a positive impact on the environmental quality. At the same time, increasing income and democracy stimulate trade. The endogeneity of trade is a familiar problem in the empirical literature on whether openness promotes growth. Harrison (1995) concludes that "existing literature is still unresolved on the issue of causality." Another causality may be identified while analyzing the environmental regulation, which imposes firms to use performing technologies and environment management products, usually imported by "transition countries" from developed countries. Thus, stringency of environmental regulation raises EGs trade intensity and environmental quality simultaneously. Aiming to answer the question concerning the need for liberalizing EGs trade in the "transition countries", we think important to address the question of the endogeneity of EGs trade intensity.

4 Theoretical assumptions and econometric specifications

4.1 Pollution

Based on macroeconomic principles, many theoretical studies already focused their research on the determinants of pollution, as for the firms' side. Pollution determinants the most largely recognized are those proposed by Grossman (1995), who regards pollution as a by-product of production activities. Total emissions can thus be calculated using the equation:

$$E_t = Y_t \sum\nolimits_{j=1}^{n} \theta_{jt} Y_{jt} \tag{1}$$

where E_t are emissions of the year t; $j = 1, 2, \ldots, n$ represent the various economy sectors. Y_t is the total GDP (scale of the economy) in year t, it can also be presented by the sum of the n sectors' added-values, either $Y_t = \sum Y_{j,t}$. $\theta_{j,t}$ is the emission intensity, i.e. the average quantity of pollution emitted for each production unit in the j sectors, so $\theta_{j,t} = E_{j,t}/Y_{j,t}$. $\gamma_{j,t} = Y_{j,t}/Y_t$ represents the ratio of the sector's j added-value in the total GDP. According to this equation, total emission can be regarded as the product of the economy's total added-value (Y_t) and the average sectorial pollution intensity, weighted by the ratio of each sector's added-value in the total GDP ($\sum_{j=1}^{n} \theta_{jt}\gamma_{jt}$). Total differentiating and dividing all equation's terms by E, we can reproduce the Grossman's decomposition as following:

$$\widehat{E} = \widehat{Y} + \sum\nolimits_j e_j \widehat{\gamma}_j + \sum\nolimits_j e_j \widehat{\theta}_j \tag{2}$$

were $e_j = E_j/E$ represents the ratio of sector's j emission in the total pollution and $\widehat{X} = \left(\frac{dX}{dt}\right) X_t$, $X \in (Y, \gamma, \theta, E)$. This decomposition defines the famous three pollution determinants. $\widehat{Y}$ indicates the scale effect, supposed to be a growth factor of pollution. Everything else equal, any production increase means proportional increase in pollution. The composition effect is represented by $\widehat{\gamma}$. Dynamic changes in $\widehat{\gamma}$ represent the impact on pollution of any change in the economic activities structure. Everything else equal, if sectors having a strong pollution intensity grow more quickly than those being low pollution intensive, any change in the economic structure will influence pollution to increase more quickly than income. $\widehat{\theta}$ represents the technique effect. The use of more efficient techniques of production and abatement can lead to a pollution reduction for the same level of economic growth and industrial structure.

A number of works, like: Lucas, Wheeler and Hettige (1992), Harbaugh, Levinson and Wilson (2000), Dean (2002), Copeland and Taylor (2001, 2004), Antweiler, Copeland and Taylor (2001), Frankel and Rose (2005) show that these three effects are endogenous and often determined by trade openness. Almost all of these studies conclude by highlighting a rather positive relationship between trade and environment.

Firstly, trade can have a direct impact on the environmental quality, in the sense that trade liberalization increases EGs' trade intensity or simply shifts production from pollution intensive goods to more ecological ones, or vice-versa. However, trade intensity growth does not occur without impact on the economic development, which on its turn has an important role in supporting the technical effect. Dean (2002), for example, using pooled provincial data on Chinese water pollution, studies the relationship between international trade and industrial pollution. Its simultaneous-equations system estimation suggests that international trade increases pollution through the effect of pollution havens, but it also contributes to China's economic growth, which reduces in its turn pollution since a higher income reinforces the public demand for a better environmental quality. In our case, the global trade intensity, as proven in the literature, is considered to act positively on the economic development, promoting efficiency and technical progress. However, while considering some specific products' trade intensity, the effects on development may be different according to these products' trade balancesheets, import tariff revenues and their possibility to compete with foreign similar products. Concerning "transition countries", EGs trade liberalization may have a negative impact on the economic development, as these goods are mainly imported, while there is none competitiveness from domestic products, and revenues in these countries from import tariffs are very significant.

Finally, another indirect impact of trade openness on environment passes through environmental regulation. Trade may directly influence stringency of the environmental regulation via "race to the bottom" or "race to the top" phenomena that are said to occur when competition between nations or states (over investment capital, for example) leads to the progressive dismantling or, respectively, increase of regulatory standards. As for EGs trade intensity, it is supposed to stimulate stringency in environmental regulation, as modern abatement technologies become less expensive and more available.

Following this reasoning, we build a system of three simultaneous equations: the first one identifying the scale - composition direct effect of EGs trade intensity on the environment, while the last two ones capturing the indirect environmental impact of EGs trade intensity - via income and environmental regulation effects.

The first equation in our system, based on Eq.2, specifies total pollution level and its economic determinants:

$$E = e\left(Y, \gamma = f\left(K/L\right), \theta = f\left(R, \tau\right), Open\right) \tag{3}$$

Where:

E – pollution level / environmental quality in a country i at time t. In our empirical study, this variable will be represented by CO_2 and SO_2 annual emissions;

Y – total production in the economy, GDP;

$\gamma = f\left(K/L\right)$ – the composition effect γ is supposed to be function of capital (K, stock of capital) and labor (L, active population) relative endowments (Antweiler *et al.*, 2001, solve for the share of polluting production in total output as a function of the capital/labor ratio);

$\theta = f\left(R, \tau\right)$ – in our study, the technique effect, θ, is function of the environmental policy stringency, τ, and the economic development level / per capita revenue, R. The regulation acts directly on firms' pollution abatement efforts, but its severity and effectiveness are in general conditioned by the economic development level. Higher economic development levels allow firms to comply to regulation with less efforts and induce more preferences for better environmental quality on behalf of the population, which indifferently of the environmental policy stringency, can require from firms more environment protection.

$Open$ – economic openness represented here by trade intensity – share of trade (exports plus imports) in GDP.

The scale (Y), composition (γ) and technique (θ, represented by R and τ) effects are considered in this equation. Everything else equal, we expect a positive coefficient for the scale and composition effects, and a negative coefficient for the technical effect. We also include in this equation our trade intensity variables, for total EGs trade (EGs_A+B) and by different EGs classifications, (EGs_A and EGs_B) in order to capture their direct impact (scale - composition effect) on emissions.

Instead of including multiplicative terms between trade openness variables, economic development and environmental regulation, we estimate the technique effect (indirect effect) of trade intensity on pollution, using the following specifications:

$$\tau = e(R, Corrup, Democ, Open) \tag{4}$$

$$R = e(K, L, Geo, Inst, Open) \tag{5}$$

Where: $Corrup$ – corruption level; $Democ$ – democracy; Geo – geography/settlement characteristics (endowments, climate, healthy environment); $Inst$ – institutional quality.

Eq. 4 is derived from recent studies on environmental policy creation. Both theoretical and empirical studies have shown that trade, democracy and corruption have substantial influence on environmental policy. Based on predictions generated by a lobby group model and empirical findings, Fredriksson *et al.* (2005) suggest that environmental lobby groups tend to positively affect the stringency of environmental policy. Moreover, political competition tends to raise policy stringency, in particular where citizens' participation in the democratic process is widespread. Pellegrini and Gerlagh (2006) find that corruption stands out as an important determinant of environmental policies, while democracy has a very limited impact. Damania, Fredriksson and List (2003) develop a theoretical model producing several testable predictions: i) trade liberalization raises the stringency of environmental policy; ii) corruption reduces environmental policy stringency; and iii) the effect of trade liberalization (corruption) on environmental policy is conditional on the level of corruption (trade openness). All these predictions are validated empirically using data from a mix of 30 developed and developing countries from 1982-1992. Finally, Zugravu, Millock and Duchene (2008), using a common agency model of government for environmental policy creation, find empirically that stringency of environmental regulation depends on the consumers' preferences for environmental quality, represented by per capita revenues (higher are revenues, more consumers are willing to pay for environment).

