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ARE DEEP AND COMPREHENSIVE REGIONAL TRADE AGREEMENTS HELPING TO REDUCE AIR POLLUTION?

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Are Deep and Comprehensive Regional Trade Agreements helping to Reduce Air Pollution?

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Abstract

This paper investigates whether membership in Regional Trade agreements (RTAs) with environmental provisions (EPs) affect relative and absolute levels of environmental quality and whether the inclusion of most comprehensive EPs is associated to higher environmental quality. In order to do so, the determinants of PM2.5 population weighted concentrations are estimated for a sample of OECD countries and OECD+BRIICS over the period 1990 to 2011. The usual controls for scale, composition and technique effects are added to the estimated model and the endogeneity of income and trade variables is addressed using instruments. The main results indicate that membership in RTAs with EPs is in general associated with higher environmental quality in absolute terms, whereas no significant results are found for RTAs without EPs. Moreover, the concentration in emissions of the pairs of countries that belong to an RTA with EPs tends to converge for the country sample.

Key Words: regional trade agreements, environmental provisions, convergence, environmental regulations

JEL: F 18, O13, L60, Q43

1. Introduction

The interactions between international trade and environmental quality have been widely recognized by scholars and policy actors since the early 1990s. Trade and the environment was already identified as a relevant area in the 1992 Rio Earth Summit and referred to as well in the Rio +20 agreement, in which more action was required to ensure that countries could pursue development policies with the necessary environmental protection to ensure a sustainable path of economic growth and social progress.

The increasing importance of regional and bilateral trade negotiations, with more than 250 RTAs in force in 2014, has been reinforced by the slow progress in the multilateral negotiation arena, in both trade and environmental issues. On the one hand, the WTO has not always succeeded in integrating environmental issues in the multilateral trade negotiations [1], usually leaving these issues to environmental multilateral agreements (MEAs). On the other hand, the MEAs have been, until present time, tackling particular aspects related to global (e.g. Kyoto) and local climate change (Montreal Protocol), or conservation and biodiversity (CITES) among many other issues. However, their effectiveness is far from been generally recognized[2]

An increasing number of recently ratified RTAs introduce environmental provisions in the main text of the RTAs or in companion side agreements. These provisions aim at protecting the environment and at establishing ways of collaboration in environmental issues. The breadth and depth of the provisions widely vary by agreement. At a minimum, new RTAs tend to incorporate environmental issues in the preamble or in some articles dealing with investment issues or exceptions. Other RTAs include a chapter dedicated exclusively to environmental matters, whereas in some cases environmental aspects are covered in a side agreement.
Since 2007 the OECD has undertaken regular reviews of how environmental issues are treated in trade agreements (OECD, 2007) and providing and updating an inventory of RTAs with environmental provisions (EPs) (OECD 2008, 2009, Gallagher and Serret, 2010 and 2011, George, 2013, 2014a and 2014b). The OECD reports refer to some ex-post assessments of environmental impacts (e.g. EU-Chile in and US for the RTAs recently signed; George, 2013) and mention the difficulty to isolate the impact of the RTAs on environmental outcomes from other factors.

The scarce literature on the impact of including EPs in RTAs motivates this research. In this paper, we focus on the effect of RTAs with EPs on PM2.5 population weighted concentrations and explore whether the inclusion of most comprehensive EPs is associated to higher air quality. We categorize RTAs according to the breadth and the depth of the EPs included in the RTAs or in the corresponding side agreements. Next, we use this categorisation in an empirical model to test whether concentrations of PM2.5 are lower in countries belonging to RTAs with more comprehensive EPs, than in RTAs with less or no EPs. The analysis is done considering the RTAs that were into force over the period of study.

[1] There are however some exceptions. Some environmental issues are being discussed under Doha and the WTO DSB and Appellate body have ruled on several trade and environmental disputes since the WTO's inception, creating interesting precedent.

[2] An excellent survey is presented in Mitchell (2003).

The rest of this paper is structured as follows. Section 2 reviews the literature on the impact of trade liberalization and RTAs on the environment. Section 3 presents the empirical framework and the main modelling strategy and outlines the methodology used to categorize EPs in RTAs and outlines the resulting categorisation. Section 4 presents and discusses the main empirical results. Finally, Section 5 draws conclusions.

2. Literature Review

2.1 The impact of trade liberalisation on the environment

The impact of trade liberalisation on the environment is a controversial issue. Increasing openness and trade generates a mixture of potential positive and negative effects on the environmental and natural resources of countries (Grossman and Krueger, 1991; GK). For this reason, the interactions between trade and the environment have been widely investigated by economists in the last two decades.

Early on, GK focused on the environmental effects of the entry into force of the North American Free Trade Agreement and decomposed the environmental impact of trade liberalization into scale, technique and composition effects. This decomposition has been frequently used by the subsequent related literature[3], with some authors stating that when trade is liberalized all these effects interact with each other (Copeland and Taylor, 2003; Managi et al, 2009).

The *scale effect* indicates that an increase in global economic activity due to increased trade raises the total amount of pollution and, as a consequence, creates environmental damages. Thus, the scale effect is expected to have a negative impact on the environment. However, the evidence from the literature also reports that higher incomes affect environmental quality positively (Grossman & Krueger, 1993; Copeland and Taylor, 2004). This suggests that when assessing the effects of growth and trade on the environment, we cannot automatically hold trade responsible for environmental damage (Copeland and Taylor, 2004). Since increasing incomes per capita are usually associated to a greater demand for environmental quality and in turn to beneficial changes in environmental policy, the net impact on the environment remains unclear. This argument is linked to the so-called environmental Kuznets curve (EKC), which basically hypothesizes the existence of an inverted U-shaped relationship between environmental quality and per capita income. The EKC

[3] Antweiller et al (2001), Stoessel (2001), Cole and Elliot (2003), Lopez & Islam (2008).

hypothesis states that environmental quality first decreases and then rises with increasing income per capita (Stern, 2004). In the last decades, numerous empirical studies have tested for the existence of an EKC (See Dinda 2004; Carson, 2010 and Stern, 2004, 2015 for a summary of the empirical literature). The literature concludes that for pollutants with local and more short-term impacts a significant EKC is more likely to hold than for global and long-term pollutants (Dinda, 2004; Carson 2010). In our opinion and also according to Carson (2010) the focus should be shifted to the mechanisms and transmission channels that affect the income-environmental quality relationship.

