Trade in environmental goods and sustainable development: What are we learning from the transition economies' experience?

Natalia Zugravu-Soilita

WP 2016.16

Suggested citation:

N. Zugravu-Soilita *(2016).* Trade in environmental goods and sustainable development: What are we learning from the transition economies' experience?. *FAERE Working Paper, 2016.16.*

ISSN number: **2274-5556**

www.faere.fr

Trade in environmental goods and sustainable development: What are we learning from the transition economies' experience?

Natalia ZUGRAVU-SOILITA

Université de Versailles Saint-Quentin-en-Yvelines
UFR des Sciences Sociales / CEMOTEV
47, Bd Vauban
78280 Guyancourt
FRANCE

Fax : +33 1 39 25 57 00
e-mail: natalia.zugravu@uvsq.fr,
nzugravu@yahoo.com

Trade in environmental goods and sustainable development: What are we learning from the transition economies' experience?

This version: May 2016

Abstract

We investigate the causal effects of trade intensity in environmental goods (EGs) on air and water pollution by treating trade, environmental policy and income as endogenous. We estimate a system of reduced-form, simultaneous equations on extensive data, from 1995 to 2003, for transition economies that include Central and Eastern Europe and the Commonwealth of Independent States. Our empirical results suggest that although trade intensity in EGs (pooled list) reduces CO_2 emissions mainly through an indirect income effect, it increases water pollution because the income-induced effect does not offset the direct harmful scale-composition effect. No significant effect is found for SO_2 emissions with respect to the list of aggregated EGs. In addition to diverging effects across pollutants, we show that results are sensitive to EGs' classification: e.g., *cleaner technologies and products*, *end-of-pipe products*, *environmentally preferable products*, etc. For instance, a double profit—environmental and economic—is found only for "*cleaner technologies and products*" in the models explaining greenhouse gases emissions. Interesting findings are discussed for imports and exports of various classifications of EGs. Overall, we cannot support *global* and *uniform* trade liberalization for EGs in a sustainable development perspective. Regional or bilateral trade agreements taking into account the states' priorities could act as building blocks towards a global, sequentially achieved liberalization of EGs.

Keywords: trade liberalization; environmental goods; environmental policy; pollution; transition countries.
JEL classification: F13, F14, F18, Q56.

Commerce des biens environnementaux et développement durable : Quelles leçons peut-on tirer de l'expérience des pays en transition ?

Mai 2016

Résumé

Dans cette étude, nous analysons les effets causaux de l'intensité des échanges internationaux de biens environnementaux (BE) sur la pollution de l'air et de l'eau, en traitant les variables de commerce, de politique environnementale et de revenu comme endogènes. Nous estimons un système d'équations simultanées de forme réduite sur des données de panel, de 1995 à 2003, pour les pays en transition de la Communauté des États Indépendants et de l'Europe Centrale et Orientale. Nos résultats empiriques suggèrent que, bien que l'intensité des échanges de BE (liste agrégée) réduit les émissions de CO_2 principalement grâce à un effet indirect passant par le revenu, ce type de commerce augmente la pollution de l'eau (l'effet négatif induit par le revenu ne permettant pas de compenser intégralement l'effet positif direct d'échelle-composition). Aucun effet significatif sur les émissions de SO_2 n'est trouvé pour le commerce total de BE. En plus des effets divergents selon la nature des polluants, les résultats apparaissent sensibles à la classification des BE : *technologies et produits moins polluants*, *produits/équipements « en bout de chaîne »*, *produits préférables pour l'environnement*, etc. Par exemple, un double bénéfice—environnemental et économique—n'est trouvé que pour le commerce de *technologies et produits moins polluants* dans les modèles expliquant les émissions de gaz à effet de serre. Des résultats intéressants sont discutés séparément pour les importations et les exportations de différentes catégories de BE. Dans l'ensemble, nous ne pouvons pas valider l'urgence d'une libéralisation *globale* et *uniforme* des échanges de BE dans une perspective de développement durable. Des accords commerciaux régionaux ou bilatéraux, prenant en compte les priorités spécifiques des États, pourraient agir comme des blocs-constructeurs vers une libéralisation globale de BE, réalisée séquentiellement.

Mots clés : libéralisation du commerce ; biens environnementaux ; politique environnementale ; pollution ; pays en transition.

Codes JEL : F13, F14, F18, Q56.

Abbreviations:

APEC – Asia-Pacific Economic Co-operation

BOD – Biological oxygen demand (the most common measure of pollutant organic material in water; e.g., a low BOD is an indicator of good quality water)

CEE – Central and Eastern Europe

CIS – Commonwealth of Independent States

CTP – *cleaner technologies and products* [category]

EGs – Environmental goods

EOP – *end-of-pipe products* [category]

EPPs – Environmentally preferable products

GHG – Greenhouse gas

HS – Harmonized System (reduced term of Harmonized Commodity Description and Coding System)

INGO – International nongovernmental organization

MEA – Multilateral environmental agreement

OA – OECD + APEC [list]

OECD – Organisation for Economic Co-operation and Development

PCA - Principal component analysis

SEP – *stringency of environmental policy* [index]

SER – *stringency of environmental regulations* [index]

UNCTAD – United Nations Conference on Trade and Development

WTO – World Trade Organization

1. Introduction

At the beginning of the 21st century, one cannot validate the thesis that economic openness yields both economic and environmental gains. Still the case for this thesis seems particularly strong for environmental goods (EGs), which can play an important role in the diffusion of ecological technologies. All increase in the availability of EGs through trade openness represents an opportunity for a "win-win-win" relationship between trade, the environment and development (Yu, 2007). First, trade should be facilitated through the reduction or elimination of both tariff and non-tariff barriers. Environmental technologies could thus be acquired on the local markets at lower costs, which should stimulate innovation and further technology transfer. Empirical studies suggest that international projects are more likely to be accompanied by technology transfers when tariffs are low in the host countries. For instance, Schmid (2012) shows that a 10% increase in EGs' tariff rate is associated with a 3 percentage-point decrease in the likelihood of technology transfer related to a clean development mechanism project. Second, the offered opportunity to obtain high-quality EGs could also directly improve citizens' quality of life by providing a cleaner environment. Finally, the liberalization of trade in EGs should be beneficial for development by helping countries achieve the tools necessary to address key environmental priorities as part of their development strategies. Thus, taking into account this triple-win scenario and thus considering that EGs could play an essential role in sustainable development, Paragraph 31(iii) of the Doha mandate, agreed to by all Members of the World Trade Organization (WTO) in 2001, calls for a reduction (or, as appropriate, elimination) of tariffs and non-tariff barriers on environmental goods and services. According to the WTO, trade liberalization of EGs would benefit both developed countries and developing countries, simultaneously enabling both environmental protection improvement and economic development. On the one hand, polluting firms in the developing countries, mainly importers of EGs, should probably increase their pollution-abatement efforts because of the reduced prices resulting from decreased import tariffs (ICTSD, 2008). Alternatively, this reduction in environmental compliance costs could encourage local governments to establish more ambitious environmental standards. On the other hand, it is expected that the exporters of EGs would benefit from obtaining new markets as the result of tariff reductions; this would contribute to economic development by creating more employment and income in eco-industrial activities.

However, the debate concerning the potential advantages of the trade liberalization of EGs lacks a consensus. For instance, because tariffs applied to EGs are lower in the developed countries than in the developing countries, it is possible that trade liberalization could be especially *economically* beneficial to the developed countries. Hamwey *et al.*'s (2003) note on the liberalization of international trade in EGs provides a good illustration of this intuition. Those authors affirm that direct commercial profits from the trade liberalization of EGs primarily benefit the most advanced WTO member countries, which receive better access to EGs markets in the developing countries. Furthermore, EGs' import tariffs can play at least two roles in countries not producing EGs or that are non-competitive producers. First, import tariffs can contribute to welfare improvement because they permit the importing country to retain a portion of the revenues of international eco-industrial firms. Second, according to the literature on the determinants of foreign direct investments, tariffs can lead to technology transfer via investments into eco-industrial activities.[1]

Literature linking trade and environment is very extensive and rich in lessons, e.g., in terms of pollution haven, race-to-the-bottom/top or pollution halo hypotheses.[2] In this study, we do not intend to pay a particular attention to these issues because our focus is not on a country's trade openness but on the role of the intensity of specific trade flows, *i.e.*, EGs, which are mainly analysed according to their uses' impact on pollution rather their production's pollution-intensity. Nonetheless, we control for the overall trade liberalization's impact and discuss some of these phenomena (in particular, the race-to-the-bottom/top) when analysing the effects on pollution of trade intensity in EGs.

Numerous studies have highlighted the potential trade gains from the liberalization of EGs. For instance, the World Bank (2007) has estimated that the removal of tariffs for wind, solar, clean coal and efficient lighting technologies in 18 top greenhouse gas (GHG)-emitting developing countries would result in trade gains of up to 7% and if simultaneously accompanied by the removal of non-tariff barriers, it could increase trade by 13%. Similarly, Hufbauer and Kim (2010) suggest that tariff elimination on EGs would increase world imports of EGs by approximately $56 billion. Jha (2008) examines the factors influencing the import of EGs in the developing countries and finds that, whereas lowering tariffs may increase imports, a higher trade gain could be obtained by the removal of non-tariff barriers. Import of EGs is also found to be sensitive to the economic size of the country, foreign direct investments, national environmental performance indicators, technical assistance, etc. Balineau and de Melo (2011) show a lack of significant imports of EGs in response to tariff reduction during the last decade. It should be noted, however, that the impacts of EGs liberalization vary across products and countries, depending on existing tariff levels and the import elasticity of demand. If trade gains from tariff reduction/removal are more or less appraised, the literature investigating the link between trade in EGs and environmental performance has been focusing on the environmental policy design in the context of EGs' trade liberalization (i.g., Feess and Muehlheusser, 1999, 2002; Copeland, 2005; Canton, 2007; Greaker and Rosendahl, 2006; Nimubona, 2012). For instance, by developing a theoretical framework to investigate the effectiveness EGs' trade liberalization in a developing country that is dependent on EGs imports, Nimubona (2012) shows that reduced trade tariffs on EGs might actually reduce the stringency of pollution taxes, which can result in increased pollution levels. The author suggests that when an import tariff on EGs cannot sufficiently extract rents generated by stringent environmental regulation for an imperfectly competitive eco-industry, the "*government regulator in an EG-importing country strategically lessens the stringency of environmental regulation to maximize domestic social welfare*". Whereas theoretical research on the liberalization of EGs and econometric studies exploring its trade gains and effects on the environmental regulations get rich and varied, empirical literature on the impact on pollution of trade intensity in EGs is still scarce (e.g.,

---

[1] Corden (1974), Svedberg (1979), etc.

[2] See Copeland and Taylor (2004), Brunnermeier and Levinson (2004), Levinson (2008), Millimet and Roy (2012), Elliott and Zhou (2013), Zugravu-Soilita (2015) for definitions and extensive reviews of the literature related to the pollution haven, race-to-the-bottom and/or pollution halo hypotheses.

Wooders, 2009; de Alwis, 2015). Generally based on simplistic models, the existing studies are likely to highlight too optimistic conclusions about the impact on pollution of EGs' trade liberalization. Moreover, they are rarely discussing the channels through which trade in EGs may influence the environmental quality. For instance, de Alwis's (2015) findings support for the liberalization of EGs based on an empirical model investigating direct and conditional effects of trade intensity in EGs on NO_x, CO_2 and SO_2. More specifically, the author argues that opening trade in EGs would be associated with declining SO_2 emissions, regardless income levels in the 62 countries considered; and this negative effect on SO_2 emissions would be stronger in the capital abundant countries. Building policies on such results may be misleading because only direct effects are explored and no assumption is made about the possible endogeneity problem in the relationship between trade in EGs, income (and/or environmental regulation) and pollution.[3] It is important, therefore, to analyse not only *direct* climate change impacts (i.e., on GHG emissions), but also *broader (direct and indirect)* environmental impacts (e.g., on the quality of water, in addition to air pollution).