We specify revenue function (5) following the endogenous growth literature. As Rodrik *et al.* (2004) point out, labor, physical and human capital, while affecting economic development, are in turn determined by deeper and more fundamental factors which fall into three broad categories: geography, institutions and trade (Acemoglu *et al.*, 2001, Frankel and Romer, 1999, Sachs, 2003, among others). Easterly and Levine (2003) provide a good overview of how each of these three determinants has been treated in the literature with the aim of explaining the vast differences in growth and levels of income amongst countries. The quality of institutions is widely considered one of the most important source of economic growth and development, while geography acting indirectly, through the channel of institutions. However, a recent study (Hibbs and Olsson, 2004) demonstrates the importance of the biogeographic initial conditions 12,000 years ago – which allowed for the transition from hunting-gathering to agriculture – as a nearly ultimate source of contemporary prosperity. Even if institutional conditions are considered, biogeography and geography remain significant explanatory variables for the differences in the level of economic development across the world. Gallup, Sachs and Mellinger (1999) state that geography plays a fundamental role in economic productivity through four main channels (direct and indirect): human health, agricultural productivity, physical location, and proximity and ownership of natural resources. Regarding the relative importance of the three deep determinants, Rodrik *et al.* (2004) report that institutions matter most for economic development once the endogeneity of intuitions and trade has been properly accounted for, leaving a negligible role for geography and trade. Sachs (2003), on the other hand, finds that geographical factors is the most important deep determinant of income and output, while Frankel and Romer (1999) underscore the importance of international trade. The authors suggest that trade has a quantitatively large and robust significant, positive effect on income.

We distinguish three endogenous variables in our system (Eq.3, Eq.4 and Eq.5): E, τ and R, and seven explana-

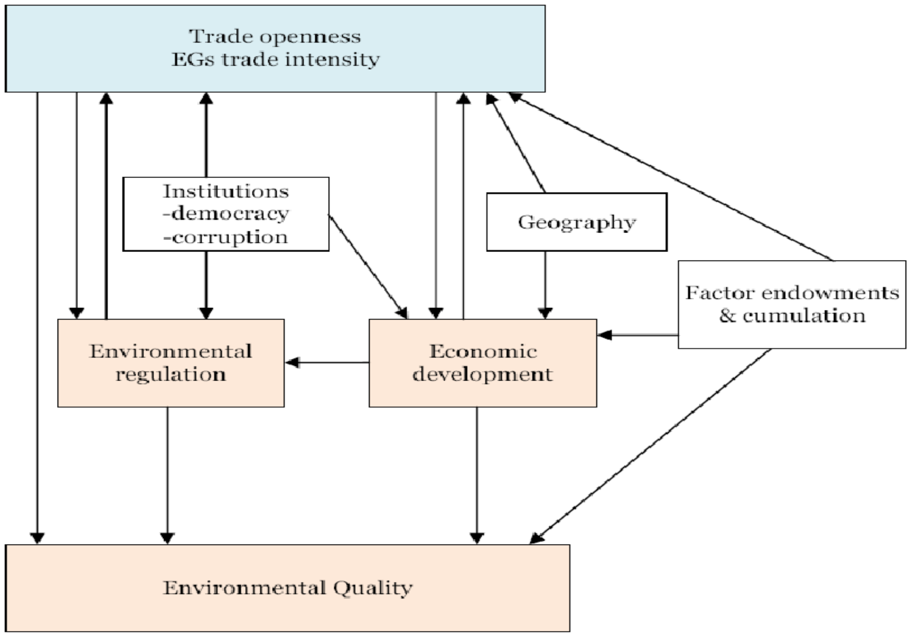


Figure 4: The relationship between trade and environment. Hypothesized causal relationship

tory variables - the system is thus over identified and may be estimated. However, this statement may be very plausible, as it is often argued that correlation between trade and income, for example, cannot identify the direction of causation between the two. Similarly, double causality may be revealed between trade and other variables in our system (see Figure 4): Y (scale effect - GDP), τ (especially for EGs' trade intensity), K and L. Hence, trade need to be endogenized and controlled for all these variables in order to assess its proper effects.

4.2 Bilateral trade

Gravity equation

One of the most used instruments for trade flows' study is the gravity equation – standard tool of the researchers in international economics designed to predict the bilateral trade between countries, which allows measuring the effect on trade of a regional, bilateral, multilateral trade agreement, of a common currency, etc.– the effect on trade of such elements beyond all that is predicted as natural trade.

Empirical research showed that several versions of gravity equation explain very well the variation of trade flows across couples of countries as well as across time (see Learner and Levinsohn, 1995). In its initial form (log-linear), the gravity equation links country's i exports towards country j to these countries' economic size and the geographical distance between them. Since Anderson (1979) it was recognized that gravity equation's predictions can be derived from very different structural models, including Ricardien, Heckscher-Ohlin (HO) and IRS (increasing returns to scale) models. This simple form can find a theoretical base within a neoclassic framework (Deardorff, 1995) and within a framework of increasing returns to scale and monopolistic competition (Helpman, Krugman, 1985; Bergstrang, 1989).

Thus, for our analysis of the economic determinants of EGs bilateral trade, we use the gravity equation based on its three reasons of success: - very good empirical explanation of trade flows; - a theoretical base well understood (monopolistic competition model with transport costs or HO model with trade costs); - a crucial role given to the geography, which took all its place in the international economics.

The gravity equation is in general a specification like:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 Dist_{ij} + u_{ijt} \tag{6}$$

where X_{ijt} represents exports of country i to country j at time t; GDP_{it} and GDP_{jt} are GDP of countries i and j at time t; D_{ij} is distance separating the two trade partners, and u_{ijt} is a error term specific to each couple of trade partners at each time period. The presence of GDP is a direct consequence of the monopolistic competition model's assumptions and their coefficients must be close to the unit. The $Dist_{ij}$ variable is in fact a good proxy for any factor influencing trade flows according to countries' geographical remoteness: transport costs, tariffs, time (perishable goods, goods for which the just in time is important etc.), transaction and communication costs.

Our assumptions compared to the general gravity model

- As the real world is not without friction, besides the geographical distance effect, there exist other trade barriers, such as for example: non-tariff barriers, regulation differences between countries, etc. Because international transactions involve multiple governance systems, the effectiveness of domestic institutions in securing and enforcing property rights in economic exchange is an important determinant of trade costs. Furthermore, formal rules affect informal norms of behavior and inter-personal trust, which influence the mores and conventions of doing business. These, in turn, may also impact on risk perceptions and preferences in international transactions. We therefore investigate the hypothesis that institutions matter for international trade. We also suppose here a direct impact of the environmental policy stringency on EGs trade flows. A more severe environmental regulation should encourage, on the one hand, an increased production, and thus more EPPs exports, and, on the other hand, a higher demand (more imports) for EGs referenced in OCDE+APEC lists, designed for the environmental quality management.

- Considering here the trade of "transition countries", where factor-endowment based trade is likely to be very significant, we cannot base our model only on the determinants issued from monopolistic theory framework, which perform the best for the most industrialized countries with intra-trade flows predominant. Works by Bergstrand (1989, 1990) have shown that the gravity equation can be derived from an ample variety of theoretical constructions some of which also incorporate some Heckscher-Ohlin (HO) features like different factor proportions. More recently Deardoff (1998) has shown that the simple gravity equation can be derived from the HO model both for the case of frictionless trade and also when transport and other border barriers are incorporated. Thus, monopolistic competition theory can successfully work in our case if differences in factor-endowments are controlled for.

- The classic gravity models assume identical, homothetic tastes across countries. But in the real-world, trade does not completely follow the Newton law, according to which imports from country i would be direct proportional to the country's j GDP multiplied by the share of country's i GDP in the world's GDP. In our case, the consumers' choices for EGs differ from one country to another, according to the environmental quality and the level of incomes. Country i will thus import products in value of country's j GDP multiplied by the share of its own GDP in the world's GDP, raised by the extent of consumers' preferences in country i for EGs produced in country j. Hence, we introduce in our gravity equation two variables assumed to capture the consumers' preferences for EGs: environmental quality and per capita revenue.

- Because countries are good at producing the quality not far from the one they demand, similar countries trade more with each other than very different countries, as suggested by Linder (1961). Linder's result that similar countries trade more with each other has been derived by Markusen (1986), who argued that richer countries produce capital-intensive goods, but also demand capital-intensive goods because these goods have more than unit-elastic income elasticity. Consequently, we think important to include in our gravity model variables designed to capture the impact on trade of absolute differences in institutional quality and stringency of environmental policy between trade partners.

- As a last point, but with the greatest interest for this study, we consider free trade agreements (FTA) as an important determinant of EGs bilateral trade. In order to ask the question concerning the need to liberalize environmental goods, we have first to identify the impact of such agreements on the existence and volume of EGs trade.