The *technique effect* is expected to have a positive impact on the environment. Researchers widely agree that trade is responsible for technology transfers and new technology should benefit the environment if pollution per output is reduced. A reduction in the emission intensity results in a decline in pollution, holding constant the scale of the economy and the mix of goods produced. Recent studies suggest that this effect can in some cases prevail over the scale effect (Levinson, 2015).

Finally, the impact of the *composition effect* of trade on the environment, namely, the effect of a change in the basket of products exported after trade liberalization, is ambiguous according to economic theory. Trade based on comparative advantage results in countries specialising in the production and the trade of those goods that the country is relatively efficient at producing. On the one hand, if comparative advantage results from differences between countries in environmental regulations, countries will benefit economically from having lax regulations, and environmental damage might result. The pollution haven hypothesis (PHH) predicts that trade liberalisation in goods will lead to the relocation of pollution-intensive production from countries with high income and more stringent environmental regulations to countries with low income and lax environmental regulations. Developing countries therefore could enjoy a comparative advantage in pollution-intensive products and become pollution havens. On the other hand, if factor endowments are the main source of comparative advantage, the factor endowment hypothesis (FEH) claims that countries where capital is relatively abundant will export capital-intensive (dirty) goods. This stimulates production while increasing pollution in the capital-rich country. Countries where capital is scarce will see a fall in pollution given the contraction of the pollution generating industries.

Thus, the effects of liberalised trade on the environment depend on the distribution of comparative advantages across countries. Earlier studies using aggregate trade did not find strong evidence of a pollution haven effect. Nevertheless, new studies using more disaggregate data and accounting for endogeneity issues and spillovers tend to find some support for it (Broner, Bustos and Carbalho, 2012; Millimet and Roy, 2015; Martinez-Zarzoso et al, 2016).

In summary, the earlier literature identifies the existence of both positive and negative effects of the liberalisation of trade on the environment. The positive effects include increased growth and technology transfers accompanied by the distribution of environmentally safe, high quality goods, services and technology. The negative effects stem from the relocation of pollution-intensive economic activities in countries with lax environmental regulations that could potentially threaten the regenerative capabilities of ecosystems while increasing the danger of depletion of natural resources. Most of the empirical literature has used changes in trade openness as a proxy for trade liberalisation (Antweiller et al., 2001; Cole and Elliot, 2003; Frankel and Rose, 2005; Managi et al., 2009). In contrast to the theoretical predictions, early findings pointed to net positive effects of trade on the environment (Frankel and Rose, 2005). The explanation for this positive effect is that trade encourages innovation, speeds the absorption of new technologies and could also bring clean production techniques from more technologically advanced countries to the less advanced.

Surprisingly few studies have been devoted so far to regional trade agreements (RTAs), except in the case of NAFTA (Grossman and Krueger, 1991; Stern, 2007). To the best of our knowledge, only two studies have used the existence of RTAs instead of trade openness as a trade policy variable that could influence pollution levels or more generally environmental outcomes (Ghosh and Yamarik, 2006; and Baghdadi, Martínez-Zarzoso and Zitouna, 2013). These two studies are described in detail in the next section.

2.2 The impacts of RTAs on the environment

The first published study evaluating the possible quantitative impact of RTAs on the environment was Ghosh and Yamarik (2006). The authors propose and estimate an empirical model where trade, growth and RTAs are linked and in which RTAs can have a direct and an indirect effect on the environment (through increasing trade and growth). Their empirical approach combines three well-known modelling strategies in the economics literature. First, the gravity model of trade, which has been considered the workhorse of empirical trade modelling since the early 1990s (Feenstra, 2004), is used to estimate the determinants of bilateral trade flows. Second, growth in GDP per capita is modelled following the growth-empirics literature that considers trade openness as one of the deep factors explaining economic growth (Frankel and Romer, 1990; Doyle and Martinez-Zarzoso, 2011). Finally, the above-mentioned literature linking trade with growth and environmental quality, based on the seminal work of Grossman and Krueger (1991) and Antweiller et al. (2001), is used to estimate the determinants of environmental degradation. As a proxy for degradation, three indicators of air quality (suspended particulate matter, sulphur dioxide and nitrogen dioxide) and four of resource utilization (carbon dioxide per capita, percentage change in deforestation, energy depletion per capita and water pollution per capita) are considered. They apply ordinary least squares (OLS) in combination with instrumental variable estimation techniques (IV), the latter being used to control for the endogeneity of trade and income, to a sample of 151 countries in 1995 (using bilateral trade data for 1990). The main findings show that membership in RTAs reduces pollution by raising trade and income per capita, indicating that there is an indirect positive effect on environmental quality. In contrast, no evidence is found for the existence of a direct effect, for instance, they do not find any evidence that membership of RTAs itself affects environmental outcomes.