The originality of this study is that it evaluates empirically the simultaneous impact of trade in EGs on two pillars of sustainable development: the environment and the economy. More specifically, we estimate EGs' trade impact on pollution by simultaneously identifying its direct and indirect effects. First, we note that an indirect effect might be observed in environmental policy because governments are known to be sensitive to international issues when establishing their domestic policies. Second, in addition to its role as a pillar of sustainable development, income is worthy of investigation as an indirect channel of EGs' trade impact on pollution because it is supposed to induce (both together with and via environmental regulation) a technique effect[4] leading to improved environmental quality. Indeed, income can have a technique effect on environmental quality through two channels: first, it can have a direct effect via consumers' richness and their willingness to pay for the environment, thus reducing pollution during consumption; second, it can have an indirect effect via environmental policy, i.e., by requiring more environmental protection and therefore, stricter environmental standards. We should then mention that removal of tariff barriers in a *net importing* country of EGs can lead to a loss of income and thus to a lower demand for environmental quality. Thus, the contribution of this study is to highlight some political implications (e.g., in terms of EGs' trade liberalization), enabling us to see the good (or bad) of EGs' trade intensity by investigating its overall environmental effect, each of its scale-composition or technique direct effects, and its environmental regulation- and income-indirect effects.

Although the Member States of the Organisation for Economic Co-operation and Development (OECD) represent the major share of the EGs market, the fastest growth rates during the last decade were occurring in the developing and the transition economies (Kennett and Steenblik, 2005). Studying the economic and environmental consequences of increasing trade in EGs, particularly through trade liberalization, is of strategic importance for the

---

[3] Distinction should be made between "moderation" (conditional effect) and "mediation" (indirect effect). The integration of an interaction term in the regression (e.g., between trade in EGs and income) would only control for a possible moderation of the environmental effect of trade in EGs by the levels of income. Never would it reveal the indirect effect on pollution of trade in EGs via the latter's impact on income.

[4] See definition in Section 3.

transition economies, for which empirical studies remain scarce (if not non-existent). In particular, an examination of transition economies from *Central and Eastern Europe* (CEE) and the *Commonwealth of Independent States* (CIS) should enable a proper identification of the effects of trade liberalization because these countries opened their economies quickly and consistently during the studied period (1995-2003). In addition, with the accession of numerous CEE countries to the European Union in 2004 and 2007, trade became increasingly intense in Western Europe during the beginning of the last decade. Consequently, and more precisely, this study seeks to investigate the economic and environmental impacts of EGs' trade openness in the transition economies between 1995 and 2003 by using instrumental variables for trade intensity in EGs[5] in a system of three simultaneous equations that explain pollution, environmental regulation stringency and per-capita income. We employ a theoretical framework inspired by Grossman (1995) and Antweiler, Copeland and Taylor (2001) for the *pollution* equation, the main theoretical assumptions of some recent studies on *environmental policy* design (Fredriksson *et al.,* 2005; Damania, Fredriksson and List, 2003, amongst others), and the endogenous growth literature (see, for example, Mankiw *et al.*, 1992; Frankel and Romer, 1999) for *income* equation.

This paper is structured as follows. Following this introduction of our research objectives and the literature on trade in EGs, section 2 presents definitions of EGs and stylized facts about our country sample. Section 3 specifies the model to be estimated, and section 4 presents the estimation strategy and data. We discuss the basic empirical results, some robustness tests and extended empirical findings in sections 5 and 6. The last section presents this study's conclusions and policy implications.

2. Definition of EGs and some stylized facts

The concept of EGs provides intellectual coverage of *all products and all technologies favourable to the environment*. However, the lack of a universally accepted definition of EGs has slowed down agreement on product coverage in negotiations on EGs. Various suggestions have been made concerning the criteria for identifying EGs. The criterion of final use or prevalent final use can be applied to the selection of equipment used in environmental activities such as pollution control and waste management. In theory, there is broad support for this criterion, which distinguishes 'traditional environmental' goods whose main purpose is to address or remedy an environmental problem (e.g., carbon capture and storage technologies). The lists drawn up by OECD and the member economies of Asia-Pacific Economic Co-operation forum (APEC) have been the references so far, despite the fact that other international organizations work on this classification criterion.[6] If EGs were to be limited to the OECD and APEC's narrow lists, only the few advanced developing countries would benefit from trade in EGs. Most developing countries do not yet have well-developed markets for such products. Other criteria could also be applied to identify

---

[5] We compute instrumental variables for EGs' trade intensity following the methodology proposed by Frankel and Rose (2005), i.e., we predict trade for various categories of EGs using gravity model estimations.

[6] See Steenblik (2005) for more details about the genesis, description and comparison of the OECD and APEC lists, which were compiled in the late 1990s.

environmentally preferable products (EPPs). Lists of EPPs (e.g., the UNCTAD[7] list) include products that cause less damage to the environment during one of their life-cycle stages because of the manner they are manufactured, collected, used, destroyed or recovered. In particular, developing countries have suggested that negotiations should not be limited to industrial products (which are of interest to developed countries) but should also include agricultural goods (which are of particular interest to developing countries) because developing countries generally have negative trade balances in traditional environmental goods but considerable export opportunities in EPPs, which often include natural resource-based, raw and processed commodities (UNESCWA, 2007). However, to identify EPPs, one must generally resort to labelling and certification measures. Because EPPs differentiate among seemingly similar products, or 'like products', the WTO has not yet considered these products in the negotiations on EGs' trade liberalization. Several WTO members, including developing countries, fear that the liberalization of EPPs will lead to discrimination against their products based on non-environmental concerns, e.g., social concerns (de Melo and Vijil, 2014). Finally, performance criteria were also proposed, e.g., energy efficiency during product use. However, because of the reality of technological progress and innovation, it can be difficult to apply such criteria in a continuous manner.

Several negotiated lists have been proposed, ranging from the apparently non-debatable 'core list' of 26 products (agreed to by Australia, Colombia, Hong Kong, Norway and Singapore in 2011) to the large so-called "WTO list" of 408 products (a combined list that includes many of the OECD and APEC goods and most of the products from the "Friends of the Environment list"). Currently, there are many difficulties involved in defining EGs, including but not limited to the following: (i) the inadequacy of the Harmonized System's (HS) descriptors regarding the tariff nomenclature, (ii) products' multiple end-use, and (iii) relativism and attribute disclosure that occur when a single good is used and disposed of in different ways (e.g., doubt about the use of bio-fuels to save energy, expressed in Steenblik, 2007 and Hufbauer et al. 2009).[8] In addition, Balineau and de Melo (2013) suggest that countries mostly submit goods in which they have a revealed comparative advantage and exclude from their submission list goods with high tariffs (thus revealing mercantilistic behaviour: i.e., countries do not propose highly protected goods).

In this study, we investigate relevant categories of EGs to obtain a proper interpretation of empirical results without restricting the analysis to the shortest list of EGs; we attempt to avoid taking an excessively broad approach that would result from an investigation of aggregate lists of highly heterogeneous EGs. More specifically, we consider explicit types of EGs derived from the extremely comprehensible categorization of EGs proposed by UNCTAD (see Appendix C and Hamwey, 2005, for more details). That categorization suggests two broad classes of EGs, which are further decomposed into 10 homogeneous groups: (1) **Class A EGs** (or traditional EGs; most of these EGs, particularly those included in the OECD and APEC lists, are under discussion in WTO negotiations), which includes manufactured goods and chemicals used directly in the provision of environmental services; and (2) **Class B EGs** (i.e., goods that are less supported in the WTO negotiations, particularly the EPPs), which includes industrial

---

[7] United Nations Conference on Trade and Development

[8] See Hamwey (2005), de Melo and Vijil (2014) for more discussion on these issues.

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. Here, we can also consider less-polluting and energy-saving technologies, the electrical-production facilities using renewable energy, and recycled materials (the so-called Class B Clean Technologies).

Because the OECD and APEC lists were the most discussed and remain (on a relative basis) the most commonly accepted lists pursuant to the Doha Round negotiations, our core empirical analysis is focused on these EGs. Although we choose to investigate two homogeneous sub-groups of EGs from the OECD+APEC list ([*end-of-pipe*] *pollution-control products* and [*beginning-of-pipe*] *pollution-prevention / resource-management products*), we also extend our empirical analysis to other sub-categories of EGs from the UNCTAD classification[9].

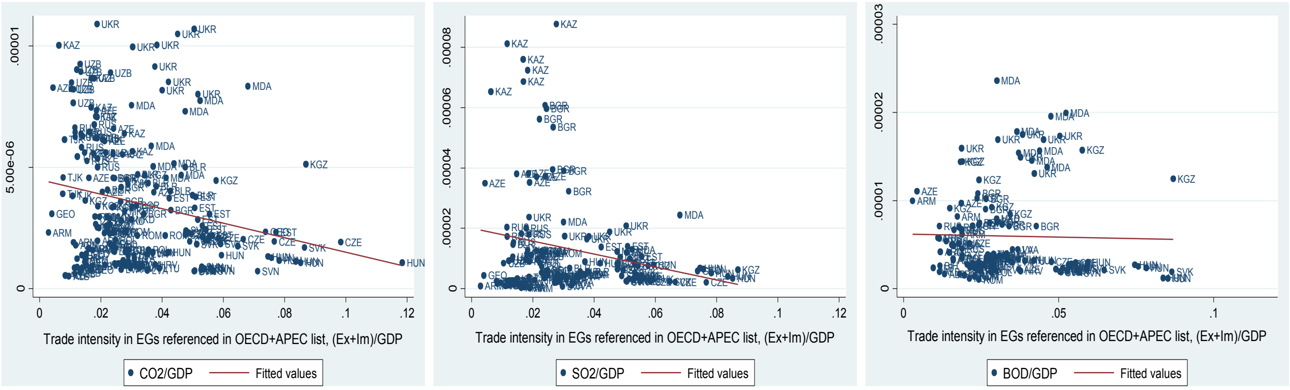
To understand the importance of trade in EGs in the transition economies, we provide some stylized facts about trade in EGs, as defined by OECD and APEC. During the studied period 1995-2003, the transition economies' trade in EGs was at its beginning stage of development, comprising only 3% of total exports and approximately 6% of total imports in 2005. However, we note substantial differences across countries. With respect to imports, a relatively similar figure (5-6%) characterized the two groups of transition economies: CEE and CIS. For EGs exports, the first country group definitely enjoyed greater advantages: 4.5% in total exports in 2005 compared to the second group, in which EGs counted only for 1.3% in total exports. In 2005, imports of traditional EGs and EPPs were two times higher than the exports of these products. Between 1995 and 2004, the trade intensity ((exports + imports) /GDP) in EGs referenced in the OECD+APEC list increased by 150% in the transition economies (and the same trend existed among CEE and CIS countries). The trade intensity of the EPPs increased by 33% during the same period, with an average annual growth rate of 5% in the case of CEE countries and an average annual growth rate of only 1% in the CIS countries. The most spectacular annual growth rates were registered for trade intensity in Class B Clean Technologies: 11% for CEE and 23% for CIS. In 2005, trade in these products represented 1.75% of the total exports and 3% of the total imports of transition economies.

Before conducting a more complex econometric analysis, it would be interesting to examine the primary data and observe correlations. Figure 1 shows an apparent negative relationship between trade intensity in EGs (OECD+APEC list) and [air] pollution in the transition economies.

---

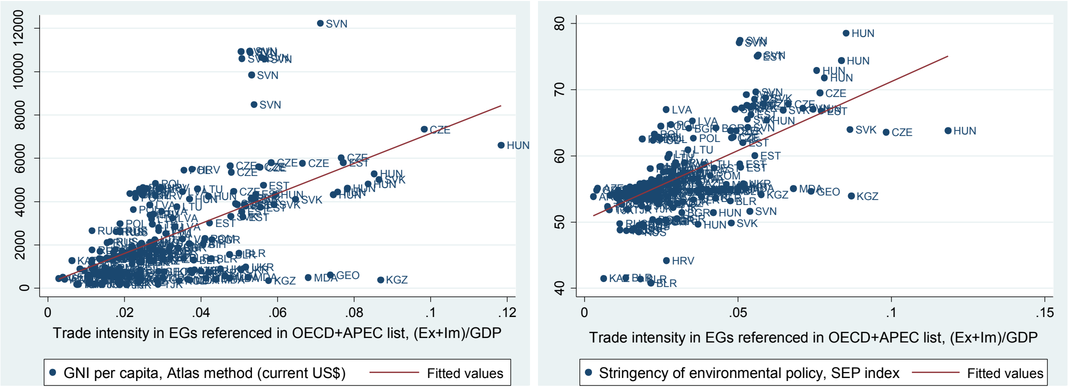
[9] See section 4.1 for more information about the categories of EGs considered in the empirical analysis.