Aiming to encompass the great number of barriers to trade (distance, adjacency, language, regulation, etc.) and the consumers' preferences for EGs or EPP, we extend the gravity equation as following:

$$\begin{aligned}\ln X_{ijt} = {} & \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln K/L_{it} + \beta_4 \ln K/L_{jt} + \beta_5 \ln \tau_{it} + \beta_6 \ln \tau_{jt} + \beta_7 \ln \triangle\tau_{ijt} \\ & + \beta_8 \ln Inst_{it} + \beta_9 \ln Inst_{jt} + \beta_{10} \ln \triangle Inst_{ijt} + \beta_{11} \ln R_{jt} + \beta_{12} \ln E_{jt} + \beta_{13} FTA_{ijt} + \beta_{14} Dist_{ij} \\ & + \beta_{15} Adj_{ij} + \beta_{16} LangOff_{ij} + \beta_{17} LangEthn_{ij} + u_{ijt}\end{aligned} \quad (7)$$

with $Inst$ representing country-specific institutional quality; FTA - existence of a free trade agreement between the trade partners; Adj, $LangOff$ and $LangEthn$ for sharing a border, official and/or ethnos groups language, respectively.

Fixed effects specification

Aiming to highlight the determinants of a specific category of EGs trade flows, which for most of "transition countries" presents only a tiny part of the total trade, econometric investigation using only macro variables, as GDP, is not the most suitable. The use of fixed effects to collect all unobservable characteristics of importing and exporting countries would be desirable. A simple method was proposed by various authors, in particular Harrigan

(1996), Hummels (1999), Eaton and Kortum (2002), and Redding and Venables (2004). It consists in estimating an equation with fixed effects; which includes a dummy variable for each country: importing and exporting, respectively:

$$\ln X_{ijt} = FE_{it} + FE_{jt} + \Theta \ln CV_{it} + \Omega \ln CV_{jt} + D_{ij} + u_{ijt} \quad (8)$$

where CV_{it} and CV_{jt} are core variables in the model: stringency of the environmental regulation, institutional quality, K/L ratios, etc.; FE_{it} and FE_{jt} are dummy variables, taking value one for the concerned country and 0 otherwise, and capture the countries' effects which are not explained by CV_{it} and CV_{jt} variables; D_{ij} represent variables common to each couple of countries and u_{ijt} indicates the error term. This method also solves the nonlinearity problems and authorizes a recourse to ordinary least squares estimation method.

5 Empirical strategy

5.1 Estimation method

Before running our Pollution Model estimations, we test exogeneity of our explanatory variables. The Durbin-Wu-Hausman test reports endogeneity for GNI/cap, SEP, EGs trade intensity and GDP. The same test shows that GDP_{t-1} is exogenous for this model. Consequently, we use in our Pollution Model estimations GDP_{t-1} instead of GDP. As GNI/cap and SEP are estimated through separate equations, we need only to instrumentalize trade flows (our Figure 4 shows also endogeneity of trade in the causality scheme of environmental quality's determinants). For this purpose, we run panel fixed-effects regressions for our gravity model and discuss the results in the next section. Using the estimated coefficients, we obtain the fitted values of bilateral trade. We then take the exponent of the fitted values and finally sum across bilateral trading partners. By this means, we obtain instrumental variables for different EGs classifications' trade flows.

Next, we have to estimate a system of three simultaneous equations, where: in the first equation, the pollution is regressed on exogenous variables, stringency of environmental policy and per capita revenues; in a second equation, environmental policy is regressed on per capita revenues and exogenous variables; and, in the last equation, revenues are regressed on exogenous variables only. The system of equations is estimated by using a three-stage least squares (3SLS) procedure[3], for several reasons. First, ordinary least squares separately applied to each structural equation would result in biased and inconsistent estimators, given the correlation between the error terms and endogenous variables. Secondly, the order condition shows that all equations are over identified, so that an indirect least squares procedure cannot be used, since it is not possible to get unique estimates of structural parameters. Identifying restrictions are required in any simultaneous systems technique. These restrictions, which typically

[3] 3SLS is a system method that estimates all of the coefficients of the model and, then, forms weights and re-estimates the model using the estimated weighting matrix (In this case, the system is formed by the equation for each of the countries. The method uses all the information contained in the system to carry out the estimations). The method estimates all the identified structural equations together as a set, instead of estimating the structural parameters of each equation separately. It is based on the Two-Stage Least Squares estimator, but is asymptotically more efficient. As its name indicates, this method has three stages. In the first stage, we regress the right-hand side endogenous variables on all exogenous variables and get the fitted values. In the second stage, we regress the endogenous variables on the fitted values and the exogenous variables. In the third stage, Feasible Generalized Least Squares are applied to get the estimators.

involve the exclusion of variables from some equations, enable the parameters of the model to be derived uniquely. The simplest identifying restriction is the order condition which requires that the number of exogenous variables excluded from an equation is at least as large as the number of endogenous variables included in that equation. To check for correctness of the specification and for the internal consistency of the entire system we run Hausman Test for Misspecification, which does not reject the null hypothesis of no systematic difference between the 3SLS and the 2SLS estimates.[4]

For our panel data we need to conduct panel 3SLS. A way of doing this is using country dummies in each equation of our system in order to capture the unobserved country-specific effects. But fixed effects/country-dummies models have some drawbacks. The fixed effects models may frequently have too many cross-sectional units of observations requiring too many dummy variables for their specification. Too many dummy variables may deplete the model of sufficient number of degrees of freedom for adequately powerful statistical tests. Moreover, a model with many such variables (particularly interactions) may be plagued with multicollinearity, which increases the standard errors and thereby also drains the model of statistical power to test parameters. Although the model residuals are assumed to be normally distributed and homogeneous, there could easily be unit-specific heteroskedasticity or autocorrelation over time that would further plague estimation.

In this study, the panel was resolved by using Stata's command '*xtdata*', which transforms data set of all the variables: '*xtdata, fe*' for fixed effects (within) estimation (for each cross-sectional unit, the average over time is subtracted from the data in each time period - time-demeaned data) and '*xtdata, re*' for random effects model. Random effects coefficients have a dual nature: they simultaneously explain change over time and the cross-sectional differences among units. The implicit assumption is that both types of effects are the same. That is, when we say that a one unit increase in X is associated with a β units increase in Y, a one unit increase might mean two things: we observe two different countries with a one unit difference in X between them, or we observe one country, and its X value increases by one unit. In a random effects model, we are assuming that both of those produce the same effect on Y. That is, for instance, we assume that if two countries have different stringency of environmental policy by 1 unit, and if for a given country the environmental regulation become more stringent by one unit, the effect on the environmental quality would be the same. In this study, we use data transformed for random effects model, for some reasons. First, descriptive statistics for main variables indicate clearly that standard deviation *between* is bigger than *within*. Second, some variables of interest for this study are mostly invariant, like: SEP, FH, $Corrup$, while our core variables $EGs\ trade\ intensity$ fluctuate moderately. Third, for each specification, we make a Breusch Pagan Lagrange-multiplier test. In all our cases random-effects are significant.

All these transformations and tests performed, we run panel three-stage least squares with random-effects estimations.[5]

[4] Under 3SLS, if any single equation is misspecified, this misspecification is transmitted to all equations, due to using an inconsistently estimated covariance matrix in the third stage. Under 2SLS, only the single equation that is misspecified is affected by the misspecification. Under the null of no misspecification, the three-stage least squares results are efficient and consistent and the 2SLS results are consistent but not efficient.

[5] using STATA command '*reg3*', as after '*xtdata*', the command of *regress* is the same as using *xtreg* directly.

5.2 Data

In our empirical study, we make use of both country-specific and bilateral data from various sources (see the Appendix C for definitions, sources and descriptive statistics of all the variables). Gross domestic product for exporting and importing countries in the Trade Model are examples of country-specific variables that we include in the analysis. Geographical distance, adjacency, and main language, amongst others, are examples of other characteristics that we take into account for each pair of countries.

We constructed two datasets for our two general models: environmental quality factors and EGs trade determinants. Our databases are balanced panels of 22 "countries in transition", limited to the 1995-2003 period for reasons of data availability (see the list of countries in the Appendix B).

We have three endogenous variables in the **Environment Model**:

- *Pollution* (CO_2 and SO_2 emissions). Data on total CO_2 emissions come from IEA and cover 22 "transition countries" from 1995 to 2003, while data on SO_2 emissions are available for these countries for 1995-2002 period (with some missing points for 2001 and 2002 years). The data source of our SO_2 variable is an exhaustive data set of worldwide emissions of sulfur dioxide, carefully constructed by Stern (2006) from his own econometric estimates. Stern's recent global emission data are viewed as the most reliable, providing one of the most recent updates (covering the largest period) and a wide country coverage. SO_2 (anthropogenic) emissions have characteristics that make them suitable to study the effects of trade on the environment (a by-product of goods production; strong local effects; regulation across many countries; and available abatement technologies). Note that the focus of the paper is on positive analysis: we are interested in linking pollution to potentially traded production. That is why we use data on emissions rather than on concentration, even though the latter would be more appropriate to address welfare issues.