There are three main limitations to Ghosh and Yamarik (2006). First, it is based on data for a single year and therefore is unable to include dynamics and to control for unobserved factors that are country-specific and time-invariant. Second, and perhaps the main shortcoming is that the authors do not explain the mechanism through which the membership to RTAs could affect the environment. Finally, a third limitation is that there are important differences among RTAs in the way they take into account environmental issues. Whereas some RTAs include an extensive range of EPs (e.g. Canada-Panama), others are limited to confirming the general exceptions of GATT (art XIV and XIV) or exceptions for specific chapters (e.g. Australia-Malaysia). The two first issues are tackled in Baghdadi et al. (2013), the only other study that evaluates the impact of RTAs on the environment to explain changes in environmental outcomes. Their approach refines and extends the modelling strategy applied in Ghosh and Yamarik (2006) by considering not only trade and GDP growth as endogenous variables, but also membership in RTAs. Moreover, the models are estimated for a panel-data set of 35 to 92 countries (depending on the indicator) over the period from 1980 to 2008 and the endogeneity of the RTA variable is addressed by using matching and difference in differences (DID) techniques. The most remarkable departure from Ghosh and Yamarik (2006) is that Baghdadi et al. (2013) introduce the idea that if a direct positive effect of RTAs on the environment exists, it should only be found for those agreements that specifically include environmental provisions (EPs) in the main text of the trade agreement, or for those that are accompanied by side environmental agreements, as in the case of NAFTA[4]. The direct effect is explained by the fact that EPs in RTAs will encourage members to apply and enforce more stringent environmental regulations and these should in turn enhance environmental quality. Hence, the link with regulations should induce an improvement in environmental outcomes independent of the trade-induced effect and even for similar levels of environmental regulations. In their paper, a distinction is made between RTA's membership in agreements with and without EPs. The first limitation of this study is that environmental degradation is proxied with a single variable, namely carbon dioxide emissions. While an important driver of climate change, CO_2 emissions are not necessarily linked to other indicators of environmental quality. A second limitation is that EPs are very heterogeneous, with some RTAs including very detailed provisions and others only mentioning the environment in the investment chapter (e.g. OECD, 2007). Hence, modelling this using a dummy variable is over-simplistic. Finally, a measure of national environmental regulations is missing in the analysis. National environmental regulations can affect environmental quality, but also trade (Tsurumi et al. 2016).

The methodology in Baghdadi et al. (2013) consists of modelling per-capita emissions as a function of population, land area per capita, GDP per-capita, trade and RTAs. Since there could be reverse causality between the independent and the dependent variables, they assume that GDP per-capita and the trade variables are endogenously determined. The authors use instrumental variables (IV) techniques to estimate GDP per-capita (with a model borrowed from the growth-empirics literature) and trade (using a gravity model) and address RTA endogeneity due to self-selection into agreements using matching econometrics in combination with DID. To test whether

[4] Ghosh and Yamarik (2006) just mention that regional trade agreements address environmental issues and give the examples of NAFTA and the EU (page 20, second paragraph: *"Whatever the route through which trading blocs impact the environment, regional trading arrangements are addressng environmental issues..."*).

countries' CO_2 emissions trajectories converge, a model for per-capita emissions is first estimated in relative terms using the log of carbon dioxide emissions per capita (log of CO_2 emissions of country *i* relative to country *j* in period t, Em_{it}/Em_{jt}) as dependent variable and expressing GDP per-capita, land area per-capita and population also in relative terms. Next, the model is also estimated in absolute terms to examine the direct effect of RTAs on absolute pollution levels. In this case, the RTA variable is generated as a weighted average, using emissions in the partner countries as weights.

The main results obtained from estimating the emissions model in relative terms provide evidence that RTAs with EPs statistically explain the convergence of pollution levels across pairs of countries. Moreover, the agreements that specifically include provisions to ensure enforcement (NAFTA) are converging at a higher rate than others (EU), which leave compliance measures to the legal system. Conversely, RTAs without EPs do not affect relative pollution levels, indicating that controlling for bilateral trade levels and overall openness, the trade policy variable (membership of RTAs) does not have a direct effect on emissions convergence for this type of agreements. When the model is estimated in absolute terms, the findings indicate that emissions are around 0.3 percent lower for countries that have RTAs with EPs, whereas the effect is not statistically significant for countries with RTAs without EPs. Hence emissions converge to a lower level when both countries belong to the same RTA and the RTA includes EPs. With respect to the trade-environment link, the results do not show a significant effect of openness on absolute levels of carbon dioxide emissions.

3. Empirical framework and analysis

In this section we present the analytical framework proposed to investigate the effect of EPs in RTAs on emissions. The main modelling strategy is partly based on Baghdadi et al. (2013) and consists of extending their approach to estimate the effects of trade and RTAs on a local pollutant using data for more years and controlling for environmental regulations. The pollutant considered is suspended particulate matter (PM2.5)[5], which is used as dependent variable in the empirical models. The

[5] We use PM2.5 instead of SPM in this study. SPM refers to particles in the air of all sizes, whereas PM2.5, usually called fine particles, are not visible to the eye and are more harmful for health.

corresponding explanatory variables and data sources are described in the data section below.

3.1 Data sources and variables

Annual data for a cross-section of countries (mainly 24 OECD+6 BRIICS[6]) over the period 1999 to 2011 are used in the empirical estimations. We also used an extended sample (173 countries) over the period 1990-2011 (data every 5 years) as robustness.

Table 1. Description of environmental indicators, data and sources

The main data for PM2.5 are from the OECD[7]. The variable used is the population weighted mean concentration of PM2.5. The data are available for a cross-section of 51 countries for the period from 1999 to 2011 (See Figure 1).

Other variables used in the estimations of the empirical models are described in what follows. An environmental policy index, which measures the environmental policy stringency in OECD countries and has been constructed by the OECD[8], is used as a proxy for policy intervention in the environmental area. The indicator is a composite country-specific measure of environmental policy stringency (EPS). The current version of the indicator covers 24 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom and the United States) plus the 6 BRIICS for the period 1990-2012. The indicator is based on scoring stringency of 15 policy instruments: 12 applying to the energy sector (though often also beyond, to industry), 2 to transport and 1 in waste (Figure 2).