Figure 1: Correlation between pollution and trade intensity in EGs



In Figure 2, we can also observe a positive correlation between EGs' trade openness and economic development and between trade openness in EGs and the severity of environmental policy (SEP index[10]).

Figure 2 Correlation between trade intensity in EGs, income and environmental policy



Consistent with the above figures, we would be willing to support trade liberalization of EGs from a sustainable development perspective. However, we should mention that the observed correlations could be caused by endogeneity instead of causality. It has been largely proven, through the environmental Kuznets curve, that income growth has a positive impact on environmental quality. Simultaneously, increasing income and democracy stimulate trade. The endogeneity of trade is a familiar problem in the empirical literature concerning whether openness promotes growth. Harrison (1995) concludes, "[the] existing literature is still unresolved on the issue of causality". Other causality issues can be identified when analysing environmental regulations, which require firms to use performance technologies and environmental management products, which usually are imported by transition economies from developed countries. Thus, stringent environmental regulation may simultaneously increase the trade intensity and environmental quality of EGs. Consequently, to answer the question about the need to liberalize the transition economies' trade in EGs so that sustainable development goals can be met, we believe that it is important to develop a system of simultaneous [reduced-form] equations that investigate indirect effects by controlling for endogeneity. As regards the endogeneity, we pay particular attention to trade variables, which are

---

[10] See definition in Section 4.1.

instrumented in our empirical analysis.

3. Theoretical assumptions and econometric specifications

In this section, we examine the direct and indirect determinants of pollution.

Pollution specification

Following the decomposition proposed by Grossman (1995), total emissions of a country can be expressed as:

$$E_{it} = Y_{it} \sum_{j=1}^{n} e_{ijt} \gamma_{ijt} \tag{1}$$

where E are total emissions; i represents countries, t – years and $j = 1, 2, \ldots, n$ are the various economy sectors. Y_{it} is the total GDP (scale of the economy) of country i in year t, it can also be presented by the sum of the n sectors' added-values, i.e., $Y_{it} = \sum_{j=1}^{n} Y_{ijt}$. $\gamma_{ijt} = Y_{ijt} / Y_{it}$ represents the ratio of the sector's j added-value in the total GDP of country i in year t. We consider parameter e_{ijt} to be the '*effective'* emission intensity (or net emissions), i.e., the average quantity of pollution actually emitted in the atmosphere/water for each unit of added-value in the j sectors of country i in year t. According to this equation, total annual emissions of a country can be regarded as the product of the economy's total added-value (Y_{it}) and the average sectorial pollution intensity, weighted by the ratio of each sector's added-value in the total GDP ($\sum_{j=1}^{n} e_{ijt} \gamma_{ijt}$).

Totally differentiating and dividing all Equation's (1) terms by E, we can rewrite it as follows:

$$\widehat{E_{\imath t}} = \widehat{Y_{\imath t}} + \sum_{j}^{n} \widehat{\gamma_{\imath \jmath t}} + \sum_{j}^{n} \widehat{e_{\imath \jmath t}} \tag{2}$$

This decomposition defines the three famous pollution determinants. $\hat{Y}$ indicates the *scale effect*, thought to be a growth factor of pollution. All else being equal, any production increase means a quasi-proportional increase in pollution. The *composition effect* is represented by $\hat{\gamma}$. Dynamic changes in $\hat{\gamma}$ represent the impact on pollution of any change in the structure of economic activities. The third term represents the *technique effect*. The use of clean technologies, more efficient production techniques and abatement efforts can lead to pollution reduction for the same level of economic growth and industrial structure.

Furthermore, we consider the average "*net"* emission intensity of polluting sectors of country i in year t to be given by the following additively separable function: $e = \theta - g(a)$, where θ is the average "*gross"* emission intensity of polluting activities depending on the technology used (i.e., when no "end-of-pipe" pollution abatement occurs, but it could result from "cleaner production" or "beginning-of-pipe" technique), and a is the total demand for products used in the "end-of-pipe" pollution abatement process.[11]

The third term of Equation (2) is the most complex one and requires additional discussion:

---

[11] With $0 \leq g(a) \leq \theta$; $g'(a) > 0$, that is, abatement effort reduces pollution, and $g''(a) < 0$, meaning decreasing returns to abatement.

- First, the term $\hat{e}$ is supposed to be a function of EGs' trade intensity, particularly of trade in *"beginning-of-pipe"* or *cleaner technologies and products* (CTP) affecting the parameter θ (pollution prevention), and of trade in *end-of-pipe products* (EOP) influencing the parameter a (pollution abatement). Indeed, trade openness is supposed to reduce the local price of EGs, which are primarily imported by the transition economies, thus inducing increased demand for these goods that is characterized by negative own-price elasticity. Thus, at the same levels of production and environmental regulation, any reduction in import tariffs would increase demand for imported EGs. Because abatement and cleaner technologies become less expensive and more widely available, one can anticipate a reduction in pollution. Therefore, *trade intensity in EGs* (CTP and EOP) is assumed to have a direct negative (technique) effect on pollution, provided it does not affect either the economic structure or production levels. Otherwise, because traditional EGs' production is generally pollution-intensive or as a result of a "rebound effect" — i.e., because it is subject to the same level of environmental regulation and despite the marginal abatement cost reduction caused by the trade liberalization of EGs, one can be encouraged to produce more by maintaining the same total initial level of abatement costs, thus increasing total pollution — EGs' trade openness also has a direct positive scale-composition effect on pollution. The sign of *trade intensity in EGs* variables should indicate the dominant direct effect on pollution: either technique (if negative) or scale-composition (if positive).
- Second, we assume the technique effect $\hat{e}$ to also be a function of the *environmental policy stringency*, τ, because regulation acts directly on firms' production technology used (θ) and pollution-abatement efforts (a).
- Third, considering total polluting emissions in a country, consumer behaviour in relation to the environment should also be taken into account because environmental regulation cannot systematically affect the abatement efforts and technology used in the consumption processes, such as household heating, transport, etc. Households are not usually asked to make capital investments for controlling pollution; instead, they are asked to alter their behaviour. Thus, consumer *willingness to pay to reduce pollution* – i.e., how much is the consumer willing to pay for a particular level of an environmental good? – is an important measure, generating a technique effect together with *environmental regulation* and *trade intensity in EGs*. Moreover, when formal regulation is weak or perceived as insufficient, communities that are strongly concerned about environmental quality may informally regulate firms (either indirectly or directly) through bargaining, petitioning and lobbying.

Consequently, the amount of abatement that is undertaken—i.e., g(a)—depends on abatement costs, the efficiency of environmental regulation and willingness-to-pay for abatement. The same assumption is made about the demand for cleaner production technologies (influencing parameter θ): i.e., the decision to adopt cleaner technologies and products depends on costs, environmental regulation and willingness-to-pay for environmental quality.

Finally, numerous works such as Lucas, Wheeler and Hettige (1992), Harbaugh, Levinson and Wilson (2002), Dean (2002), Copeland and Taylor (2001, 2004), Antweiler, Copeland and Taylor (2001), and Frankel and Rose (2005) show that scale, composition and technique effects are endogenous. Moreover, they are often determined by the country's overall trade openness, which can have a direct impact on environmental quality in the sense that tariff reduction either increases trade intensity and thus influences economic growth (first term in Equation (2)) or simply shifts production from pollution-intensive goods to more ecological goods, or vice-versa (second term in Equation (2)). Finally, trade openness can have a direct impact on both technologies used and abatement efforts. For example, Dean (2002), using pooled provincial data on Chinese water pollution, studies the relationship between international trade and industrial pollution. That author's simultaneous-equations system estimation suggests that although international trade increases pollution through the effect of pollution havens, it also contributes to China's economic growth, which reduces in its turn pollution because higher income reinforces public demand for better environmental quality. Thus, trade openness is an economic determinant of pollution to be considered together with all variables representing scale, composition and technique effects.

Following the above-discussed assumptions, we can write the specification explaining a country's total pollution:

$$E_{it} = e(Y_{it},\ \gamma_{it},\ \theta_{it},\ a_{it},\ Open_{\ it}) \tag{3}$$

with: $\gamma_{it} = f(K_{it}/L_{it}),\ \theta_{it} = f(CTP_{it}, \tau_{it}, R_{it}),\ a_{it} = f(EOP_{it}, \tau_{it}, R_{it})$; where: *Y* is the scale of economy (total GDP); $\gamma = f\left(K/L\right)$ - the composition effect supposed to be function of capital (*K*, stock of capital) to labour (*L*, active population) relative endowments (Antweiler, Copeland and Taylor, 2001, solve for the share of polluting production in total output as a function of the capital-to-labour ratio); *CTP* – trade intensity in "beginning-of-pipe" or cleaner technologies and products; *EOP* – trade intensity in "end-of-pipe" EGs; τ is the stringency of the environmental regulation; *R* – per capita income supposed to capture the willingness-to-pay for environmental goods, as it is commonly assumed that environmental quality is a normal good; *Open* – instrumented variable of overall trade openness.

All else being equal, we expect positive coefficients for the scale and composition effects and negative coefficients for variables capturing the technique effect. The coefficients of our trade-intensity variables are supposed to represent the prevailing direct impact on emissions (the counterbalance between a positive scale-composition effect and a negative-technique effect).

Environmental Regulation and Economic Development specifications

In addition to a direct impact on pollution, we also suppose that trade intensity in EGs can affect the severity of both environmental regulation and economic development (per-capita income). In addition to controlling for endogeneity, estimating a system of simultaneous equations would allow us to identify indirect channels of influence of trade intensity in EGs on environmental quality.

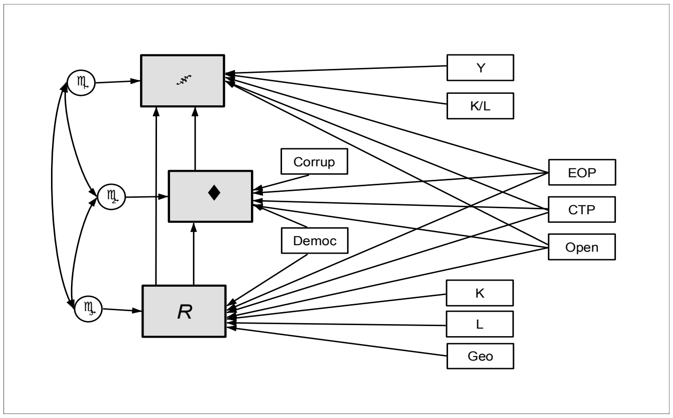
First, we derive the ***Environmental Regulation*** specification from recent studies on environmental policy design. Both theoretical and empirical studies have shown that *trade*, *democracy* and *corruption* have a substantial influence on environmental policy. Damania, Fredriksson and List (2003) have developed a theoretical model that has produced several testable predictions: i) *trade liberalization* increases the stringency of environmental policy; ii) *corruption* decreases the stringency of environmental policy; and iii) the effect of trade liberalization (corruption) on environmental policy is conditional on the level of corruption (trade openness). All of these predictions are validated empirically using data from a mix of 30 developed and developing countries from 1982-1992. Trade may directly influence the stringency of environmental regulations via either "race to the bottom" (negative effect) or "race to the top" (positive effect) phenomena that are said to occur when competition between nations or states (over investment capital, for example) leads to the progressive dismantling of or increase in regulatory standards. 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 increase the stringency of policy, particularly when *citizens' participation in the democratic process* is widespread. Pellegrini and Gerlagh (2006) find that corruption stands out as an important determinant of environmental policies, whereas democracy has a very limited impact. Zugravu, Millock and Duchene (2008), using a common agency model of government for environmental policy creation, make the empirical finding that the stringency of environmental regulation depends on *consumers' preferences for environmental quality*, represented by per capita revenues. Indeed, higher revenues induce more preferences for better environmental quality on behalf of the population and thus, more stringent environmental regulation. Finally, some works highlight the endogeneity of environmental policy design with respect to EGs supply. Greaker and Rosendahl (2006) conclude that especially stringent environmental regulation might be well-founded because it increases the competition between technology suppliers, leading to lower domestic abatement costs. Consequently, if *liberalization of EGs* takes place, this phenomenon may amplify. Thus, import tariffs' cut-off induces the government to raise its environmental standards, anticipating firms' ability to more easily comply with them as EGs become more available. However, as stated in Greaker and Rosendahl (2006), "an especially stringent environmental policy is not a particularly good industrial policy with respect to developing successful new export sectors based on abatement technology". Moreover, theory suggests that (1) strict environmental standards weaken a country's competitive position in pollution-intensive industries and (2) enforcement causes firms that are active in pollution-intensive industries to relocate their activities to less-regulated countries. Thus, depending on the competitiveness of local industries, *trade intensity in EGs* (*EOP* and *CTP*, respectively) can have an ambiguous effect on the stringency of environmental regulation.