- *Stringency environmental policy*, one of the most difficult variable to measure since comparable data do not exist for all countries in the world and over time. We use in this study the SEP (stringency of environmental policy) index constructed by Zugravu, Millock and Duchene (2008). This index comprises at the same time variables of environmental policy and of industry's and the population's capacity to organize in lobbies (nongovernmental organizations, etc.) in order to put pressure on government's behavior towards a more environmentally-friendly direction. SEP index is calculated using five indicators: number of multilateral environmental agreements, existence of a regulation on air pollution, density of international nongovernmental organizations, number of ISO 14001 certified companies, and adhesion to the Responsible Care® Program.

- *Per capita income/Economic development* represented in our study by per capita Gross National Income (GNI/cap), data coming from WDI 2007, World Bank. We do not use GDP per capita for this indicator in order to make distinction between the scale of economy (GDP) and revenues (GNI), which entering simultaneously our pollution equation.

As explanatory variables in the Environment Model, we list EGs trade intensity, relative factor endowments (data on labor, L, and capital, K, from WDI 2007), geographic and institutional factors. We use the variable Lat (latitude) as a proxy for geographic factors. Latitude gives the location of a place on Earth north or south of the equator and it is one of the most important factors determining location's climate. The institutional factors are represented by two variables: $Corrup$ and FH, which mean corruption level and democracy, respectively. The first variable comes from the database constructed by Kaufmann *et al.* (2005), namely, it is the opposite of the *Corruption Control index*. This index measures the extent to which governments fight corruption and it takes values ranging between -2.5 and +2.5, the maximum values signifying less corruption. The change of sign that we do thus yields an indicator that varies directly with the degree of corruption of the country. All aspects of governance are interrelated. As a result, Kaufmann *et al.* indicators are highly positively correlated. For that reason, for our democracy variable, we use a different data source. Democracy, is measured in our study with the *Freedom House democracy index*. *Freedom in the World* published by Freedom House ranks countries by political rights and civil liberties that are derived in large measure from the Universal Declaration of Human Rights. Countries are assessed as free, partly free, or unfree. The political rights and civil liberties categories contain numerical ratings between 1 and 7 for each country or territory, with 1 representing the most free and 7 the least free. In our study, we use a variable FH computed by taking the mean of political rights and civil liberties indicators.

Using the estimated coefficients from our Trade Model (see Table 1), we obtain fitted values for bilateral trade. We then take the exponent of the fitted values and finally sum across bilateral trading partners. By this means, we obtain an instrumental variable for the openness and EGs trade intensity.

For our **Trade Model**, we use bilateral exports as dependent variable, such that each pair of countries yields two observations, with each country either as exporter or importer. Original trade flows data come from CEPII's database, $BACI$, world database for international trade analysis at the product-level, providing the most disaggregated (HS6) international trade database (more than 5000 products) for the largest number of countries (over 200) and years (from 1995 to 2005). We combine this database with the EGs classification lists, which are also specified at HS 6 digit level, and obtain a new dataset for trade in EGs. CEPII's database *Distances* provides the bilateral data: different distance measures and dummy variables indicating whether the two countries are contiguous or share a common language. There are two common languages dummies, the first one based on the fact that two countries share a common official language, and the other set to one if a language is spoken by at least 9% of the population in both countries. The dataset incorporates geographical variables for 225 countries in the world, including the geographical coordinates (latitude, longitude) of their capital cities, the languages spoken in the country under different definitions, a variable indicating whether the country is landlocked, etc. Finally, but also with great interest for this Model, we use FTA variable, which is a dummy taking value one if the couple of countries have signed a free trade agreement (FTA). This variable should indicate us the marginal effect of liberalizing trade on the scale of EGs trade flows relative to other factors.

A detail discussion of zero trade is necessary here. In many cases, these zeros occur simply because some pairs of countries did not trade in a given period. For example, it would not be surprising to find that Tajikistan and Togo did not trade EGs in a certain year. These zero observations pose no problem at all for the estimation of gravity equations in their multiplicative form. In contrast, the existence of observations for which the dependent variable is zero creates an additional problem for the use of the log-linear form of the gravity equation. A number of methods has been developed to deal with this problem (see Frankel, 1997, for a description of the various procedures). The approach followed by the large majority of empirical studies is simply to drop the pairs with zero trade from the data set and estimate the log-linear form by OLS. This truncation, however, makes the OLS estimator of β inconsistent. The severity of the problem will depend on the particular characteristics of the sample and model used, but there is no reason to believe that it will always be negligible. Naturally, there are other reasons for observing pairs of countries with zero trade. For example, zeroes may be the result of rounding errors. If trade is measured in thousands of dollars (as in our case), it is possible that for pairs of countries for which EGs bilateral trade did not reach a minimum value, say $500, the value of trade is registered as zero. Because there is a large number of pairs of countries for which the value of EGs bilateral trade is expected to be very small, it is likely that the rounding down will not be totally offset. To deal with this problem, we use a simple and very popular technique: we keep in our study all zero-trade observations and transform data by multiplying trade flows by 1000 (to transform thousands) and adding one unity (to use logs).

All variables in our Models are log-linear and the estimates' coefficients represent thus the marginal effects of explanatory variables on endogenous variables.

6 Empirical results

6.1 Determinants of EGs bilateral trade

For our gravity model, we report comparative results for total bilateral trade (model 1), trade of EGs_A+B (model 2), trade of EGs_A (model 3), and trade of EGs_B (model 4). Most of the coefficients estimated in Table 1 agree with those traditionally reported in the literature and are highly significant.

Before investigating the effects of FTAs and institutions, we first discuss standard variables often applied in the literature. We regress bilateral trade on the levels of gross domestic product in the exporting and importing country. Our specification of the gravity model corresponds to basic new trade theory models, in which trade is positively related to market size. We find that GDP positively and significantly affects trade. Since we focus on exports rather than total bilateral trade, we can also examine whether the effect of GDP on trade differs between the country of origin and the country of destination of trade flows. The results indicate that import demand for EGs (all classifications, EGs_A+B) and export supply of EGs_A are income elastic: a 1% increase in GDP raises bilateral trade on average by about 2 %. Our Trade Model allows for an effect of the relative factor endowments on trade. Trade is estimated to increase with the capital accumulation in the importing country (model 1). These coefficients are statistically significant at the 1% level. Capital abundance in the importing country appear to be a determinant of EGs_A trade (model3), but has no significant effect on EGs_B trade (model 4). The coefficient of the distance variable has the expected negative sign, since it is a proxy of all possible trade and information costs, and is highly significant. The adjency and language dummies have the expected positive sign and also are statistically significant at the 1% level. The distance and border effects are larger for EGs than for overall trade

Table 1: Trade estimation, Importer and Exporter Fixed Effects

	(1) $\ln Trade$	(2) $\ln Trade\_EGs\_A+B$	(3) $\ln Trade\_EGs\_A$	(4) $\ln Trade\_EGs\_B$
$\ln GDP\_M$	0.7109***	2.0099***	2.0315***	2.1088***
$\ln GDP\_X$	0.9245***	0.6084*	2.1169***	0.0701
$\ln K/L\_M$	0.3148***	0.1577	0.3302**	0.0382
$\ln K/L\_X$	-0.0501	0.0396	0.0384	0.1589
$\ln SEP\_M$	0.0123	0.2029	0.4305	0.6887*
$\ln SEP\_X$	0.5828***	1.0697***	1.4454***	0.6483
$\ln DiffSEP$	-0.1060***	-0.0772***	-0.2520***	-0.1488***
$\ln FH\_M$	0.1595**	-0.1264	0.2554	0.3551*
$\ln FH\_X$	0.0226	0.1222	0.5674***	0.5861***
$\ln DiffFH$	-0.0981***	-0.0880***	-0.3178***	-0.5265***
$\ln GNI/cap\_M\_1$	0.0867	0.2572	-0.1281	0.3356
$\ln CO_2/cap\_M\_1$	0.0213	0.0306	0.1050	-0.5349**
FTA	0.3842***	0.3365***	0.9039***	1.4460***
$\ln Dist$	-1.0412***	-1.1375***	-1.7971***	-2.0578***
Adj	0.8526***	1.2093***	1.2745***	1.9009***
$LangEthn$	0.6218***	0.9523***	1.2541***	1.7121***
$LangOff$	0.5042**	1.0786**	1.5850***	2.8361***
$Importer\ FE$	Yes	Yes	Yes	Yes
$Exporter\ FE$	Yes	Yes	Yes	Yes
$R-squared$	0.71	0.47	0.61	0.46
$N.of obs.$	24147	24147	24147	24147

* p<0.1, ** p<0.05, *** p<0.01

flows, and among EGs classifications, these effects are even more important for EGs_B trade than for EGs_A trade. Geographical distance seems to be a barrier to EPPs trade in a greater extent than for EGs referenced in OCDE + APEC lists. The importer and exporter dummy variables represent all country-specific factors that might be relevant for their propensity to trade, either in the role as exporter or as importing country. The resulting parameter estimates for bilateral variables generally become more precise and do not suffer from omitted variable biases.