Figure 2. Economy-Wide EPS indicator

Bilateral exports are from UN-COMTRADE and data for factors influencing bilateral trade, namely country and country pair characteristics are from CEPII. The "gravity" variables used include distance between capital cities of the trading

[6] Brazil, Russia, India, Indonesia, China and South Africa.

[7] Data on PM 2.5 are elaborated by the OECD using data from the Atmospheric Composition Analysis Group (Boys et al., 2014). Avilable at: **http://fizz.phys.dal.ca/~atmos/martin/?page_id=140**.

[8] Data kindly provided by Tomasz Kozluk. See Botta and Kozluk (2014).

countries, dummy variables for common language, common colony, exit to the sea, area of the countries, common border.

Data for factors explaining income per capita in the growth regressions (population growth, school enrolment, human development index) are from the WDI and the Pen World Table 8.1[9].

Information concerning RTAs and the EPs included in each agreement has been collected from the World Trade Organization (WTO) and from the legal text of the agreements obtained from the corresponding government agencies of the signatory countries.

3.2 Modelling framework. Environmental-impact model

Three main theoretically-based models serve as a basis for the empirical application. First, the gravity model of trade is used to predict bilateral trade. Second, GDP per capita is predicted estimating a model based on the growth-empirics literature. Finally, the core model is based on the theory developed by Antweiller et al. (2001) relating trade with environmental quality and includes proxies for the so-called scale, composition and technique effects as determinants of environmental impact.

Panel data techniques are used to control for the endogeneity of the RTA variable in the environmental-impact model, whereas using instrumental variables we will address the endogeneity of income and trade variables. In what follows we proceed with the description of the core equations for environmental impact. The details of the first step procedures for the instrumental variables estimation are explained in Appendix 1.

According to the underlying theories that relate trade with the environment, environmental damage depends on population, land area per capita, per-capita GDP, openness to trade and RTAs. These variables are assumed to control for scale, technique and composition effects[10].

First, to examine the direct effect of RTAs on absolute environmental quality we specify the estimated equation as,

[9] PWT-8.1:http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1.

[10] Our model considers the main factors affecting emissions in line with Frankel and Rose (2005) and Baghdadi et al. (2013). Moreover, as in Frankel and Rose (2005) and Ghosh and Yamarik (2006), a Kuznets-curve term, namely the square term of the log of income per capita, is added in Model 1. We also estimated the model without a Kuznets-curve term using the instrumentation strategy.

$$
\begin{aligned}
\ln(E_{it}) = \gamma_0 + & \gamma_1 \ln(Pop_{it}) + \gamma_2 \ln(Landcap_{it}) \\
& + \gamma_3 \ln\left(\widehat{GDPcap}_{it}\right) \\
& + \gamma_4 \ln\left(\widehat{GDPcap}_{it}\right)^2 + \gamma_5 \ln\left(\widehat{Open}_{it}\right) + \gamma_6 \ln(EPS_{it}) + \\
& + \gamma_7 \sum_j w_{jt} * rtaenv_{ijt} + \gamma_8 \sum_j w_{jt} * rtanenv_{ijt} + \mu_{it}
\end{aligned}
\tag{1}
$$

where E_{it}, the natural logarithms of population-weighted PM2.5 for country *i* at time *t*, is the dependent variable. All the independent variables are also in natural logarithms apart from the two RTA variables. Population (Pop_{it}) as a proxy for the scale effect, land per capita ($Landcap_{it}$) allows for the possibility that population density could lead to environmental degradation (for a given level of per capita income), GDP per capita predicted from a growth equation ($\widehat{GDPcap}_{it}$) and its squared term serve to test the EKC hypothesis that predicts that environmental quality eventually increases with income, predicted openness ($\widehat{Open}_{it}$) serves as proxy for the composition effect and could be positively or negatively affecting environmental quality, as discussed in the previous section. The proxy used for environmental policy is the stringency index (EPS_{it}), which is assumed to have a positive impact on environmental quality (negative effect on emissions). *Rtaenv* denotes agreements with EPs and *Rtanenv* denotes RTAs without EPs. Both variables are generated as a weighted average of the variables $rtaenv_{ijt}$ (that takes the value of one when countries *i* and *j* have a RTA with EPs in force in year *t*, zero otherwise), and $rtanenv_{ijt}$ (that takes the value of one when countries *i* and *j* have a RTA without EPs in force in year *t*, zero otherwise). w_{jt} denotes the weights given to the different RTAs, equal weights for all agreements are used as default.

Equation (1) will be estimated distinguishing between RTAs with EPs (*rtaenv*) and RTAs without EPs (*rtanenv*). In this way, we are able to test the prediction that only RTAs with EPs as a policy variable should affect a given environmental indicator directly, whereas RTAs without EPs should only affect the environment through trade or income.