We can thus write the following specification for the stringency of environmental policy:

$$\tau_{it} = z(R_{it}, Democ_{it}, Corrup_{it}, Open_{it}, EOP_{it}, CTP_{it}) \tag{4}$$

with *Democ* for democracy and *Corrup* for corruption level, the other variables being specified in Equation (3).

Next, we specify the ***Income function***, following the endogenous growth literature. As Rodrik, Subramanian and Trebbi (2004) highlight, labour, physical and human capital, while affecting economic development, are in turn determined by deeper, more fundamental factors that fall into three broad categories: geography, institutions and trade (see 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. Institutional quality is widely considered one of the most important sources of economic development, whereas geography acts indirectly, through the channel of institutions. However, Hibbs and Olsson (2004) demonstrate the importance of initial biogeographic conditions 12,000 years ago—conditions that facilitated 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 variations in the level of economic development around 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, Subramanian and Trebbi (2004) report that institutions are the most significant to economic development once the endogeneity of intuitions and trade have been properly accounted for, leaving a negligible role for geography and trade. Sachs (2003), however, finds that geographical factors are the most important deep determinants of income and output, whereas Frankel and Romer (1999) underscore the importance of international trade. Those authors suggest that trade has a quantitatively large and robust significant, positive effect on income. However, when considering transition economies, the impact of trade liberalization on development may be different depending on adjustment costs. The most serious adjustment costs associated with trade liberalization and the transition process from centralized to market economies are the social costs that are either reflected in various indicators of poverty or measured by the level of unemployment. Recent experience in CEE/CIS countries also confirms the importance of better public and private governance and a favourable business climate for reducing poverty. Trade liberalization is often made responsible for both the deterioration in these countries' trade balances and fiscal problems stemming from the contraction of foreign trade-related taxes in budget revenues. Income specification may be written as follows:



$$R_{it} = \varphi(K_{it}, L_{it}, Geo_i, Inst_{it}, Open_{it}, EOP_{it}, CTP_{it}) \tag{5}$$

where *Geo* represents geography/settlement characteristics; *Inst* - institutional quality represented here by civil liberties and political rights, namely *Democ* variable.

We build the following system of three reduced-form, simultaneous equations: the first identifies the *direct effect* on pollution of trade intensity in EGs, whereas the second two capture the *indirect effects* of trade intensity in EGs, passing through environmental regulation and income, respectively.

$$\begin{cases} E_{it} = e(Y_{it}, K_{it} / L_{it}, \tau_{it}, R_{it}, EOP_{it}, CTP_{it}, Open_{it}) \\ \tau_{it} = z(R_{it}, Democ_{it}, Corrup_{it}, EOP_{it}, CTP_{it}, Open_{it}) \\ R_{it} = \varphi(K_{it}, L_{it}, Democ_{it}, Geo_{i}, EOP_{it}, CTP_{it}, Open_{it}) \end{cases} \quad (6)$$

We distinguish three endogenous variables in our system, E, τ and R, along with nine explanatory variables (Y, K, L, *Democ*, *Corrup*, *Geo*, *Open*, *EOP*, and *CTP*). The system is thus overidentified and may be estimated. However, it is often argued that the correlation between trade and income makes it difficult to identify the causality direction between the two. Similarly, double causality may be revealed between trade and environmental regulation, as mentioned in the previous section. Consequently, trade should also be considered endogenous, and thus instrumented, by controlling for all of the variables in the system affecting it to assess its proper effects. We follow the methodology proposed by Frankel and Rose (2005) to instrument trade by predicting bilateral "natural" flows in a gravity equation, which is one of the most-used tools for this purpose for at least the following reasons: very good empirical explanation of trade flows; a theoretical base that is well understood (i.e., either a monopolistic competition model with transport costs or a Heckscher–Ohlin model with trade costs); and the crucial role given to geography, which has taken its place in international economics.

4. Empirical strategy

4.1. Data

In our empirical study, we use both country-specific and bilateral data from various sources (see Appendix B for the definitions and sources of all variables).[12] In addition to trade variables, which are instrumented in our study, we use three endogenous variables in our system of simultaneous equations:

- *Pollution* (CO_2, SO_2, and BOD are used to encompass at least two dimensions, air and water pollution, because EGs may have multiple uses and impacts on the overall environmental quality). Data on total CO_2 emissions come from IEA and cover 24 CEE/CIS countries from 1995 to 2003, whereas data on SO_2 emissions are available for 22 countries from 1995-2002 (with some missing points for 2001 and 2002).[13] The data source of the SO_2 variable is an exhaustive data set of worldwide emissions of sulphur dioxide, carefully constructed by Stern (2006) from his own econometric estimates. SO_2 (anthropogenic) emissions have characteristics that make them suitable for studying 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

---

[12] Gross domestic product for exporting and importing countries in trade variables' instrumentation 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 consider for each pair of countries in the gravity model.

[13] See the list of countries in Appendix A.

paper is positive analysis, i.e., we are interested in linking pollution to potentially traded production. That is why we use data on emissions instead of on concentration, even though the latter would be more appropriate to address welfare issues. For organic water pollution (BOD in kg per day), we use data from the World Bank that cover 18 countries from 1995-2003, with some year/country missing points. Finally, we consider total GHG emissions for comparison, but because these data are available only for 2 years (1995 and 2000) in the time period considered (1995-2003), we analyse this pollutant only in the first part of our empirical work. Data on GHG come from the *Climate Analysis Indicators Tool*, World Resources Institute.

- *Stringency of environmental policy* (SEP), our proxy for environmental regulation, is one of the most difficult variables to measure because comparable data do not exist for every country in the world and over time. We use the *SEP* index constructed by Zugravu, Millock and Duchene (2008). This index simultaneously comprises variables both of environmental policy and of industries and the population's ability to organize in lobbies (nongovernmental organizations, etc.) to pressure government behaviour in a more environmentally friendly direction. The *SEP* index is computed following the Z-score technique as applied to five indicators: the number of signed multilateral environmental agreements (MEAs), the existence of an air-pollution regulation, the density of international nongovernmental organizations (INGOs), the number of ISO 14001-certified companies, and adhesion to the Responsible Care® Program. Aware of this measure's potential limits, we perform robustness tests by employing an alternative proxy for the stringency of environmental regulations (*SER* index) that is computed using—in addition to INGOs, MEAs and ISO 14001—an output indicator (GDP per unit of energy used, climate netted out) that is a real measure of the impact of the former component variables in the aggregated index. This should enable us to distinguish countries that apply effective environmental measures from those that adopt a "theoretical" environmental policy with no efforts to assure compliance.
- *Income/Economic development* is represented in our study by per capita Gross National Income (*GNI/cap*), with the data coming from the WDI (World Bank). We follow the strategy of Antweiler, Copeland and Taylor (2001), which considers the difference between *GDP* (measuring the intensity of the economic activity in a given country) and *GNI/cap* (capturing here the richness of a country's inhabitants and more specifically, their willingness-to-pay for environmental goods). Thus, to distinguish between the scale of the economy and income, *GDP* and *GNI/cap* enter simultaneously our pollution equation.

As explanatory variables in our system of simultaneous equations, we list GDP, relative factor endowments, geographic and institutional factors, instrumented variables for overall trade openness and EGs' trade intensity[14]. We use the variable *Lat* (latitude) as a proxy for geographic factors. Latitude gives a place's location on Earth either north or south of the equator and is one of the most important factors determining a location's climate. Institutional factors are represented by two variables, *Corrup* and *Democ*, which mean corruption level and democracy,

---

[14] See Appendix B for data definition and sources.

respectively. The first variable comes from the database constructed by Kaufmann *et al.* (2005), namely, it is the opposite of the *Corruption Control* index.[15] Kaufmann *et al.*'s (2005) indicators are highly positively correlated. For that reason, we use a different data source for our democracy variable, which is represented in our study by the *Freedom House democracy* index. *Freedom in the World*, which is published by Freedom House, ranks countries according to their political rights and civil liberties, both of which are largely derived from the Universal Declaration of Human Rights.[16] In our study, we use a variable *Democ*, which is computed by taking the inverse of the mean of political rights and civil liberties indicators. Thus, higher values of *Democ* correspond to higher democracy levels.

Finally, trade openness is proxied in our study by trade intensity—namely, (Exports+Imports)/GDP—and is instrumented using a gravity equation. Bilateral trade values come from the UN COMTRADE's world-trade database reporting flows at a high level of product disaggregation. We combine this database with the EGs' classification lists[17] specified at the HS 6-digit level and obtain a new dataset for trade in EGs. Thus, we obtain several EGs' trade variables:

- *Trade_EGs* and *TradeInt_EGs*: trade flows (*Trade*) and trade intensity (*TradeInt*) in EGs (pooled lists);
- *TradeA_OA* and *TradeIntA_OA*: trade flows and trade intensity in Class A EGs, OECD + APEC (OA) list. The **OA list** covers three groups: A) pollution management (mainly end-of-pipe products), B) cleaner technologies and products, and C) resources management. Combining the second two groups in the same-EGs' category of goods designed to prevent environmental degradation, we obtain the following sub-groups of EGs referenced in OA list:
    - *TradeA_EOP* and *TradeIntA_EOP*: trade flows and trade intensity in end-of-pipe products from the OA list, distinguishing between air and water pollution (although these variables have the same name in our regressions, they involve different products while explaining air or water pollution); and
    - *TradeA_CTP* and *TradeIntA_CTP*: trade flows and trade intensity in products preventing environmental degradation, here called cleaner technologies and products from the OA list;
- *TradeA_OtherEGs* and *TradeIntA_ OtherEGs*: trade flows and trade intensity in Other type Class A EGs not included in the OA list;
- *TradeB_CT* and *TradeIntB_CT*: trade flows and trade intensity in Clean Technologies, Class B EGs; and
- *TradeB_EPP* and *TradeIntB_EPP*: trade flows and trade intensity in Environmentally Preferable Products, Class B EGs.

There are other class B EGs, which are very particular classifications reported in Appendix C that are not considered in this

---

[15] This index measures the extent to which governments fight corruption and takes values ranging between -2.5 and +2.5, the maximum values signifying less corruption. The change of sign that we make thus yields an indicator that varies directly with the degree of a country's corruption.

[16] 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.

[17] See Appendix C for definitions.

study. Here, we focus on the most-discussed categories of EGs.

4.2. Estimation technique

Before estimating our system of simultaneous equations, we test the exogeneity of our explanatory variables. The Durbin-Wu-Hausman test reports endogeneity for *GNI/cap*, *SEP*, *trade intensity in EGs* and *GDP*. The same test shows that the one-year lagged GDP is exogenous for this model; we thus use the variable GDP_{t-1} in our estimations. Because *GNI/cap* and *SEP* are endogenous in our theoretical specifications (being estimated through separate equations), we need only to instrument trade flows. For this purpose, we run panel fixed-effects gravity equations to obtain valid instruments for our trade variables.[18]

Our system of three simultaneous equations is estimated by using a three-stage least squares (3SLS) procedure[19]. To do this, we need to check for both the correctness of the specification and the internal consistency of the entire system. Thus, we run the Hausman Test for Misspecification, which does not reject the null hypothesis of no systematic difference between the 3SLS and the 2SLS estimates, meaning that the 3SLS estimators are both consistent and efficient.[20] Moreover, the underidentification test (Anderson LM statistic: 19.481, with Chi-sq(3) P-val=0.0002) indicates that the matrix is full column rank—i.e., the model is identified—whereas the Sargan-Hansen test of overidentifying restrictions (Chi-sq(2) P-val =0.5014) does not allow us to reject the null hypothesis of instruments' validity, i.e., the instruments are uncorrelated with the error term and the excluded instruments are correctly excluded from the estimated equation.