Although differing between indicators and according to the country's role as exporter or importer, the impact of variation in the quality of institutions on trade is substantial. An increase in democracy (FH) of 10% leads to an estimated increase of overall bilateral imports by 1.6%, EGs_B bilateral imports by 3.6%, and EGs_A and EGs_B bilateral exports by approximately 6%. These results are supported by the findings of Brock and Boadu (2004), who report import demand elasticities for environmental goods and services (EGS) for the world in aggregate and for six world regions and show that political and economic freedoms (amongst per capita incomes, exchange rates, and debt) affect the demand for EGS. We find also a positive and statistically significant effect of stringency of environmental policy (SEP) on EGs_B imports and on EGs_A exports. Our results show that differences in institutional quality (SEP and FH) reduce significantly overall bilateral trade, and even more the EGs bilateral trade flows (models 3 and 4). Countries with similar environmental regulations trade more EGs referenced in the OECD and APEC lists. On the basis of these findings, we can conclude that institutions, and especially environmental regulation, are dominant in explaining why rich countries trade more EGs (class A) in general, and more so amongst each other, while developing countries trade less amongst themselves (EPPs principally). We found no effect of consumer preferences (proxied by GNI/cap and CO_2/cap) on EGs bilateral trade, except the negative impact of pollution on EPPs trade (model 4), for which we have no explanation. Finally, we find FTA

having a statistically significant and positive impact on EGs bilateral trade. Pairs of countries that have signed FTAs trade 2.5 times more EGs_A and 4 times more EGs_B than countries under no trade agreement.

Following our Trade Model estimations results, we can conclude that liberalizing EGs may raise at least twice EGs trade flows of "transition countries". However, more attention must be paid to other determinants, and namely institutional quality and stringency of environmental policy.

6.2 Economic and environmental impact of EGs trade

The OLS estimate provides only partial estimators for the effects of trade on environment. This method does not give any idea of the indirect impact in comparison with direct effects, from where our interest for three stage least squares. Our empirical results for the Environment Model are reported in Table 2.The first three columns display findings for CO_2 emission determinants, while the three last ones present the results for SO_2 emissions. Models (1) and (4) estimate the environmental impact of openness/overall trade intensity in comparison to the models focused on EGs. Models (2) and (5) show the effects of $EGs\_A + B$ trade intensity, and models (3) and (6) display distinct estimates for EGs_A and EGs_B trade intensities, for CO_2 and SO_2, respectively.

We start by analyzing the empirical results for each equation in our system. In order to separately identify the scale effect (due to GDP) and technique effect (due to GNI, and also SEP), we follow the strategy of Antweiler, Copeland and Taylor (2001), which consists in considering the difference between GDP (which measures the intensity of the economic activity in a given country) and GNI (which measures the richness of country's habitants and their willingness to pay for environmental quality). As for the composition effect of the international trade, it is estimated in a flexible way, by authorizing its sign and its size to be dependent on the capital endowments. The empirical results for our environmental quality equation confirm the theoretical assumptions: GDP (all six models) and physical capital endowments (models 2 and 3) tend to increase pollution, while the GNI and the SEP reduce it. SEP captures the technique effect of the environmental regulation, which is estimated separately from the technique effect induced by the richness of country's habitants, GNI/cap. Trade openness appears to have a direct positive impact on pollution (models 1 and 4). EGs trade intensity has no direct impact on SO_2 emissions., while $EGs\_A + B$ trade intensity increases CO_2 emissions. The same impact is found for EGs_A trade intensity. As for EGs_B, their trade intensity has a direct negative and statistically very significant effect on CO_2 emissions (model 3).

The estimation results for environmental policy equation show a positive effect of GNI/cap in our CO_2 models. Corruption tends to reduce stringency of the environmental policy. We find also that countries with more open trade regimes tend to have stricter environmental regulations. Similar results are found by Damania, Fredriksson and List (2003), who show also that the effect of trade liberalization on environmental regulations is conditional on the level of corruption: the greater the level of corruption in government, the larger are the effects of openness to trade on environmental stringency; moreover, a reduction of corruption has a greater effect on policy in a closed economy. An interdependent effect of trade and corruption is also found in our models (1) and (4), but its interpretation is opposite to the findings of Damania, Fredriksson and List (2003): the effects of openness to trade

Table 2: Environmental impact of EGs trade intensity

	(1)	(2)	(3)	(4)	(5)	(6)
$EnvQual$	$\ln CO_2$	$\ln CO_2$	$\ln CO_2$	$\ln SO_2$	$\ln SO_2$	$\ln SO_2$
$\ln GDP\_1$	1.2626***	1.1591***	1.0021***	1.4181***	1.4675***	1.4329***
$\ln K/L$	0.0730	0.2093**	0.2749***	-0.1451	-0.1277	-0.1534
$\ln GNI/cap$	-0.6808***	-0.2791**	-0.6716***	-0.4918**	-0.3539	-0.4248*
$\ln SEP$	-2.3139***	-7.1313***	-7.0277***	-2.7337*	-2.5847	-3.5286*
$\ln Openness$	0.1876***			0.2923*		
$\ln TrInt\_EGs\_A+B$		0.2432***			-0.1022	
$\ln TrInt\_EGs\_A$			0.3232***			0.0045
$\ln TrInt\_EGs\_B$			-0.1560***			0.0885
$constant$	-4.5016	13.7410***	19.9851***	-6.2232	-9.2438	-3.5527
$\ln SEP$						
$\ln GNI/cap$	0.0457**	0.0698***	0.0417*	0.0196	0.0318	0.0197
$\ln FH$	-0.0302	-0.0123	-0.0133	-0.0333	-0.0331	-0.0387
$\ln Corrup$	-0.3271***	-0.0568	-0.0544	-0.5062***	-0.1859***	-0.1407**
$\ln CorrOpen$	-0.1534***	-0.0024		-0.2852***		
$\ln Openness$	0.5963***			1.0950***		
$\ln TrInt\_EGs\_A+B$		0.0359***			0.0402***	
$\ln TrInt\_EGs\_A$			0.0180**			0.0178*
$\ln TrInt\_EGs\_B$			-0.0018			0.0029
$constant$	4.9092***	3.6991***	3.9805***	5.7507***	4.4402***	4.4706***
$\ln GNI/cap$						
$\ln K$	0.6392***	0.6622***	0.5291***	0.6526***	0.6689***	0.5564***
$\ln L$	-0.6138***	-0.6457***	-0.5950***	-0.5928***	-0.6051***	-0.5789***
$\ln FH$	0.1532***	0.1523***	0.0947**	0.1947***	0.1962***	0.1189**
$\ln Lat$	2.0873***	2.4155***	1.3433**	2.2581***	2.4513***	1.4623**
$\ln Openness$	0.0949***			0.0468		
$\ln TrInt\_EGs\_A+B$		0.0264			-0.0049	
$\ln TrInt\_EGs\_A$			0.1087***			0.0917***
$\ln TrInt\_EGs\_B$			-0.0318			-0.0288
$constant$	-7.2181***	-8.8922***	-1.5175	-8.6563***	-9.7785***	-2.9441
N. of obs.	198	198	198	148	148	148

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

on environmental stringency are largest in the "transition countries" with small corruption levels, and a reduction of corruption has a greater effect on policy in a opened economy. As expected, the EGs_A+B trade intensity has a significant and positive impact on the environmental stringency (models 2 and 5), while looking for differences between EGs class A and B, only trade intensity of EGs referenced in OECD and APEC lists (class A) has a significant effect on the stringency of the environmental policy (models 3 and 6).

The revenue equation estimates confirm the predictions of the endogenous growth literature. For all our six models, we find that relative capital abundance, better institutions (FH/democracy), distance from equator (Lat/geography) and openness raise per capita income. These results are robust (except openness in model 4) and very significant. As for EGs trade intensity, we find that only EGs_A trade intensity have a positive statistically significant impact at the 1% level on income.

To conclude, we compute the overall impact of EGs trade intensity on the environmental quality in order to see if its indirect technique effects offset or complement the direct scale-composition effect. If focusing on EGs_A+B trade intensity, we find a direct positive effect on CO_2 pollution - EGs trade intensity increases CO_2 emissions -, and an indirect negative effect via SEP, that offsets the first one. On the whole, trade intensity of the broad list of EGs (classes A+B) has a negative net impact on CO_2 emissions. No statistically significant effect is found for

$EGs\_A + B$ on SO_2 emissions.