Second, in order to test for the convergence of emissions, we estimate a log-linear equation in relative terms in which the dependent variable is the log of the level of a given environmental indicator in country i relative to country j in period t (lnY_{ijt} = $|\ln(E_{it}/E_{jt})|$. The estimated model is given by,

$$ln\, Y_{ijt} = \beta_0 + \beta_1 \left|\ln\left(\frac{Pop_{it}}{Pop_{jt}}\right)\right| + \beta_2 \left|\ln\left(\frac{Landcap_{it}}{Landcap_{jt}}\right)\right| + \beta_3 \left|\ln\left(\frac{\widehat{GDPcap}_{it}}{\widehat{GDPcap}_{jt}}\right)\right|$$

$$+\beta_4 \left|\ln\left(\frac{\widehat{Open}_{it}}{\widehat{Open}_{jt}}\right)\right| + \beta_5 \left|\ln\left(\frac{EPS_{it}}{EPS_{jt}}\right)\right| + \beta_6 \ln \widehat{Biltrade}_{ijt} + \beta_7\, rtaenvint_{ijt}$$

$$+ \beta_8\, rtanenvint_{ijt} + \varepsilon_{\,ijt} \tag{2}$$

where Pop_{it} (Pop_{jt}) is population in number of inhabitants in country i (j) in year t. $Landcap_{it}$ ($Landcap_{jt}$) is land area in square kilometres per capita, $\widehat{GDPcap}_{it}$ ($\widehat{GDPcap}_{jt}$) is predicted GDP per capita at constant US dollars in country i (j) in year t. $\widehat{Open}_{it}$ ($\widehat{Open}_{jt}$) refers to the openness ratio measured as predicted export- and import-openness ratio in country i (j). EPS_{it} (EPS_{jt}) is the environmental policy index in country i (j) in year t. $\widehat{Biltrade}_{ijt}$ denotes predicted bilateral trade between countries i and j in period t and rtaenvint_{ijt} and rtanenvint_{ijt} are dummy variable that take the value of 1 when countries i and j have a RTA in force in year t with and without EPs, respectively.

The details of the estimation used to obtain $\widehat{GDPcap}_{it}$ are outlined in the Appendix (A.1.1). Similarly, predicted openness (both bilateral and multilateral) is obtained from the estimation of a gravity model of trade using a large dataset on pair-wise trade (see Appendix A.1.2). In particular, we use Badinger's specification of the gravity model (Badinger, 2008). The exponent of the fitted values across bilateral trading partners is aggregated to obtain a prediction of total trade for a given country $(\widehat{Open}_{it})$, which is used as regressor in model (1). The endogeneity of the RTA variable is solved by using panel data techniques as suggested by Baier and Bergstrand (2007).

As robustness we also estimate a long run version of model (1) in which the estimation technique used is dynamic generalized method of moments (GMM) for panel data (Arellano and Bond, 1991; Blundell and Bond, 2000).

A considerable strength of the GMM method is the potential for obtaining consistent parameter estimates in the presence of measurement error and endogenous right-hand-side variables. In practical terms, when using panel data, the unobserved country-specific component is eliminated by taking first differences of the left- and right-hand-side variables and the endogeneity issue is solved by using the lagged values of the levels of the endogenous variables as instruments. The model is specified as,

$$\Delta \ln (E_{it}) = \pi_0 + \Delta \ln (E_{i,t-1}) + \tau \Delta X_{it} + \varphi_t + \epsilon_{it} \quad (3)$$

The validity of specific instruments can be tested in the GMM framework by using the Hansen test of over-identifying restrictions. In the context of this research, we consider as endogenous variables the lagged dependent variable (ln $Env_{i,t-1}$) and the variables related to RTA with EP (rtaenv, score, breadth and depth) and the instruments used are the second and third lagged values in levels of the respective variables.

3.3. Categorisation of Environmental Provisions in RTAs

On the basis of the key types of environmental provisions identified from the annual OECD updates on RTAs and the environment, a set of indicators of the degree of environmental commitment has been developed for an ex-post assessment of environmental provisions in RTAs. Different types of environmental provisions found in RTAs have been divided into nine categories for the purpose of this analysis: “General”, “Exceptions”, “Environmental Law”, “Public Participation”, “Dispute Settlement”, “Partnership and Co-operation”, “Specific Environmental Issues”, “Implementation Mechanism”, and “Multilateral Environmental Agreements”. Based on these nine key types of environmental provisions, three indicators of the degree of environmental commitment have been developed. The indicators are constructed using a number of questions relating to the content of the each RTA. Each question leads to a 0 or 1 answer (See Appendix 2). The questions are then weighted to give a total score for each RTA. Weights are adjusted to reflect the heterogeneity of different environmental provisions that may lead to differing impacts on the ultimate environmental outcome. In other words, the higher the expected impact of an environmental provision is, the higher the weight is given to that category. Weightings are adjusted so that there is not undue influence on a final score due to one particular over-weighted question or category. The total score for all questions across all categories is 100, to facilitate conversion of the index to a usable normalised variable. Questions are assigned either “breadth” or “depth” label in case this will be a distinguishing characteristic in the model. In terms of breadth, the indicators aim to measure the degree of attention given to environmental issues in the agreement. In terms of depth, they aim to measure the extent to which the legal texts bind the parties to adhere to or implement their environmental provisions. The weighting system aims to capture the relative importance of different types of provisions. Weights have been assigned based on a review of OECD and other literature relating to the design, prevalence and implementation of environmental provisions (including George, 2014; 2011; Gallagher, 2011, OECD, 2007).

To examine the direct effect of RTAs on the environmental indicators, model (1) is modified to include the described environmental commitment index and the depth and the breadth of the environmental commitments of the RTAs with EPs. Hence, the two dimensions of the provisions, *depth* and *breadth* and the overall *score*, which is the sum of breath and depth, are used separately in equation (1) to acknowledge that each of them can have a different effect on the given environmental indicators, so three different equations will be estimated.

The same IV strategies, as described above, are used to identify the income and trade effects on the environment. We also use a DID-panel strategy as a way to overcome endogeneity issues.

Next, we will examine whether the *depth* and the *breadth* of the RTA’s EPs contribute to convergence in environmental indicators between pair of countries belonging to the same RTA. The estimated model is based on model (2), Where RTA_{ijt} is replaced by w_score_{ijt}, which measures the EP-commitment score and its two dimensions, *depth* and *breadth*, of the agreement between countries *i* and *j* in year *t* (separate models are estimated for each variable: *score*, *breadth* and *depth*). The rest of variables have been described below equation (2).Modifications of models (1) and (2) will be estimated using population-weighted PM2.5 concentrations as dependent variable.