For our panel data we need to conduct panel 3SLS. One way to do so is to use country dummies in each of our system's equations to capture the unobserved country-specific effects. However, fixed effects/country-dummies models have some weaknesses. Too many dummy variables can significantly reduce the degrees of freedom needed for powerful statistical tests. In addition, a model with too many dummies may suffer from multicollinearity, which increases the standard errors. Consequently, the panel was resolved in this study by using Stata's command `*xtdata*', which transforms the data set of all of the variables as follows: `*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, allowing a simultaneous explanation of changes over time and among units. We opt for a random-effects estimation for four reasons. First, descriptive statistics for our core variables (in

---

[18] 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. In this manner, we obtain instrumental variables for various EGs classifications' trade flows, which appear to be exogenous in our system of simultaneous equations, as also reported by the Durbin-Wu-Hausman test. Moreover, the statistic (chi2=6.51; Prob>chi2 = 0.1642) of the Hausman specification test does not allow us to reject its null hypothesis, indicating that the model with the instrumented trade openness variable performs better than with its real value, i.e., in the first case, the coefficients are consistent and efficient.

[19] Three stages are necessary to obtain the 3SLS coefficients: we first regress the right-hand-side endogenous variables on all of the exogenous variables from the model; second, we regress the endogenous variables on the fitted values from the first stage and the exogenous variables of the model; and third, we apply the Feasible Generalized Least Squares to get structural parameters.

[20] Under the null hypothesis of no misspecification, the 3SLS results are both efficient and consistent, whereas the 2SLS coefficients are consistent but not efficient. We should note that if any equation from the structural model is mis-specified, only this single equation is affected while estimating with the 2SLS technique; conversely, any single misspecification is transmitted to all equations under 3SLS estimation because of the use of an inconsistently estimated covariance matrix in the third stage.

particular, trade intensity in EGs) clearly indicate that standard deviation *between* is higher than *within*. Second, some variables of interest to this study are either mostly time-invariant or fluctuate moderately, such as institutional variables. Third, for each specification, we run a Breusch Pagan Lagrange-multiplier test. In all of our specifications, random effects are significant. Finally, the random-effects assumption is that individual specific effects are uncorrelated with the independent variables. The fixed-effect assumption is that the individual specific effect is correlated with the independent variables. If the random-effects assumption holds, the random-effects model is more efficient than the fixed-effects model. In our regressions, the residuals are supposed to be orthogonal to the predetermined variables because the model is estimated through 3SLS, which corrects estimators for endogeneity and cross-equation error correlations. Consequently, random-effects estimations are assumed to perform better.

5. Empirical results

Empirical results from the estimation of our system of simultaneous equations for CO_2 emissions (model 1), SO_2 (model 2), BOD (model 3) and total GHG emissions (model 4) are reported in Table 1. In these models, we first investigate trade in EGs classified by the OECD and APEC lists.

In our regressions, *SEP* represents the technique effect engendered by the environmental regulation, which is estimated separately from a technique effect induced by consumers' willingness-to-pay for environmental quality, *GNI/cap*. The composition effect is estimated in a flexible way by authorizing its sign and size to be dependent on the relative capital endowments. Our empirical results confirm the following theoretical assumptions: *GDP* (models 1 to 4) and, to a lesser extent, physical capital endowments (model 4) tend to increase pollution, whereas *SEP* (all models) and per-capita income (except for SO_2 emissions) reduce it.

Trade openness in general appears to increase both CO_2 and SO_2 emissions. Trade intensity in *end-of-pipe EGs* is found to increase CO_2, BOD and total GHG emissions and to decrease SO_2 emissions. Abatement processes thus seem to be most efficient in transition economies' SO_2-polluting activities because the direct-technique effect of trade in end-of-pipe products dominates over its scale-composition effect for this pollutant. For trade in *cleaner technologies and products*, we find a direct negative and statistically significant effect both on GHG emissions and on CO_2 (models 1 and 4). We find that trade intensity in these types of EGs has no direct impact on SO_2 and BOD emissions (models 2 and 3). To conclude in terms of climate change issues, we qualify trade in *end-of-pipe EGs* as harmful for the environment (however, a beneficial role is found for SO_2 reduction). Conversely, trade in *cleaner technologies and products* appears to contribute to climate-change mitigation. Nonetheless, if indirect effects are not considered, this conclusion is very partial.

The estimation results for ***Environmental policy equation*** show a positive effect of *GNI/cap* in our CO_2 and BOD models. Corruption is found to reduce the stringency of the environmental policy in the SO_2 model. With regard to trade openness (*Open*), we find no support for "race to the bottom" or "race to the top" phenomena. As expected, trade intensity in *end-of-pipe products* increases the stringency of environmental regulation (models 1, 2 and 3). Increased availability of end-of-pipe abatement technologies and products enables governments to set more rigorous environmental standards because compliance becomes effortless. Conversely, we find a negative impact of trade intensity in *cleaner technologies and products* on the severity of the environmental policy (models 1-3). We can suppose, based on Greaker and Rosendahl's (2006) findings, that stringent environmental regulation was not the optimal strategy for transition economies seeking to promote this new industry (they were mostly net importers of such products during the investigated time period), considering both that cleaner technologies and products' production is generally pollution intensive and that severe environmental policy may hurt international competitiveness. This last finding gives some support to the "race to the bottom" hypothesis while considering trade in cleaner technologies and products; Nimubona (2012) also makes a similar finding in a theoretical model for EG-import-dependent countries in the presence of imperfectly competitive foreign eco-industries.

Table 1 Impact on pollution of trade intensity in EGs (OA list)

Pollution	(1) lnCO_2	(2) lnSO_2	(3) ln*BOD*	(4) ln*GHG*
ln*GDP_1*	1.3085***	1.4177***	0.8465***	1.3117***
ln*K/L*	0.0845	-0.2390	-0.1389*	0.3461**
ln*GNI/cap*	-0.5593***	0.0672	-0.4619***	-1.0327***
ln*SEP*	-4.6132***	-5.0351***	-1.8951***	-6.2267***
ln*TradeIntA_EOP*	0.1173**	-0.2277*	0.1026*	0.3034**
ln*TradeIntA_CTP*	-0.1208**	0.0394	-0.0358	-0.2194**
ln*Open*	0.3472***	0.6151***	0.1451	0.2628
ln*SEP*				
ln*GNI/cap*	0.0604***	-0.0017	0.0652**	0.0030
ln*Democ*	-0.0125	-0.0078	0.0337	0.0095
ln*Corrup*	-0.0478	-0.1320**	-0.1153	-0.0298
ln*TradeIntA_EOP*	0.0336***	0.0437***	0.0207	0.0492**
ln*TradeIntA_CTP*	-0.0225**	-0.0207*	-0.0273*	-0.0232
ln*Open*	0.0189	0.0061	0.0295	-0.0174
constant	3.2909***	3.8435***	3.7715***	3.4565***
ln*GNI/cap*				
ln*K*	0.5754***	0.5651***	0.5633***	0.6483***
ln*L*	-0.6453***	-0.5825***	-0.6951***	-0.7079***
ln*Democ*	0.0731	0.0668	-0.0525	0.0844
ln*Lat*	0.5524**	0.9060***	0.7999**	0.5600
ln*TradeIntA_EOP*	-0.0140	0.0285	0.0414	-0.0097
ln*TradeIntA_CTP*	0.0858***	0.0512*	0.0638**	0.0692
ln*Open*	-0.0599	-0.0698	-0.1227**	-0.0628
constant	1.1472	-1.2546	0.8363	0.6682
N. of obs.	216	148	128	48

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

The ***income equation***'s estimates confirm the predictions of the endogenous growth literature. We find that relative capital abundance and distance from the equator increase per-capita income. These results are both robust (i.e., there are similar results for models explaining pollutants of different nature) and highly significant. With respect to the trade intensity in EGs, we find that only trade intensity in *cleaner technologies and products* has a positive, statistically significant impact on income in our CO_2, SO_2 and BOD models. Finally, although trade openness has no impact on income in air-pollution models, it appears to reduce GNI/cap in the model explaining BOD emissions. Large trade deficits and related high unemployment rates in CEE/CIS could partially explain this finding. Thus, our results contradict (to an extent) our theoretical assumptions, i.e., that trade increases income (see Frankel and Romer, 1999). However, Rigobon and Rodrik (2004) suggest that the Frankel and Romer's (1999) finding is not robust to the inclusion of institutional quality. The authors conclude, "openness (trade/GDP) has a negative impact on income levels after we control for geography and institutions". We thus confirm this finding after having controlled for both geography (distance from equator) and institutions (civil liberties and political rights).

To summarize the findings explored in Table 1 and draw some conclusions, we compute trade intensity in EGs' overall impact on pollution (Table 2 below), to see if its indirect effects, via *SEP* and *GNI/cap*, amplify, reduce or even offset its direct impact on pollution (prevailing scale-composition or technique effect). For instance, the overall (direct + indirect) effect on CO_2 emissions of trade intensity in CTP (*lnTradeIntA_CTP*) is computed as following[21]: (-0.1208) [direct effect] + (-0.0225)*(-4.6132) [indirect effect via SEP] +0.0858*(-0.5593) [indirect effect via GNI/cap]= **-0.065**.

Table 2 Overall environmental impact of trade intensity in EGs, as defined by OECD and APEC

	CO_2	SO_2	BOD	GHG
trade intensity in class A (OA list) end-of-pipe products	-	-	+	-
trade intensity in class A (OA list) cleaner technologies and products	-	+	+	-

- For ***trade intensity in end-of-pipe products***, we find that the direct positive (prevailing scale-composition) effect on CO_2, and GHG emissions in general, is offset by the indirect negative technique effect via *SEP*, thus generating a negative net impact on these pollutants (see Table 2). In other words, if trade in end-of-pipe EGs appears to reduce the country's total GHG emissions, it is not because of its direct, final-use technique effect but because of an induced technique effect on overall economic activity through upgraded environmental regulations. The same net impact is found for SO_2 emissions, with the difference that the negative indirect effect via *SEP* amplifies their direct technique effect, which has been found to prevail over the scale-composition effect. As regards the BOD emissions, in addition to its positive, prevailing direct scale-composition effect, trade intensity in end-of-pipe products does not have any indirect technique effect on these types of emissions, thus resulting in a harmful overall impact on water pollution. No impact on income is found for trade intensity in these products. In conclusion, *trade intensity in end-of-pipe products was found to increase pollution in the transition economies via a direct positive, prevailing scale-composition, effect* (CO_2, BOD and GHG models). Fortunately, this harmful effect *is offset* (CO_2, SO_2 and GHG models) *by a positive impact on the stringency of environmental regulations*. Although environmental benefits are found for air pollution, our empirical results do not support the double profit (economic and environmental) of trade in end-of-pipe EGs in transition economies.
- Our empirical results underscore a negative direct impact of ***trade intensity in cleaner technologies and products*** on CO_2, and GHG emissions in general, strengthened by a *negative indirect effect* (the harmful impact via *SEP* being offset by a beneficial effect via income) in the case of CO_2 pollution. Regarding *SO_2 and BOD models*, in which no direct impact is found, *the indirect effect via income does not compensate the detrimental effect induced through SEP, thus producing a positive (or harmful) net impact* on these pollutants. For this type of EG trade

---

[21] Only statistically significant elasticities are considered.

intensity, double profit (environmental and economic) is found only in the model that explains CO_2 emissions. Thus, these products' trade liberalization could be particularly supported while targeting climate-change mitigation.

We therefore identify various transmission channels for these two categories of EGs: direct technique effects for both of them, but on different pollutants, and even a prevailing harmful scale-composition direct effect for end-of-pipe products; and favourable indirect effects passing through environmental regulation in the case of end-of-pipe products and via income in the case of cleaner technologies and products.

6. Robustness checks and extended empirical analysis

6.1. Tests for environmental regulation variable

First, we perform a robustness test for the *SEP* variable. We run models (1) to (4) by replacing the *SEP* variable with a new proxy, the Stringency of Environmental Regulation (SER) index. This proxy differs from the previous one by using as components (in addition to the density of INGOs and the number of ISO 14001 certified companies) the number of *ratified MEAs* instead of signed MEAs and *energy efficiency* instead of the existence of a regulation on air pollution and adhesion to the Responsible Care® Program. Countries that ratify more MEAs prove their governments' concern about environmental protection. We believe that it is important to consider MEA ratification in robustness tests because it is often argued that it is the ratification, not the year of signature, which imposes the requirement of compliance with an international environmental treaty. Moreover, because no definition of composite variables really exists, we also believe it important to have an index with consistent but different component variables. Moreover, because the *SEP* variable is created using the Z-score method, we have decided to discuss here empirical estimators for the *SER* index computed using the principal component analysis (PCA) technique, thus highlighting robustness for both component variables and computation technique. Table 7 in Appendix E reports comparative estimates for our system of simultaneous equations (CO_2, SO_2, BOD and GHG) using the *SER* index as proxy for the stringency of environmental regulation. The empirical results confirm the robustness of our previous findings, namely, for *EGs' trade intensity* estimates. Other core variables, such as environmental regulation and income, retain their sign and significance levels, having very similar coefficients.