Moreover, looking at distinct EGs lists, we can find some more interesting results, with some political implications. Only trade intensity of EPPs has a direct scale-composition (negative) effect on pollution (CO_2 emissions only) and it has no technique indirect effects. This result is in some way obvious, as EPPs production and/or consumption is less pollutant (scale-composition direct effect), and their uses are not usually pollution abatement processes (so no technique indirect effects). More interesting and ambiguous results are found for EGs referenced in OECD and/or APEC lists (class A). These products' trade intensity has a positive direct scale-composition effect on CO_2 emissions and negative technique effects passing through both SEP and GNI/cap. However, the total technique (indirect) effect is small and does not compensate the direct positive scale-composition effect. Hence, the overall effect on pollution is positive, i.e. EGs_A trade intensity raises CO_2 emissions. On the contrary, looking at SO_2 emissions, EGs_A trade intensity has no direct impact but perform only a negative indirect (technique) effect passing via SEP and GNI/cap, i.e. EGs_A trade intensity reduces SO_2 emissions.

Conclusion

Using an extensive dataset on "transition countries" and rigorously developed empirical techniques and models, this study looks to support or disapprove the need for "transition countries" to liberalize trade in EGs, and to highlight some political implications.

This study treats trade, environmental policy and income as endogenous and estimates the overall impact of EGs trade intensity on the environment using the technique of instrumental variables and three stage least squares estimation method on panel data. EGs trade is instrumented using gravity model estimates and enters exogenously our system of three simultaneous equations: pollution, environmental policy and income. We identify a direct scale-composition effect of EGs trade intensity on environmental quality, and a indirect technique effect passing through the stringency of environmental regulation end per capita revenues. The interest here is to compute the overall impact: if it is positive, one can support the EGs trade liberalization.

Following our empirical results for the environmental impact of trade intensity in goods referenced in one of EGs lists (class A + class B), we find that EGs trade intensity has a negative net impact on CO_2 emissions in the "transition countries": the total technique (negative) effect offsets the positive scale-composition effect. Nevertheless, this finding can be misleading while asserting that trade intensity of EGs of any classification improves the environmental quality. In fact, following our empirical results, we cannot formally support liberalization of EGs listed by OECD and/or APEC - the reference list in WTO negotiations -, as their impact is ambiguous in our study: we find an overall positive impact on CO_2 emissions and a negative impact on SO_2 emissions. Moreover, we find a positive impact of these EGs' trade intensity on income. Does it happen through technological progress and modernization, cross-country wage harmonization? Or, is it simply the effect of import tariffs (as "transition countries" are net importers of these products)? The response is not so obvious, but our results show that, in the second case, liberalizing EGs trade (OECD + APEC lists) may have a harmful impact on the environment, as revenues (from tariffs) decrease and the technique effect does not offset the positive scale-composition effect on pollution.

On the contrary, we find a negative scale-composition (direct) impact on CO_2 emissions of EPPs trade intensity. The "transition countries" can thus have interest to liberalize these products' trade in order to directly benefit for the environmental quality (CO_2 reductions). No other ambiguous/indirect effect is found for EPPs trade intensity. However, these results do not mean for "transition countries" to pay attention only to EPPs trade liberalization and exclude from negotiations the EGs referenced in OCDE+APEC lists. The two lists of EGs (classes A and B) are of interest for "transitions countries" in order to benefit for the environmental quality directly (EPPs) and indirectly via technique effects (OECD and APEC lists). These lists have not to be exhaustive, but adapted case by case and flexible to negotiations.

Finally, we find that free trade agreements raise twice the trade flows of EGs referenced in OCDE+APEC lists, and four times the EPPs trade. But liberalization is not the only determinant factor of the EGs trade intensity. Our study highlights the importance of the institutional quality and, particularly, the role of stringency of the environmental policy in determining the volume of EGs trade. Countries with more efficient environmental policy trade more, especially with countries having similar SEP. Hence, to increase EGs trade flows, attention must be paid not only to liberalization issues, but also to cross-country harmonization of environmental regulation, and institutional quality in general.

References

Acemoglu, Daron, Simon Johnson and James A. Robinson (2001), The Colonial Origins of Comparative Development: An Empirical Investigation, *American Economic Review*, 91(5), 1369-1401

Anderson J. E., (1979), A theoretical Foundation For the gravity equation, *American Economic Review* 69, p 106 – 116

Antweiler W., Copeland B.R. and Taylor M.S. (2001), Is Free Trade Good for the Environment? *American Economic Review* 91(4), 877-908.

Bergstrand J. (1989), The Generalised Gravity Equation, Monopolistic Competition, and the Factor-Proportions theory in International Trade, *The Review of Economics and Statistics*, n°71, p. 143-153.

Bergstrand, J, (1990), The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade, *Economic Journal 100*, pp1216-1229.

Brock Avery and Fred O. Boadu (2004), Global Demand for U.S. Environmental Goods and Services, *Journal of Agricultural & Applied Economics*, vol. 36, issue 1, pages 49-64

Canton, J. (2007), Environmental Taxation and International Eco-Industries, Nota de lavoro 26-2007, FEEM.

Claro, Edmuno, Nicolas Lucas,Mahesh Sugathan,Mario Marconini and Enrique Lendo (2007), Trade in Environmental Goods and Services and Sustainable Development: Domestic Considerations and Strategies for WTO Negotiations. *ICTSD Environmental Goods and Services Series, Policy Discussion Paper.*

Corden, W. Max. (1974), Trade Policy and Economic Welfare *Oxford: Clarendon Press.*

Copeland B.R. and Taylor M. S. (2001), International Trade and the Environment: A Framework for Analysis, NEGR Working Paper No. 8540, Oct.

Copeland Brian R. and Taylor M.S. (2004), Trade, Growth and the Environment. *Journal of Economic Literature* 42(1), 7-71.

Copeland, B. (2005), Pollution Policy and the Market for Abatement Services, *Mimeo*, University of British Columbia, Vancouver, Canada.

Damania, Richard, Fredriksson, Per G. and List, John A. (2003),Trade liberalization, corruption, and environmental policy formation: theory and evidence, *Journal of Environmental Economics and Management*, 2003; 46 (3):490-512

Dean J. (2002), Does Trade Liberalization Harm the Environment? A New Test. *Canadian Journal of Economics*, 35(4), 819-842.

Deardorff A. (1995), Determinants of Bilateral Trade : Does gravity Work in Neoclassical World ?, *NEGR Working Paper* n°5377, December.

Deardoff, A. (1998), Determinants of Bilateral Trade: Does Gravity Work in A Neoclassical World? In J.A. Frankel, ed. *The Regionalization of the world economy.* Chicago: University of Chicago Press.

Easterly, William and Levine, Ross (2003), Tropics, Germs, and Crops: How Endowments Influence Economic Development, *Journal of Monetary Economics*, 50(1): 3-39

Eaton, Jonathan, and Samuel Kortum. (2002),.Technology, Geography, and Trade, *Econometrica* 70: 1741-1779

Feess, E., and G. Muehlheusser, (2002), Strategic Environmental Policy, Clean Technologiesand the Learning Curve, *Environmental and Resource Economics* 23: 149-166

Feess, E. and G. Muehlheusser (1999), Strategic Environmental Policy, International Trade, and the Learning Curve: The Significance of the Environmental Industry, *Review of Economics*, 50(2): 178-94.

Frankel J. (1997), Regional Trading Blocs in the World Economic System, *Institute for International Economics*, Washington D.C.

Frankel, J., and D. Romer (1999). Does Trade Cause Growth? *American Economic Review*, 89(3):379-399.

Frankel J.A. and Rose A.K. (2005), Is Trade Good or Bad for the Environment? Sorting out the Causality, *Review of Economics and Statistics* 87(1), 85-91.

Fredriksson Per G., Eric Neumayer, Richard Damania and Scott Gates (2005), Environmentalism, democracy, and pollution control, *Journal of Environmental Economics and Management*, vol. 49, issue 2, pages 343-365

Gallup, J. L., J. D. Sachs, and A. Mellinger (1999), Geography and Economic Development, *CID Working Paper*, No. 1, March 1999.

Greaker, M. and E. Rosendahl (2006), Strategic Climate Policy in Small, Open Economies, *Discussion Paper n448*, Statistics Norway.

Grossman G. and Krueger A. (1995), Economic Growth and the Environment, *Quarterly Journal of Economics*, 353-377

Hamwey, R., Hoffmann, U., Vikhlyaev, A., and R. Vossenaar (2003), Liberalization of International Trade in Environmental Goods and Services, *Background Paper,* Sub-Regional Brainstorming Workshop on the Trade and Environment Issues Contained in Paragraphs 31 and 32 of the WTO Doha Ministerial Declaration.