4. Empirical Results

This section presents the main results. We hypothesise that more stringent environmental regulations at the national level will reduce local air pollution after they are fully implemented and hence the effects will appear after some time. Moreover, for a given level of environmental regulations, participating in RTAs with EPs could also help reducing air pollution mainly if the EPs provide enforcement mechanisms and encourage the member countries to effectively apply their national regulations. However, for RTAs without such provisions, countries may be less motivated to effectively enforce their regulations and there will be no additional effect on the environmental indicators coming from participation in RTAs without EPs.

Models (1) and (2) and their modified versions including the commitment index of EPs are estimated for PM2.5 (population weighted mean concentrations) and the main results are presented in Tables 2 and 3, respectively. Yearly data for this pollutant are only available starting in 1999 and for a maximum of 48 countries. The results we present in the main text are for the 30 countries sample, for with the environmental policy proxy is available. The results are very similar to those obtained for the extended sample presented in Appendix 4 (Table A.4.1). The within estimator with an autocorrelation term of order (1) is the preferred estimator[11] and a non-linear effect for income is assumed (EKC hypothesis).

Column (1) in Table 2 presents the estimates of the determinants of emissions and includes the variables *rtaenv* and *rtanenv*, the number of RTA agreements signed by each country and year with and without EPs, respectively. The variable *rtaenv* shows a negative and significant coefficient (at the 5% level) indicating that for each additional RTA with EPs, mean concentration of PM2.5 decrease by around 0.3

[11] The model is estimated with the Stata command xtregar with fixed effects. Similar results were obtained with alternative specifications (e.g xtreg,fe and time dummies). The Hausman test suggested that the error term is correlated with the time-invariant country heterogeneity suggesting that only the within estimator is consistent. The model was also estimated using group specific time-dummies for OECD and non-OECD countries and no significant differences in the results were observed.

percent, whereas rtanenv is not statistically significant. The negative and significant coefficient of only *rtaenv* indicates that RTAs with environmental provisions (EPs) seem to reduce PM2.5 concentrations. The EPS coefficient is also negative and significant indicating that an increase in the index of 10 percent reduces concentrations in around 0.6 percent (this variable was entered with 3 lags and in general only the third lag is statistically significant, the coefficient shown in the table is the sum of the significant coefficients).

Table 2. Determinants of PM2.5 emissions concentrations

The result for income variables show evidence of a Kuznets-curve model with the squared coefficient of GDP per capita being statistically significant and showing the expected negative sign. It indicates that concentrations are negatively correlated with GDP per capita for income levels that surpass the turning point, which is shown at the bottom of the Table and it is around 3.6-4 thousand USD. The sign and significance of the target variables *rtaenv* and *lneps* are almost unchanged, in comparison with a model without the squared income term; apart from the fact that *lneps* shows a slightly lower coefficient, as expected. The predicted openness variable shows a positive coefficient that is always statistically significant at conventional levels, indicating that higher levels of trade do seem to increase concentrations of PM2.5. However the magnitude of the effect is close to zero and hence negligible in economic terms. For instance, an increase in trade of 100 percent is associated with an increase in PM2.5 concentrations of only 0.2 percent.

In column (2) the *rtaenv* dummy variable is replaced by the commitment index explained in the previous section. The result indicates that the score is negatively correlated with PM2.5 concentration levels and the same is the case for the two dimensions of the index the breadth and the depth components (columns 3 and 4, respectively), with a higher magnitude of the coefficient for the depth dimension. An increase in 1 point in the breadth score decrease PM2.5 concentrations by around 2.4 percent, whereas the same increase in the depth score decrease PM2.5 concentrations by around 9 percent.

Table 3 presents the results for convergence in emissions. The dependent variable is the ratio of PM2.5 concentrations per capita in natural logarithms. A negative sign in the target variables *rtaenvint* (*w_score, breath, depth*) indicates that there is convergence in emissions between countries that participate in RTAs with EPs. The result in column (1) indicates that the rate of convergence is 9 percent for pair of countries in RTAs with EPs and 12 percent in agreements without EPs. However, once the commitment index and its dimensions, instead of the simple dummy, are used as regressors (columns 2 to 4) the corresponding estimated coefficient for RTAs without EPs is not statistically significant, whereas the score, breadth and depth variables show a negative and statistically significant coefficient at the one percent level, indicating convergence in emissions in RTAs with more comprehensive EPs. The coefficient of bilateral exports (*lexp_predict*) is in most cases not statistically significant and the eps ratio present a negative coefficient indicating that convergence in environmental regulations is negatively correlated with convergence in emissions of PM2.5.

Table 3. Determinants of convergence in PM2.5 emissions

4.3. Robustness

Table 4 presents similar results to those shown in Table 2 using an extended sample of 173 countries for which the data are available every 5 years since 1990 until 2010 and then yearly until 2012. The results for the variable *rtaenv* (in column 1) show a negative and significant coefficient (at the 5% level) indicating that for each additional RTA with EPs, mean concentration of PM2.5 decrease by around 0.5 percent (versus 0.3 percent in Table 2), whereas *rtanenv* is also statistically significant (it was not in Table 2) but the effect is halved. The negative and significant coefficients of both RTAs with and without environmental provisions (EPs), could be due to the fact that in this case we are not able to control for national environmental regulations, since the EPS indicator is only available for a sample of 30 countries. It could be that some countries with RTAs without EPs have also more stringent regulations than others without RTAs.

Model (1) has been also estimated using dif-GMM. The results are shown in Appendix 3 (Table A.3.2); for model (1). In general the results confirm those obtained with the static panel data models indicating that both, membership in RTAs with EPs as well as an incremental inclusion of environmental issues in the text of the agreements, contribute to improve environmental quality. In general the dif-GMM long run estimates show stronger effects than the estimates in the main text that could be interpret as short run effects.