6.2. Alternative EGs classifications

In this subsection, we extend our empirical analysis by considering alternative classifications of EGs. We investigate the environmental impact of trade intensity in other Class A EGs that are not included in the OA list (*TrInA_OtherEGs*), along with the most-often discussed Class B EGs: clean technologies used for power generation and environmentally preferable products (*TradeIntB_CT* and *TradeIntB_EPP*, respectively). Many developing countries wish to have these products included in the EGs list for WTO negotiations on trade liberalization.

Table 3 displays results for alternative classifications of EGs. On the whole, our control variables retain their sign and significance compared to our benchmark estimations (models 1 to 3). With respect to EGs, only *trade intensity in* *environmentally preferable products* has a direct negative effect on CO_2 emissions, and it has no technique indirect effects. This result is in some sense obvious, because *environmentally preferable products*' production, consumption, and/or disposal are less polluting (suggesting a negative scale-composition direct effect) and their uses are not pollution-abatement processes (so no technique effect is expected). No significant effect is found for SO_2 emissions, which are industrial by-products and thus are not directly linked to consumer products. However, trade intensity in *environmentally preferable products* seems to raise water pollution through an induced reduction in income.

With respect to other Class A EGs that are not included in the OA list, trade intensity in *other type A EGs* appears to only reduce water pollution through the indirect income channel, which offsets its surprisingly negative impact on the stringency of environmental policy. Similar to *environmentally preferable products*, although no significant effect is found for SO_2 emissions, a harmful impact is found for CO_2 emissions.

Table 3 Environmental impact of trade intensity in EGs, alternative classifications

EnvQual	(5) lnCO_2	(6) lnSO_2	(7) ln*BOD*
ln*GDP_1*	1.2480***	1.4638***	0.7953***
ln*K/L*	0.1260	-0.2679	-0.1330*
ln*GNI/cap*	-0.6199***	-0.0805	-0.5104***
ln*SEP*	-3.7811***	-5.5621***	-1.4967***
ln*TradeIntA_OtherEGs*	0.0516	-0.0338	0.0152
ln*TradeIntB_CT*	0.0064	-0.0791	0.0993**
ln*TradeIntB_EPP*	-0.1177**	0.0154	-0.0773
ln*Open*	0.3316***	0.5972***	0.1885*
ln*SEP*			
ln*GNI/cap*	0.0612***	0.0244	0.0681**
ln*Democ*	0.0078	0.0195	0.0405
ln*Corrup*	-0.0639	-0.1213*	-0.1695*
ln*TradeIntA_OtherEGs*	-0.0246**	-0.0227	-0.0281**
ln*TradeIntB_CT*	0.0185**	0.0231**	0.0104
ln*TradeIntB_EPP*	0.0076	0.0040	0.0014
ln*Open*	0.0302	0.0220	0.0602**
constant	3.4487***	3.8749***	3.9520***
ln*GNI/cap*			
ln*K*	0.5609***	0.5593***	0.5296***
ln*L*	-0.6192***	-0.5472***	-0.6605***
ln*Democ*	0.0314	0.0471	-0.0289
ln*Lat*	0.7146***	1.1746***	0.8202**
ln*TradeIntA_OtherEGs*	0.0369	0.0608**	0.0756***
ln*TradeIntB_CT*	0.0427**	0.0153	0.0672***
ln*TradeIntB_EPP*	0.0092	0.0124	-0.0586**
ln*Open*	-0.0866*	-0.1251**	-0.1216**
constant	0.0172	-2.3917**	1.1094
N. of obs.	216	148	128

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

Finally, *trade intensity in Class B clean technologies* reduces CO_2 and SO_2 emissions through indirect channels, primarily through environmental regulation (CO_2 and SO_2 models) but also through the income effect (CO_2 model). The opposite effect is found for BOD emissions that increase with trade intensity in *Class B clean technologies* via its direct positive scale-composition effect, which is reduced but not offset by the negative indirect-income effect (see Table 4 for overall impacts).

Table 4 Overall environmental impact of trade intensity in alternative EGs classifications

	CO_2	**SO_2**	**BOD**
trade intensity in other class A EGs	+	no effect	-
trade intensity in class B clean technologies	-	-	+
trade intensity in class B environmentally preferable products	-	no effect	+

Finally, in this sub-section we run some additional regressions on the lists of aggregated EGs (see Table 8 in Appendix E). The first three models regress pollution on trade intensity in all of the EGs referenced in the OA list (EOP and/or CTP), whereas the last three models consider any environmental good that is included in either class A or class B. The six estimation models underline similar findings: when considering pooled/large lists, trade intensity in EGs is found to have an overall negative impact on CO_2 emissions as a result of the only significant indirect income effect. Considering BOD emissions, the indirect income effect does not offset the direct positive scale-composition effect, thus inducing a globally harmful effect on water quality. No impact is found for SO_2 emissions. This last finding may be explained by the divergent effects found on SO_2 emissions for trade intensity in the OA list's two sub-categories: *end-of-pipe products* and *cleaner technologies and products*. Those sub-categories create the interest in separately studying specific and accurate EGs classifications, which enable the identification of homogeneous EGs sub-categories that have different transmission channels. For overall trade openness, in all of the regressions we find a globally harmful impact on environmental quality. In other words, higher trade intensity generates more pollution in the transition economies, either directly through the scale/composition effects or indirectly through its negative effect on levels of per-capita income. Unlike Antweiler, Copeland and Taylor (2001) and Dean (2002), and after having controlled for trade in goods designed to improve environmental quality, i.e., EGs, we do not find any technique effect on pollution for trade openness in the transition countries.

6.3. Environmental impact of EGs imports and exports

Subsequently, we investigate the environmental impact of exports and imports of EGs separately instead of examining trade intensity in EGs. This aspect seems to be very important for CEE/CIS countries, which were net importers of EGs during the analysed period; moreover, the overall impact (economic and environmental) of these products' liberalization would mainly depend on the effect of imports of EGs on income, environmental policy and pollution. Consequently, we rewrite the Table 1 models (1) to (3) by replacing trade intensity (*TradeInt*) variables with imports (*Im*) and exports (*Ex*). Table 5 displays the estimation results, which are relatively similar to those found in Table 1 and are quite robust (except for *K/L* and *Open* variables, changing statistical significance).

We can draw some interesting conclusions about the EGs. Examining the direct impact on pollution, we find that ***imports*** of *end-of-pipe products* reduce CO_2, SO_2 and BOD emissions, whereas imports of *cleaner technologies and products* increase air pollution (CO_2 and SO_2). These results show a prevailing direct technique effect for imports of end-of-pipe products and a dominating direct scale-composition effect for imports of cleaner technologies and products (the latter usually generating productivity gains, which may lead, through abound effects, to more production and thus more pollution). Examining further indirect effects, we found for the imports of end-of-pipe products a negative impact on *SEP*, which induces a global positive impact on BOD emissions but does not offset the direct negative effects on CO_2 and SO_2 emissions. Our empirical results underscore the negative indirect effects on pollution of the import of CTP, passing through both increased income and strengthened environmental standards and thus generating these imports' negative net impact on BOD and CO_2 emissions. However, because no indirect technique effect is found on SO_2 emissions, the global impact on sulphur dioxide pollution remains positive. In conclusion, focusing on the negative overall effects on pollution, we show that imports of end-of-pipe products contribute to improved environmental quality through a direct technique effect, whereas imports in cleaner technologies and products have indirect effects via environmental regulation and income.

Table 5 Environmental impact of EGs imports and exports

EnvQual	(12) lnCO_2	(13) lnSO_2	(14) lnBOD
ln*GDP_1*	1.5600***	1.5946***	1.0243***
ln*K/L*	0.1548*	-0.2048	-0.1345
ln*GNI/cap*	-0.4352***	0.0711	-0.4066***
ln*SEP*	-7.0137***	-6.6030***	-3.2374***
ln*ImA_EOP*	-0.3503***	-0.2843**	-0.3049**
ln*ExA_EOP*	0.2123***	-0.0956	0.1338*
ln*ImA_CTP*	0.2843***	0.3704**	0.2244
ln*ExA_CTP*	-0.0634	0.0070	0.0230
ln*Open*	0.2910**	0.2637	0.1717
ln*SEP*			
ln*GNI/cap*	0.0712***	0.0291	0.0582**
ln*Democ*	-0.0099	-0.0072	-0.0211
ln*Corrup*	0.0090	-0.0923	-0.0201
ln*ImA_EOP*	-0.0331***	-0.0265*	-0.1001***
ln*ExA_EOP*	0.0375***	0.0375**	0.0379***
ln*ImA_CTP*	0.0315***	0.0252	0.0973***
ln*ExA_CTP*	-0.0148	-0.0142	0.0000
ln*Open*	0.0022	-0.0050	-0.0443
constant	2.7834***	3.4894***	3.0502***
ln*GNI/cap*			
ln*K*	0.3555***	0.3146***	0.4225***
ln*L*	-0.7032***	-0.6346***	-0.7259***
ln*Democ*	-0.0333	-0.0334	-0.1009
ln*Lat*	0.9862***	1.2095***	0.7897**
ln*ImA_EOP*	0.0298	0.0262	-0.0255
ln*ExA_EOP*	0.0721***	0.1149***	0.0766**
ln*ImA_CTP*	0.0690***	0.0824***	0.0811*
ln*ExA_CTP*	-0.0175	-0.0559**	0.0189
ln*Open*	-0.2340***	-0.2403***	-0.2262***
constant	4.5488***	3.1061***	3.9627***
N. of obs.	216	148	128

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

With respect to ***exports***, no effect (direct or indirect) is found for *cleaner technologies and products*, whereas a global negative impact on our three pollutants is revealed for exports of *end-of-pipe products*. Concerning this last issue, despite a direct positive scale-composition effect, our results underline a prevailing negative indirect effect, i.e., end-of-pipe products' exports increase the income and severity of environmental regulations, thus inducing an overall beneficial effect on the environment. These findings may be explained by a relatively higher propensity to export end-of-pipe products than cleaner technologies and products in the CEE/CIS countries, highlighting the role of exports in increasing income and the capacity to comply with regulations.

Finally, we perform additional regressions to identify the environmental impact of EPPs' imports and exports (see Table 9 in Appendix E). Our results confirm some practical intuitions. We found an overall negative impact on pollution (CO_2 and BOD emissions) for EPPs' imports mainly because of a negative direct scale-composition effect: these products are recognized as more environmentally friendly than their substitutes during the consumption and disposal processes; moreover, they have an indirect income effect (CO_2). Conversely, our results suggest that EPPs' exports increase BOD emissions (positive net impact), mainly through a harmful effect on the stringency of environmental regulations. Like trade intensity, no significant effect on SO_2 emissions is found for EPPs' imports and exports.

Table 6 Overall environmental impact of EGs' imports and exports

		CO_2	**SO_2**	**BOD**
Imports	*end-of-pipe products*	-	-	+
	cleaner technologies and products	-	+	-
	environmentally preferable products	-	no effect	-
Exports	*end-of-pipe products*	-	-	-
	cleaner technologies and products	no effect	no effect	no effect
	environmentally preferable products	-	no effect	+

7. Conclusions

Should transition countries open their markets to EGs? The answer is much more complex than it would seem to be because various aspects—EGs classifications, countries' priorities concerning specific pollutants, the role of tariff revenues in total income, etc.—should be considered before concluding.