Harbaugh W., Levinson A. and Wilson D. (2000), Re-examining the Empirical Evidence for an Environmental Kuznets Curve, *NEGR Working Paper No. 7711.*

Harrigan, J. (1996), Openness to trade in manufactures in the OECD, *Journal of International Economics* 40, 23-39.

Harrison, Ann (1995), Openness and Growth: A Time-Series, Cross-Country Analysis for Developing Countries, *NBER Working Paper* No. 5221, August.

Helpman, E. and P. Krugman (1985), Market Structure and Foreign Trade, Cambridge, Massachusetts, *MIT Press.*

Hibbs, D. A., and O. Olsson (2004), Geography, biogeography, and why some countries are rich and others are poor, *PNAS*, Vol. 101, No. 10, pp. 3715-3720, 9

March 2004.

Hummels, D. (1999), Toward a geography of trade costs. *Mimeo*, University of Chicago.

Kennedy, P.W. (1994), Equilibrium Pollution Taxes in Open Economies with Imperfect Competition, *Journal of Environmental Economics and Management*, 27(1): 49-63.

Kennett, M. and R. Steenblik (2005), Environmental Goods and Services: A Synthesis of Country Studies, *Trade and Environment Working Paper n2005 03*, Organization for Economic Cooperation and Development, Paris, France.

Learner E. and J. Levinsohn (1995), International Trade Theory: The Evidence, *in Handbook of Internal Economics*, Vol. 3. Amsterdam: North Holland.

Linder, Staffan (1961), An Essay on Trade and Transformation, New York: John Wiley and Sons.

Lucas R., Wheeler D. and Hettige H. (1992), Economic Development, Environmental Regulation, and the International Migration of Toxic Industrial Pollution, 1960-1988, *International Trade and the Environment*, Ed. Patrick Low (Washington DC: World Bank).

Markusen, James R. (1986), Explaining the Volume of Trade: An Eclectic Approach, *American Economic Review* 76, 1002-1011.

Pellegrini L. and R. Gerlagh (2006), Corruption, Dem7b55ae8feocracy and Environmental Policy: an Empirical Contribution to the Debate, *Journal of Environment and Development*, 15 (3): 332-354

Redding, S. and A.J. Venables (2004), Economic geography and international inequality. *Journal of International Economics* 62, 53-82.

Rodrik, Dani, Arvind Subramanian and Francesco Trebbi (2004), Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development, *Journal of Economic Growth*, 9(2):131-165

Sachs, Jeffrey D (2003), Institutions Don't Rule: Direct Effects of Geography on Per Capita Income, National Bureau of Economic Research, Inc, *NBER Working Papers*: 9490.

Stern D.I. (2006), Reversal of the trend in global anthropogenic sulfur emissions, *Global Environmental Change* 16 (2006) 207–220

Svedberg, P. (1979), Optimal tariff policy on imports from multinationals, *Economic Record* 55, pp. 64-67

UNCTAD (2003), Environmental Goods: Trade Statistics of Developing Countries, TD/B/COM.1/EM.21/CRP.1, Geneva, Switzerland.

Zugravu N., Millock K. and Duchene G. (2008), The Factors Behind CO_2 Emission Reduction in Transition Economies, *FEEM Working paper* n° 2008.58.

WTO (2005), Report of the Workshop on Environmental Goods. Job(05)21. Held 11 October 2004.

Appendices

A Composition of the EGs lists, HS-96 6-digit codes

EGs_OCDE + APEC lists 220100, 220710, 230210, 252100, 252220, 280110, 281410, 281511, 281512, 281610, 281830, 282010, 282090, 282410, 283210, 283220, 283510, 283521, 283523, 283524, 283525, 283526, 283529, 283822, 285100, 290511, 320910, 320990, 380210, 381500, 391400, 392020, 392490, 392690, 460120, 560314, 580190, 591190, 681099, 690210, 690220, 690290, 690310, 690320, 690390, 690919, 700800, 701710, 701720, 701790, 701990, 730900, 731010, 731021, 731029, 732510, 780600, 840410, 840420, 840510, 840991, 840999, 841000, 841011, 841012, 841013, 841090, 841320, 841350, 841360, 841370, 841381, 841410, 841430, 841440, 841459, 841480, 841490, 841780, 841790, 841911, 841919, 841940, 841950, 841960, 841989, 841990, 842119, 842121, 842129, 842139, 842191, 842199, 842220, 842381, 842382, 842389, 842490, 842833, 843680, 846291, 847290, 847410, 847410, 847432, 847439, 847982, 847989, 847990, 848110, 848130, 848140, 848180, 850231, 850590, 851410, 851420, 851430, 851490, 851629, 853931, 854140, 854389, 870892, 890710, 890790, 901320, 901540, 901580, 901590, 902229, 902290, 902511, 902519, 902580, 902590, 902610, 902620, 902680, 902690, 902710, 902720, 902730, 902740, 902750, 902780, 902790, 902810, 902820, 902830, 902890, 903010, 903020, 903031, 903039, 903083, 903089, 903090, 903110, 903120, 903130, 903149, 903180, 903190, 903210, 903220, 903281, 903289, 903290, 903300, 960310, 960350, 980390

EGs_EPPs 050900, 121110, 121120, 121190, 130110, 130120, 130190, 130219, 140190, 140310, 140390, 140410, 150510, 150590, 152110, 152190, 230690, 230890, 310100, 320190, 320300, 320910, 321000, 400110, 400121, 400122, 400129, 400280, 450110, 450200, 450310, 450390, 460120, 460191, 460210, 480610, 500200, 500400, 500600, 500710, 500720, 500790, 510111, 510119, 510121, 510129, 510130, 510310, 510320, 510400, 510510, 510521, 510529, 510610, 510710, 510910, 510910, 511111, 511119, 511190, 511211, 511219, 511290, 511290, 530110, 530121, 530129, 530210, 530290, 530310, 530410, 530521, 530591, 530710, 530720, 530810, 530890, 531010, 531090, 531100, 531100, 560710, 560721, 560729, 560750, 560890, 570110, 570220, 570231, 570241, 570251, 570291, 570310, 580110, 581099, 600129, 600199, 600241, 600291, 630120, 630510, 670100, 680800, 850680, 850780, 960310

Source: UNCTAD (2003), Environmental Goods: Identifying Items of Export Interest to Developing Countries

B List of countries

CO_2 models: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Slovenia, Tajikistan, Ukraine and Uzbekistan, with no observation missing for 1995-2003 years (198 observations: 22 countries for 9 years).

SO_2 models: some data are missing for 2001 and 2002 years.

Country / Year	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	**Total**
Albania	1	1	1	1	1	1	0	0	**6**
Armenia	1	1	1	1	1	1	1	0	**7**
Azerbaijan	1	1	1	1	1	1	0	0	**6**
Belarus	1	1	1	1	1	1	1	0	**7**
Bulgaria	1	1	1	1	1	1	1	0	**7**
Czech Republic	1	1	1	1	1	1	1	1	**8**
Estonia	1	1	1	1	1	1	1	0	**7**
Georgia	1	1	1	1	1	1	0	0	**6**
Hungary	1	1	1	1	1	1	1	1	**8**
Kazakhstan	1	1	1	1	1	1	0	0	**6**
Kyrgyzstan	1	1	1	1	1	1	0	0	**6**
Latvia	1	1	1	1	1	1	1	0	**7**
Lithuania	1	1	1	1	1	1	1	0	**7**
Poland	1	1	1	1	1	1	1	1	**8**
Republic of Moldova	1	1	1	1	1	1	0	0	**6**
Romania	1	1	1	1	1	1	1	0	**7**
Russian Federation	1	1	1	1	1	1	0	0	**6**
Slovakia	1	1	1	1	1	1	1	1	**8**
Slovenia	1	1	1	1	1	1	1	0	**7**
Tajikistan	1	1	1	1	1	1	0	0	**6**
Ukraine	1	1	1	1	1	1	0	0	**6**
Uzbekistan	1	1	1	1	1	1	0	0	**6**
Total	**22**	**22**	**22**	**22**	**22**	**22**	**12**	**4**	**148**