5. Discussion and conclusions

The main results for local and global emissions show that RTAs with EPs seems to have a reducing effect on air pollution measured using PM2.5 emissions concentrations and also help emissions to converge among the participants in the RTAs. The empirical results indicate that a direct positive effect of RTAs on reducing air pollution exists, which is mainly present for those agreements that specifically include environmental provisions (EPs) in the main text of the trade agreement, or for those that are accompanied by side environmental agreements. The direct effect could be explained by the fact that the EPs in RTAs will encourage members to apply and enforce more stringent environmental regulations and these should in turn reduce environmental damage. Hence, the link with regulations induces a decrease in environmental degradation independent of the trade-induced effect. This effect is also independent from the effect induced by other national environmental policies that are summarized in the environmental performance index, which is also used as an explanatory variable in the regressions. The results also indicate that the content of the EPs also matter for the environment. Indeed, the results show that higher levels of environmental regulations are also positively correlated with environmental quality. In particular, this is the case for PM2.5 emissions concentrations.

In the absence of more stringent policies, the number of premature deaths due to outdoor air pollution will increase from approximately 3 million people annually in 2010 to 6-9 million in 2060 (OECD 2016). The associated monetised cost will increase from USD 3 trillion in 2015 to USD 18‑25 trillion in 2060, with the most affected areas being densely populated with high concentrations of PM2.5. Earlier projections by the OECD estimated that the worldwide mortality due to particulate matter alone (PM2.5 and PM10) is expected to increase from 1 million in 2000 to over 3.5 million in 2050 (OECD, 2012). The practice of including provisions that refer to the environment in regional trade agreements is a complementary way to address this alarming projection of air quality degradation and its related cost.

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TABLES

Table 1. Description of environmental indicators, data and sources

(variable name)	Definition	Source	Period
PM 2.5 (pm25pc)	PM less than 2.5 microns in diameter from motor vehicles, fossil-fuel power plants, wood burning (micrograms per cubic meter). Population Weighted mean Concentration	Boys et al., 2014 OECD elaboration. Extended sample kindly provided by the OECD.	1999-2011 1990-2011
EPS	Environmental stringency performance index	Botta and Kozluk (2014)	1990-2011
Exports	Exports of goods in US$	UN-COMTRADE	1990-2011
Income per capita (GDPcap)	GDP per capita in US $ per inhabitant	WDI, World Bank	1990-2011
Population (Pop)	Number of inhabitants	WDI, World Bank	1990-2011
RTAs (rtaenv, rtanenv)	Dummy variable that equals to 1 if country i and j belong to the same RTA, zero otherwise (Rtaenv= RTAs with EPs; Rtanenv= RTAs without EPs)	De Sousa et al 2012 World Trade Organization (WTO) , legal text of the agreements	1990-2011
Openness (Open)	(Exports+Imports)/GDP	WDI, World Bank	1990-2011
Landcap	Land area per capita in squared Km per inhabitant	CEPII	Time invariant
W-score, Depth and Breadth dimensions	Commitment index of environmental provisions	World Trade Organization (WTO) , legal text of the agreements	1990-2011
School Enrolment (School1, School2)	School1=Primary School School2=Secondary School	Pen World Table 8.1 (PWT-8.1: http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1	1990-2011

Table 2. Determinants of PM2.5 emissions concentrations

	(1)	(2)	(3)	(4)
VARIABLE	PM2.5	PM2.5	PM2.5	PM2.5
Rtaenv	-0.00295***			
	[0.00106]			
W_score		-0.0108**		
		[0.00423]		
Breadth_ws			-0.0236**	
			[0.00972]	
Depth_ws				-0.0868***
				[0.0328]
Rtanenv	0.0016	0.0012	0.0012	0.0011
	[0.0018]	[0.0018]	[0.0018]	[0.0018]
Ln_pop	-1.976***	-1.996***	-2.013***	-1.981***
	[0.429]	[0.434]	[0.437]	[0.432]
Ln_GDPcap	2.094***	2.117***	2.099***	2.127***
	[0.543]	[0.553]	[0.555]	[0.549]
Ln_GDPcap^2	-0.126***	-0.128***	-0.127***	-0.128***
	[0.0310]	[0.0317]	[0.0318]	[0.0315]
Ln_open_pred	0.00203***	0.0020***	0.0020***	0.0020***
	[0.0005]	[0.0005]	[0.0005]	[0.0005]
Ln_eps	-0.0571***	-0.0577***	-0.0571***	-0.0571***
	[-2.940]	[-3.030]	[-3.060]	[-3.000]
Constant	11.20***	11.44***	11.79***	11.14***
	[1.930]	[1.931]	[1.930]	[1.933]
Turning point	4062.37	3903.12	3638.11	4058.60
R2-overall	0.865	0.868	0.868	0.868
R2-within	0.263	0.258	0.255	0.26
Nobs	348	348	348	348
Countries	29	29	29	29

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10.
Ln denotes natural logarithms.