Our study supports developing countries' concerns about EGs classifications and their double profit, i.e., economic and environmental. Trade intensity in the most-discussed EGs for liberalization (e.g., the OECD and APEC lists) does not have an unequivocally beneficial effect on the environment. After consideration of the main transmission channels and different pollutants, we found an overall negative impact of trade intensity in EGs on CO_2 and a positive impact on BOD emissions. No significant effect is found for SO_2 emissions. However, we underline the importance of distinguishing between *end-of-pipe products* used in abatement processes, and *cleaner technologies and products* designed to improve production techniques with respect to the environment. Trade intensity in end-of-pipe products has a negative direct technique effect only on SO_2 emissions, whereas trade intensity in cleaner technologies and products has the same effect on CO_2 and total GHG emissions. Overall, we find that although trade intensity in end-of-pipe products reduces air pollution (CO_2, total GHG and SO_2 emissions) primarily *through an indirect impact on environmental regulation*, it increases water pollution (BOD). Concerning cleaner technologies and products, our empirical results underscore a negative net impact on GHG (particularly on CO_2) emissions, with the direct negative effect amplified by an *induced indirect income effect*; and a positive overall impact on SO_2 and BOD emissions found because of a harmful effect on environmental regulation. Moreover, some EGs, most of which are not currently subject to WTO negotiations on trade liberalization (*other class A EGs products* not included in OA list and *the environmentally preferable products*), are found to reduce some pollutant emissions in the transition economies.

Thus, CEE/CIS countries that are primarily suffering from *air pollution* should be interested in opening their markets to *OA EGs* lists (especially *end-of-pipe products*) and some *Class B EGs* (namely, *clean technologies* for power generation and *environmentally preferable products*), whereas countries that are essentially concerned with *water pollution* would oppose liberalization of the former EGs, preferring *other Class A EGs* that are found to reduce BOD emissions.

Our empirical results suggest some considerations to be taken into account for net importers of EGs. Opening trade in EGs would have an "immediate" net effect on pollution that primarily would depend on the effect of imported EGs: generally, our empirical results suggest CO_2 reduction and divergent effects on SO_2 and BOD according to the sub-categories of EGs considered. Concerning negative overall effects on pollution, we show that imports of end-of-pipe products contribute to environmental quality improvement through a direct technique effect, whereas imports in cleaner technologies and products contribute through indirect effects via environmental regulation and income. Thus, our study highlights the importance of considering *indirect effects* because when estimating EGs' trade impact on pollution, we often found an indirect negative (technique) effect compensating for a direct positive (scale-composition) impact, such as for cleaner technologies and products' imports. The indirect income effect is particularly important for CEE/CIS countries and two circumstances should be considered. If the indirect income effect is primarily caused by technological progress, liberalizing EGs trade might be interesting even if the direct harmful scale-composition effect continues to dominate. Indeed, transition economies might rely on beneficial indirect effects (via *income* and/or *SEP*) during negotiations on liberalizing EGs to benefit, in the short term, from a technique effect ensuring better environmental performance in the long term. Conversely, if the positive effect on income is mainly caused by import tariffs, their cut-off could only harm the environment. In that case, the transition economies should be encouraged to integrate the global market by promoting their own exports. This integration would accelerate economic development, thereby improving environmental quality because our empirical results reveal the positive effect on income and global negative impact on pollution for exports of end-of-pipe products and cleaner technologies and products, for which CEE/CIS countries have yet some relative comparative advantage. Without the promotion of exports, EGs' trade liberalization might not be an economically interesting issue for a net importing country with significant revenues from import tariffs.

In conclusion, we cannot support global and uniform trade liberalization for EGs. Because countries differ in their industrialization level and market size and do not have the same initial conditions while integrating a trading-bloc, regional or bilateral trade agreements could act as building blocks towards a global, sequentially achieved liberalization of EGs. Our empirical findings encourage further investigation of the determinants of trade in EGs, enabling the evaluation of trade liberalization's marginal effect compared with other potential barriers, such as institutional factors and user/consumer preferences, facilitating increased trade in EGs without threatening income levels in the net importing countries.

References

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

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

Balineau G., de Melo J (2011), Stalemate at the Negotiations on Environmental Goods and Services at the Doha Round, Ferdi Working Paper 28.

Balineau G., de Melo J (2013), Removing Barriers to Trade in Environmental Goods: An Appraisal, World Trade Review, 12(4), 693-718.

Brunnermeier S., Levinson A. (2004), Examining the Evidence on Environmental Regulations and Industry Location. Journal of Environment and Development 13: 6-41

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

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

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

Copeland B.R. and M.S. Taylor (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 R., Per G. Fredriksson and J.A. List (2003), Trade liberalization, corruption, and environmental policy formation: theory and evidence, Journal of Environmental Economics and Management, 2003; 46 (3):490-512

de Alwis J. M. D. D. J. (2015), Environmental Consequence of Trade Openness for Environmental Goods. Sri Lankan Journal of Agricultural Economics, 16(1). pp.79–98. DOI: http://doi.org/10.4038/sjae.v16i1.4606

de Melo J., Vijil M., (2014), Barriers to Trade in Environmental Goods and Environmental Services: How Important Are They? How Much Progress at Reducing Them? Nota di Lavoro 36.2014, Milan, Italy: Fondazione Eni Enrico Mattei.

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

Elliott RJR, Zhou Y (2013), Environmental Regulation Induced Foreign Direct Investment. Environment and Resource Economics 55(1): 141-158

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.

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

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., E. Neumayer, R. Damania and S. 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. (1995), Pollution and growth: What do we know? In: Goldin and Winter (Editors.), The Economics of Sustainable Development. Cambridge University Press, 1995.

Hamwey R. (2005), Environmental Goods: Identifying Items of Export Interest to Developing Countries, CBTF Briefing Note, UNCTAD secretariat.

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., A. Levinson and D. Wilson (2002), Re-examining the Empirical Evidence for an Environmental Kuznets Curve, NEGR Working Paper No. 7711.

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

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.

Hufbauer G.C., Charnovitz S., Kim J. (2009), Global Warming and the World Trading System, Peterson Institute for International Economics.

Hufbauer G. C., Kim J (2010), Reaching a Global Agreement on Climate Change: What are the Obstacles? Asian Economic Policy Review, 5(1), 2010, pp. 39-58.

International Center for Trade and Sustainable Development (ICTSD) (2008), Liberalization of Trade in Environmental Goods for Climate Change Mitigation: The Sustainable Development Context, Geneva.

Jha V. (2008), Environmental Priorities and Trade Policy for Environmental Goods: A Reality Check, ICTSD Trade and Environment Series Issue, Paper No.7. Geneva: ICTSD.

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

Levinson A. (2008), Pollution Haven Hypothesis. New Palgrave Dictionary of Economics, 2nd Edition

Lucas R., D. Wheeler and H. Hettige (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).

Millimet DL, Roy J. (2012), Three New Tests of the Pollution Haven Hypothesis When Environmental Regulation is Endogenous. IZA Discussion Paper #5911

Nimubona A.D. (2012), Pollution Policy and Trade Liberalization of Environmental Goods. Environmental and Resource Economics 53(3): 323-346

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

Rigobon R. and D. Rodrik (2004), Rule of Law, Democracy, Openness, and Income: Estimating the Interrelationships. NBER Working Paper No. 10750.

Rodrik D., A. Subramanian and F. Trebbi (2004), Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development, Journal of Economic Growth, 9(2):131-165

United Nations Economic and Social Commission for Western Asia (UNESCWA) (2007), The Liberalization of Trade in Environmental Goods and Services in the ESCWA and Arab Regions, New York: United Nations.

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

Schmid G. (2012), Technology transfer in the CDM: the role of host-country characteristics, Climate Policy, 12(6), 722-740. Stern D.I. (2006), Reversal of the trend in global anthropogenic sulfur emissions, Global Environmental Change 16 (2006) 207–220

Steenblik R. (2005), Environmental Goods: A Comparison of the APEC and OECD Lists, Paris: OECD, 2005,

Steenblik R. (2007), Biofuels-At What Cost? Government Support for ethanol and biodiesel in selected OECD countries: A synthesis of reports addressing subsidies in Australia, Canada, the European Union, Switzerland and the United States", Global Subsidies Initiative of the International Institute for Sustainable Development (IISD), Geneva, Switzerland.

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

Wooders P. (2009), Greenhouse gas emission impacts of liberalising trade in environmental goods. Winnipeg, Man: International Institute for Sustainable Development.

World Bank (2007), International Trade and Climate Change, Washington DC: World Bank, 2007.

Yu VPB. (2007), WTO Negotiating Strategy on Environmental Goods and Services in the WTO. International Centre for Trade and Sustainable Development (ICTSD).

Zugravu-Soilita N. (2015), How does Foreign Direct Investment Affect Pollution? Toward a Better Understanding of the Direct and Conditional Effects, Environmental and Resource Economics, 21 Aug 2015

Zugravu-Soilita N., Millock K. and Duchene G. (2008), The Factors Behind CO_2 Emission Reduction in Transition Economies, FEEM Working paper n° 2008.58 (published French version article in Louvain Economic Review 2009/4(75))

Appendices

A. List of countries

Country		CO_2 models *	SO_2 models **	BOD models ***
Albania	*CEE*	+	+	+
Armenia	*CIS*	+	+	+
Azerbaijan	*CIS*	+	+	+
Belarus	*CIS*	+	+	-
Bulgaria	*CEE*	+	+	+
Croatia	*CEE*	+	-	+
Czech Republic	*CEE*	+	+	+
Estonia	*CEE*	+	+	-
Georgia	*CIS*	+	+	-
Hungary	*CEE*	+	+	+
Kazakhstan	*CIS*	+	+	-
Kyrgyzstan	*CIS*	+	+	+
Latvia	*CEE*	+	+	+
Lithuania	*CEE*	+	+	+
Poland	*CEE*	+	+	+
Republic of Moldova	*CIS*	+	+	+
Romania	*CEE*	+	+	+
Russian Federation	*CIS*	+	+	+
Slovakia	*CEE*	+	+	+
Slovenia	*CEE*	+	+	+
Tajikistan	*CIS*	+	+	-
The former Yugoslav Rep.	*CEE*	+	-	+
Ukraine	*CIS*	+	+	+
Uzbekistan	*CIS*	+	+	-
Total		*24*	*22*	*18*

* 216 observations: 24 countries for 9 years (1995-2003).

** 148 observations: 22 countries for 8 years (1995-2002); some data are missing for 2001 and 2002 years.

*** 128 observations: 18 countries for 9 years (1995-2003) with many missing points.

B. Data summary

Variable	Definition	Source
CO_2	Carbon dioxide emissions, in kT	International Energy Agency
SO_2	Sulfur Emissions, in TgS	David Stern (2006)
BOD	Organic water pollutant (BOD) emissions (kg per day)	WDI 2007, World Bank
GHG	Greenhouse Gas emissions (CO_2, CH4, N_2O, PFCs, HFCs, SF6)	CAIT (WRI)
GDP	GDP in constant 2000 US$	WDI 2007, World Bank
GNI/cap	GNI: Atlas method, current US$- Net per capita income	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 labour)	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)
SER	*Stringency of Environmental Regulation* Index	Author's calculation
Corrup	Corruption index	Kaufmann *et al.* (2005)
Democ	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)	UN Comtrade database
TradeA_OA	Bilateral trade in class A EGs, aggregated OECD and APEC list (OA)	Author's database (using UN Comtrade database & EGs lists)
TradeA_EOP	Bilateral trade in OA list's end-of-pipe / pollution control products; involve different products while explaining air or water pollution	Author's database (using UN Comtrade database & EGs lists)
TradeA_CTP	Bilateral trade in OA list's cleaner technologies & products /beginning-of-the-pipe products (pollution prevention / resource management products)	Author's database (using UN Comtrade database & EGs lists)
Open	Openness /Total trade intensity: (Export+Import)/GDP	Author's calculation
TradeIntEGs	Trade intensity in EGs (all classifications confused)	Author's calculation
TradeIntA_OA	Trade intensity in class A EGs, OA list	Author's calculation
TradeIntA_EOP	Trade intensity in OA list's end-of-pipe / pollution control products; involve different products while explaining air or water pollution	Author's calculation
TradeIntA_CTP	Trade intensity in OA list's cleaner technologies & products /beginning-of-the-pipe products (pollution prevention / resource management products)	Author's calculation
TradeIntA_OtherEGs	Trade intensity in other class A EGs not included in the OA list	Author's calculation
TradeIntB_CT	Trade intensity in class B EGs: Clean Technologies (used for power generation)	Author's calculation
TradeIntB_EPP	Trade intensity in class B EGs: Environmentally Preferable Products	Author's calculation
Ex…/Im…	Exports and imports, respectively, for different EGs classifications	Author's calculation
…_1	One year lagged variable	

C. EGs classifications

UNCTAD has identified two types of environmental goods for analytical purposes:

- **Class A EGs**, which include all chemicals and manufactured goods used directly in the provision of environmental services.
- **Class B EGs**, which include all 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.