Table 3: List of transition countries in SO2 models

C Data summary

Variable	Definition	Source
CO_2	Carbon dioxide emissions, in kT	International Energy Agency
SO_2	Sulfur Emissions, in TgS	David Stern (2006)
GDP	GDP in constant 2000 US$	WDI 2007, World Bank
GNI/cap	GNI: Atlas method, current US dollars - Net income per capita	WDI 2007, World Bank
K	Capital stock calculated by using the following formula: Creation of fixed assets$_t$ +0.95*Capital stock$_{t-1}$.	WDI 2007, World Bank + author's calculation
L	Active population (the labor)	WDI 2007, World Bank
K/L	Capital stock to Labour ratio	Author's calculation
SEP	Stringency of Environmental Policy Index	Zugravu N., Millock K. and Duchene G. (2008)
$Corrup$	Corruption index	Kaufmann *et al.* (2005)
FH	The average of the two variables of Freedom House : « Political Rights » and « Civil Liberties »	Freedom House
Lat	Technically, latitude is an angular measurement in degrees ranging from 0° at the equator to 90° at the poles	CEPII's database $Distances$
$Trade$	Bilateral trade (all products)	CEPII's database $BACI$
$Trade\_EGs\_A+B$	Bilateral trade of EGs (all EGs classifications confused)	CEPII's database $BACI$ and EG lists
$Trade\_EGs\_A$	Bilateral trade of class A EGs (OECD and APEC lists)	CEPII's database $BACI$ and EG lists
$Trade\_EGs\_B$	Bilateral trade of class B EGs (environmentally preferable products, UNCTAD list)	CEPII's database $BACI$ and EG lists
$Openness$	Total trade intensity - Openness: (Export+Import)/GDP	Author's calculation ($BACI$)
$TrInt\_EGs\_A+B$	Trade intensity of EGs (all classifications confused)	Author's calculation ($BACI$ & EGs lists)
$TrInt\_EGs\_A$	Trade intensity of class A EGs (OECD and APEC lists)	Author's calculation ($BACI$ & EGs lists)
$TrInt\_EGs\_B$	Trade intensity of class B EGs (environmentally preferable products, UNCTAD list)	Author's calculation ($BACI$ & EGs lists)
FTA	Free Trade Agreement Notified to the WTO and in Force: dummy=1 if the pair of countries signed a FTA , 0 - otherwise	World Trade Organization
$Dist$	Outdistance in km between the capitals of business partners	CEPII's database $Distances$
Adj	Adjacency: dummy=1 if the pair of countries shares a common border, 0 - otherwise	CEPII's database $Distances$
$LangOff$	Official language: dummy=1 if the pair of countries have the same official language, 0 - otherwise	CEPII's database $Distances$
$LangEthn$	Ethnos groups language: dummy=1 if the pair of countries shares a common language (ethnos groups), 0 - otherwise	CEPII's database $Distances$
$Diff$...	... variable difference between importer and exporter	
...$\_M$ /...$\_X$	Importer / Exporter specific variable	
...$\_1$	One year lagged variable	

Table 4: Data definitions and sources.

Table 5: Summary statistics for gravity models

Variable	Mean	Std. Dev.	Min.	Max.	N
$Trade$	1.28E+08	7.18E+08	2	2.49E+10	46655
$Trade\_EGs\_A+B$	1.92E+07	1.31E+08	1	4.70E+09	46655
$Trade\_EGs\_A$	5.79E+06	5.17E+07	1	3.51E+09	46655
$Trade\_EGs\_B$	6.21E+05	4.50E+06	1	3.39E+08	46655
GDP_M	1.96E+11	8.50E+11	3.72E+07	1.10E+13	43899
GDP_X	2.00E+11	8.48E+11	3.83E+07	1.10E+13	44103
K/L_M	7.22E+03	2.42E+04	51.52	4.03E+05	39506
K/L_X	6.49E+03	1.90E+04	51.88	4.03E+05	40834
SEP_M	57.79	7.75	36.19	98.07	36320
SEP_X	58.21	7.65	36.19	98.07	36512
$DiffSEP$	8.95	6.85	0	48.38	36026
FH_M	96.87	58.13	28.57	200	35296
FH_X	98.81	57.69	28.57	200	35609
$DiffFH$	0.71	0.50	0	1.71	34099
GNI/cap_M	6453.34	9166.53	90	61830	43680
CO_2/cap_M	6031.42	5895.31	0	6.92E+04	40252
FTA	0.03	0.18	0	1	46655
$Dist$	5580.78	3868.09	59.62	18478.29	46491
Adj	0.03	0.17	0	1	46491
$LangEthn$	0.01	0.10	0	1	46491
$LangOff$	0.00	0.05	0	1	46491

Table 6: Summary statistics for Environment models

Variable	Mean	Std. Dev.	Min.	Max.	N
$year$	1999	2.59	1995	2003	216
SO_2	3.82E+05	8.44E+05	200	4.89E+06	160
CO_2	1.28E+05	3.08E+05	1440	1.59E+06	207
GNI/cap	2.37E+03	2.43E+03	170	1.22E+04	204
SEP	56.90	6.52	40.77	78.54	216
GDP	3.21E+10	5.88E+10	8.15E+08	3.07E+11	204
K	1.32E+10	2.20E+10	2.42E+08	1.11E+11	198
L	7.96E+06	1.47E+07	6.66E+05	7.36E+07	207
Lat	106.34	6.55	94.52	119.42	216
$Corrup$	40.95	10.25	24.41	73.37	211
FH	0.75	0.45	0.29	1.50	216
$Openness$	0.84	0.39	0.11	2.01	204
$TrInt\_EGs\_A+B$	0.15	0.11	0.01	0.90	204
$TrInt\_EGs\_A$	0.03	0.02	0	0.12	204
$TrInt\_EGs\_B$	0.01	0.00	0	0.05	204
$Predicted\ Openness$	0.42	0.43	0	2.32	203
$Predicted\ TrInt\_EGs\_A+B$	4.03	7.04	0	60.30	203
$Predicted\ TrInt\_EGs\_A$	0.98	4.42	0	45.79	203
$Predicted\ TrInt\_EGs\_B$	0.02	0.10	0	0.99	203

Variables	SO_2	CO_2	GNI/cap	SEP	Openness	TrInt_EGs_A+B	TrInt_EGs_A	TrInt_EGs_B	GDP	K	L	Lat	Corrup	FH
SO_2	1.0000													
CO_2	0.9628	1.0000												
	(0.0000)													
GNI/cap	0.0010	-0.0030	1.0000											
	(0.9904)	(0.9624)												
SEP	-0.2174	-0.2256	0.7354	1.0000										
	(0.0058)	(0.0011)	(0.0000)											
Openness	-0.0081	0.0136	0.1838	0.4952	1.0000									
	(0.9205)	(0.8318)	(0.0037)	(0.0000)										
TrInt_EGs_A+B	0.0628	0.0784	0.1694	0.3139	0.5594	1.0000								
	(0.4394)	(0.2186)	(0.0075)	(0.0000)	(0.0000)									
TrInt_EGs_A	-0.0382	-0.0073	0.2228	0.3228	0.5333	0.8443	1.0000							
	(0.6385)	(0.9085)	(0.0004)	(0.0000)	(0.0000)	(0.0000)								
TrInt_EGs_B	-0.0320	-0.0270	0.1558	0.2281	0.5387	0.8323	0.9027	1.0000						
	(0.6933)	(0.6725)	(0.0140)	(0.0010)	(0.0000)	(0.0000)	(0.0000)							
GDP	0.8427	0.8998	0.1905	-0.0058	0.0414	0.1773	0.0954	0.0472	1.0000					
	(0.0000)	(0.0000)	(0.0026)	(0.9348)	(0.5165)	(0.0051)	(0.1342)	(0.4589)						
K	0.7812	0.8566	0.2447	0.0627	0.0540	0.2197	0.1490	0.0877	0.9847	1.0000				
	(0.0000)	(0.0000)	(0.0001)	(0.3803)	(0.4046)	(0.0006)	(0.0210)	(0.1755)	(0.0000)					
L	0.9410	0.9884	-0.0523	-0.2489	0.0127	0.0718	-0.0246	-0.0461	0.8849	0.8368	1.0000			
	(0.0000)	(0.0000)	(0.4119)	(0.0003)	(0.8424)	(0.2601)	(0.7003)	(0.4697)	(0.0000)	(0.0000)				
Lat	0.2953	0.3522	0.3845	0.2882	0.3143	0.0489	0.0779	0.0234	0.4030	0.4023	0.3318	1.0000		
	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.4435)	(0.2216)	(0.7142)	(0.0000)	(0.0000)	(0.0000)			
Corrup	0.0670	0.0931	-0.7380	-0.6768	-0.4116	-0.1855	-0.2314	-0.1964	-0.1184	-0.1564	0.1280	-0.5967	1.0000	
	(0.4073)	(0.1396)	(0.0000)	(0.0000)	(0.0000)	(0.0034)	(0.0002)	(0.0019)	(0.0627)	(0.0153)	(0.0420)	(0.0000)		
FH	-0.0927	-0.0828	0.7219	0.6590	0.3902	0.2730	0.2892	0.2427	0.1343	0.1743	-0.1228	0.5492	-0.8072	1.0000
	(0.2439)	(0.1890)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0346)	(0.0068)	(0.0510)	(0.0000)	(0.0000)	

Table 7: Cross-correlation table