In order to analyse environmental good trade flows, these two broad sets of EGs have been further decomposed into 10 homogeneous groups of EGs:

Class A EGs have been subdivided into 2 groups:

- **OA list** comprised of the group of all EGs included on the OECD and APEC lists while avoiding double-counting of goods appearing on both lists. **OA list** covers three groups: A) pollution management, B) cleaner technologies and products, and C) resources management group. The first group includes mainly end-of-pipe products, while the two last ones generally cover clean technologies and products used to prevent environmental degradation.
- **Oth-TypeA-EGs list** comprised of several goods used to provide environmental services which have not been captured by the OECD and APEC lists. This list contains, for example, plastic gloves and protective eyewear which are used in environmental clean-up and remediation activities.

Class B EGs that have been subdivided into 8 groups:

- **CT list** comprised of clean technologies used for power generation. This list includes energy efficient natural gas based power generation and renewable energy technologies and their components.
- **EPP-core** list comprised of consumer and industrial non-durable and semi-durable EPP goods. Goods on the EPP list have been selected based on environmentally superior end-use and disposal characteristics only (i.e., not based on PPMs). This list includes a wide variety of goods including natural fibres for industrial uses and in the form of textiles; natural rubber; natural vegetable derivatives, colourings and dyes.
- **CT-fuel list** including fuels for CT, and some conventional (i.e., fuel-switching), power generation technology applications. This list includes natural gas, propane and butane, as well as ethanol and a range of agricultural feedstocks – bagasse and oilseeds – used respectively to produce ethanol and biodiesel fuels.
- **EPP-RCY** list comprised of recoverable materials that are reintegrated into the production cycle. This list includes scrap and waste paper, wood, plastics, rubber and various scrap metals.
- **EPP-WOOD** list comprised of wood and wood-based products including building supplies and furniture.
- **EPP-WSA** list comprised of apparel manufactured from natural wool and silk fibres.
- **EPP-CM** list comprised of raw cotton materials and cotton textiles.
- **EPP-CA** list comprised of apparel manufactured from natural cotton fibres.

Source: Hamwey (2005)

D. Composition of EGs group lists examined in this paper, by HS-96 6-digit code[1]

Class A, OECD+APEC list for '*end-of-pipe products*'
230210, 252100, 252220, 281410, 281511, 281512, 281610, 281830, 282010, 282090, 282410, 283210, 283220, 283510, 283521, 283523, 283524, 283525, 283526, 283529, 283822, 380210, 392020, 392490, 392690, 560314, 580190, 591190, 681099, 690210, 690220, 690290, 690310, 690320, 690390, 690919, 701710, 701720, 701790, 730900, **731010**, 731021, 731029, 732510, 780600, **840410**, 840510, 840991, 841000, 841320, **841350**, **841360**, **841370**, 841410, 841430, 841440, 841459, 841480, 841490, 841780, 841790, 841940, 841960, 841989, 842119, 842121, **842129**, **842139**, 842191, **842199**, 842220, 842381, 842382, 842389, 842490, **842833**, 846291, 847290, 847410, 847432, 847439, 847982, 847989, 847990, **848110**, **848130**, **848140**, **848180**, **850590**, 851410, 851420, 851430, 851490, 851629, **870892**, 890710, 890790, 901320, 901540, 901580, 901590, 902229, 902290 , 902511, 902519, 902580, 902590, 902610, 902620, 902680, 902690, 902710, 902720, 902730, 902740, 902750, 902780, 902790, 902830, 902890, 903010, 903020, 903031, 903039, 903083, 903089, 903090, 903110, 903120, 903130, 903149, 903180, 903190, 903220, 903281, 903289, 903290, 903300, **960310**, 960350, 980390 – ***142 items***

Class A, OECD+APEC list for '*cleaner technologies & products*' (including resource management products)

220100, 220710, 280110, 284700, 285100, 290511, **320910**, 320990, 381500, 391400, **460120**, 700800, 701990, **840420**, 840999, **841011**, 841012, **841013**, **841090**, **841381**, **841911**, **841919**, **841950**, **841990**, 843680, **850231**, 853931, **854140**, 854389, 902810, 902820, 903210 – ***32 items***

Other type Class A EGs (Oth-TypeA-EGs)
284700, 392321, 392329, 392620, 401519, 440130, 441700, 611610, 630533, 630611, 630612, 630619, 640110, 640191, 640192, 640199, 691010, 691090, 820110, 820120, 820130, 820140, 820150, 820160, 820190, 820210, 842820, 842832, **842833**, 842839, 842890, 842959, 847490, 850530, **850590**, 850810, 850820, 850880, 850890, 850910, 850930, 853949, 870490, **870892**, 900490, 902000 – ***46 items***

Class B, *Clean Technologies* (CT)
392510, **731010**, 731100, 732211, 732219, 732290, 761100, 761300, 830249, 840211, 840212, 840219, 840220, 840290, 840310, 840390, **840410**, **840420**, 840490, 840681, 840682, 840690, 840890, **841011**, **841012**, **841013**, **841090**, 841181, 841182, 841199, **841350**, **841360**, **841370**, **841381**, 841391, 841620, 841630, 841869, **841911**, **841919**, **841950**, **841990**, **842129**, **842139**, **842199**, 847960, **848110**, **848130**, **848140**, **848180**, 848190, 848310, 848360, 848410, 848490, 850131, 850132, 850133, 850134, 850161, 850162, 850163, 850164, 850211, 850212, 850213, 850220, **850231**, 850239, 850240, 850300, 850421, 850422, 850423, 850431, 850432, 850433, 850434, 850440, 850490, 851150, 851610, 851621, **854140**, 900190, 900290 – ***86 items***

Class B, *Environmentally Preferable Products* (EPP-core)
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** – ***106 items***

---

[1] In total we have 377 products: 161 are present in the current WTO408 list (of which 106 are from OA list) and 20 in the WTO26 list (with 14 codes from OA). With the exception of the Oth-TypeA-EGs and EPP-core lists, which generally contain unique products not present in the other lists (with a few exceptions), the OA and CT lists share some common goods (see codes in blue and violet colors).

E. Alternative empirical estimations

Table 7 Robustness tests for environmental regulation variable

EnvQual	(15) lnCO_2	(16) lnSO_2	(17) ln*BOD*	(18) ln*GHG*
ln*GDP_1*	1.3173***	1.3928***	0.9170***	1.2379***
ln*K/L*	0.2251***	-0.0902	-0.1660**	0.3976***
ln*GNI/cap*	-0.4011***	0.1995	-0.3270***	-0.4993***
ln*SER(pca)*	-5.3192***	-5.5440***	-2.5800***	-6.2782***
ln*TradeIntA_EOP*	0.1587***	-0.1937*	0.1161**	0.0688
ln*TradeIntA_CTP*	-0.2091***	0.0085	-0.0881	-0.1389**
ln*Open*	0.5486***	0.6670***	0.2400**	0.4496***
ln*SER(pca)*				
ln*GNI/cap*	0.1192***	0.0572***	0.1586***	0.0841***
ln*Democ*	-0.0282	0.0103	0.0004	0.0056
ln*Corrup*	-0.0270	-0.1441***	-0.0076	-0.0546
ln*TradeIntA_EOP*	0.0401***	0.0281***	0.0074	0.0153
ln*TradeIntA_CTP*	-0.0412***	-0.0237***	-0.0290**	-0.0145
ln*Open*	0.0561***	0.0223	0.0464**	0.0153
constant	2.6656***	3.6359***	2.8829***	3.2908***
ln*GNI/cap*				
ln*K*	0.5646***	0.5613***	0.5452***	0.6332***
ln*L*	-0.6191***	-0.5843***	-0.6646***	-0.6862***
ln*Democ*	0.0689	0.0338	-0.0540	0.0973
ln*Lat*	0.6782***	0.9624***	0.9544***	0.7633
ln*TradeIntA_EOP*	-0.0056	0.0440	0.0499	-0.0036
ln*TradeIntA_CTP*	0.0848***	0.0449*	0.0636**	0.0639
ln*Open*	-0.0724	-0.0755	-0.1365**	-0.0717
constant	0.3957	-1.5313	0.0488	-0.1190
N. of obs.	195	143	118	43

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

Table 8 Environmental impact of trade intensity in EGs, pooled lists

EnvQual	(19) lnCO_2	(20) lnSO_2	(21) ln*BOD*	(22) lnCO_2	(23) lnSO_2	(24) ln*BOD*
ln*GDP_1*	1.2850***	1.4363***	0.8131***	1.3003***	1.4618***	0.8319***
ln*K/L*	0.1214	-0.3056	-0.1004	0.1168	-0.2838	-0.1296*
ln*GNI/cap*	-0.5798***	-0.0464	-0.5679***	-0.5817***	-0.0868	-0.5225***
ln*SEP*	-4.1630***	-5.4159***	-1.6520***	-4.2262***	-5.4577***	-1.7760***
ln*TradeIntA_OA*	-0.0111	-0.0991	0.1084***			
ln*TradeInt_EGs*				-0.0136	-0.0985	0.0863**
ln*Open*	0.2783***	0.5864***	0.0796	0.2803***	0.5814***	0.1151
ln*SEP*						
ln*GNI/cap*	0.0702***	0.0323	0.0672**	0.0614***	0.0190	0.0653**
ln*Democ*	0.0023	0.0153	0.0374	-0.0044	0.0061	0.0294
ln*Corrup*	-0.0533	-0.1155*	-0.1058	-0.0517	-0.1184*	-0.1067
ln*TradeIntA_OA*	0.0012	0.0042	-0.0056			
ln*TradeInt_EGs*				0.0068	0.0115	-0.0024
ln*Open*	0.0188	0.0102	0.0242	0.0082	-0.0027	0.0177
constant	3.5721***	4.0368***	3.8767***	3.5525***	4.0331***	3.8693***
ln*GNI/cap*						
ln*K*	0.5610***	0.5640***	0.5614***	0.5537***	0.5677***	0.5446***
ln*L*	-0.6392***	-0.5986***	-0.6816***	-0.6215***	-0.5876***	-0.6647***
ln*Democ*	0.0302	0.0182	-0.0459	0.0763	0.0801	-0.0132
ln*Lat*	0.2061	0.6346**	0.4574	0.4794*	0.8197***	0.7943**
ln*TradeIntA_OA*	0.0880***	0.0860***	0.1070***			
ln*TradeInt_EGs*				0.0714***	0.0650***	0.0956***
ln*Open*	-0.0546	-0.0758	-0.1110**	-0.0277	-0.0378	-0.0945*
constant	1.8589**	-0.3035	1.4918	0.7595	-1.1641	0.2856
N. of obs.	216	148	128	216	148	128

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

Table 9 Environmental impact of EPPs imports and exports

	(25)	(26)	(27)
EnvQual	lnCO_2	lnSO_2	ln*BOD*
ln*GDP_1*	1.4629***	1.4706***	1.0607***
ln*K/L*	0.2995***	-0.1226	-0.0593
ln*GNI/cap*	-0.5435***	-0.2630	-0.2498**
ln*SEP*	-5.3937***	-5.7376***	-3.2307***
ln*ImB_EPP*	-0.1465***	-0.0882	-0.1294***
ln*ExB_EPP*	0.0187	0.0340	0.0270
ln*Open*	0.5916***	0.5648***	0.4952***
ln*SEP*			
ln*GNI/cap*	0.0930***	0.0449	0.1028***
ln*Democ*	0.0051	0.0444	0.0301
ln*Corrup*	-0.0006	-0.1095	-0.0570
ln*ImB_EPP*	-0.0011	0.0017	0.0012
ln*ExB_EPP*	-0.0082	-0.0117	-0.0232**
ln*Open*	0.0393**	0.0366*	0.0509*
constant	3.2970***	4.0367***	3.6058***
ln*GNI/cap*			
ln*K*	0.5213***	0.5420***	0.5664***
ln*L*	-0.6592***	-0.5983***	-0.6619***
ln*Democ*	0.0242	0.0464	0.0197
ln*Lat*	1.3564***	1.5158***	1.2039***
ln*ImB_EPP*	0.0359**	0.0132	0.0148
ln*ExB_EPP*	0.0709***	0.0808***	0.0699***
ln*Open*	-0.1452***	-0.1244***	-0.0986*
constant	-0.6630	-2.6662***	-0.9442
N. of obs.	216	148	128

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