Table 3. Determinants of convergence in PM2.5 emissions

VARIABLES	(1) PM2.5	(2) PM2.5	(3) PM2.5	(4) PM2.5
L.rtaenvint	-0.0911*			
	[0.0543]			
L.w_score1		-0.00669***		
		[0.00121]		
L.breadth_ws1			-0.0170***	
			[0.00265]	
L.depth_ws1				-0.0364***
				[0.00643]
L.rtanenvint	-0.121***	-0.00801	0.0434	-0.0700**
	[0.0263]	[0.0341]	[0.0386]	[0.0281]
lnlandcap_ratio	0.168***	0.211***	0.213***	0.210***
	[0.0584]	[0.0619]	[0.0617]	[0.0620]
lnpop_ratio	0.0943	0.158	0.168	0.147
	[0.103]	[0.139]	[0.138]	[0.140]
lngdppc_pred_ratio	-0.00588	-0.0139	-0.0144	-0.0139
	[0.0321]	[0.0351]	[0.0351]	[0.0352]
lntrade_ratio	-0.00268*	-0.00412**	-0.00403**	-0.00411**
	[0.00152]	[0.00184]	[0.00184]	[0.00183]
lnexp_predict	0.264	-0.467	-0.509	-0.446
	[0.637]	[0.743]	[0.740]	[0.749]
L.lneps_ratio	-0.0179**	-0.0249**	-0.0242**	-0.0256**
	[0.00911]	[0.0110]	[0.0110]	[0.0109]
Constant	0.293	0.00573	-0.0376	0.0431
	[0.209]	[0.402]	[0.400]	[0.406]
Observations	10,556	7,020	7,020	7,020
R-squared	0.040	0.055	0.056	0.052
Number of id	812	540	540	540

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10. L. denotes the lag operator, indicating that the first lag of the corresponding variable is used in the analysis. Ln denotes natural logarithms.

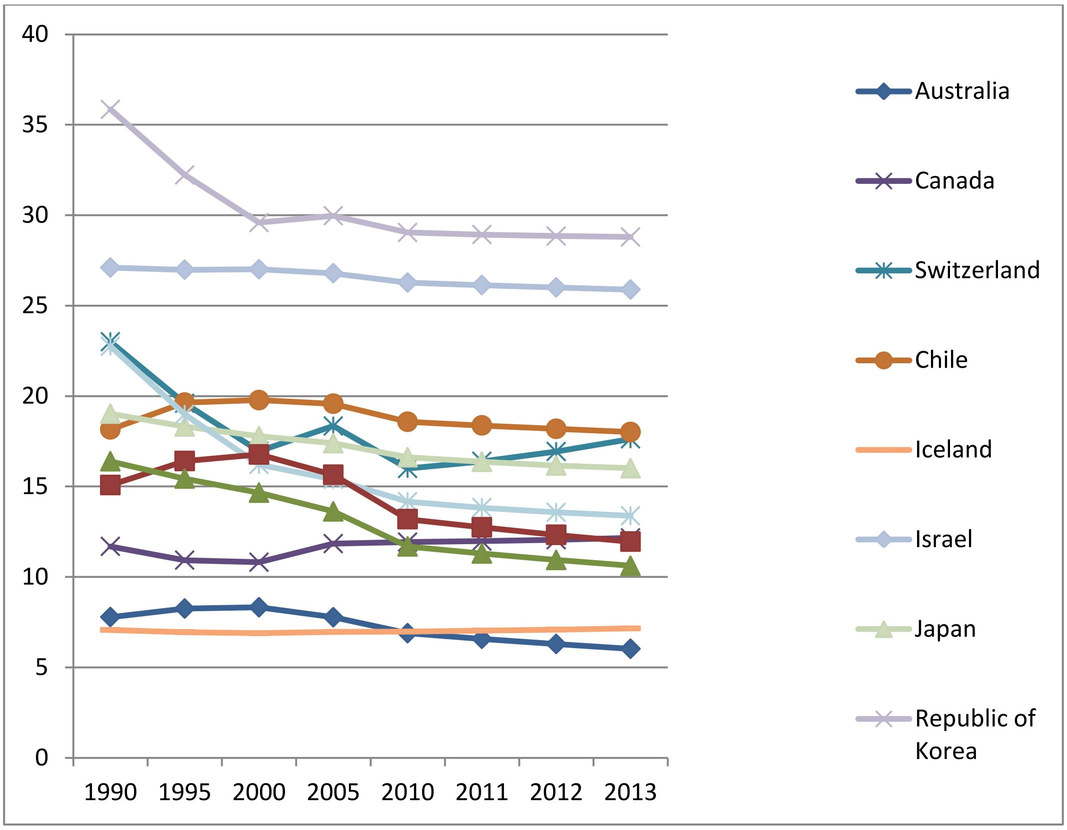
Table 4. Extended sample with 173 countries

VARIABLES	(1) PM2.5	(2) PM2.5	(3) PM2.5	(4) PM2.5
Rtaenv	-0.00487***			
	[0.00115]			
w_score1		-0.0185***		
		[0.00625]		
breadth_ws1			-0.0276***	
			[0.00930]	
depth_ws1				-0.0545***
				[0.0190]
Rtanenv	-0.00251***	-0.00271***	-0.00269***	-0.00277***
	[0.000887]	[0.000936]	[0.000940]	[0.000928]
ln_pop	0.136	0.143	0.143	0.144
	[0.0957]	[0.1000]	[0.0997]	[0.101]
lngdpcap	0.583**	0.661**	0.661**	0.662**
	[0.270]	[0.275]	[0.274]	[0.275]
lngdpcap2	-0.0347*	-0.0401**	-0.0402**	-0.0402**
	[0.0194]	[0.0197]	[0.0197]	[0.0197]
ln_open_predict	0.297	0.385	0.382	0.393
	[0.271]	[0.306]	[0.304]	[0.309]
1995.year	-0.0579**	-0.0683**	-0.0681**	-0.0688**
	[0.0267]	[0.0292]	[0.0291]	[0.0294]
2000.year	-0.0944***	-0.107***	-0.107***	-0.108***
	[0.0336]	[0.0351]	[0.0350]	[0.0351]
2005.year	-0.110*	-0.138*	-0.137*	-0.139**
	[0.0661]	[0.0699]	[0.0698]	[0.0702]
2010.year	-0.113	-0.147*	-0.146*	-0.150*
	[0.0833]	[0.0872]	[0.0872]	[0.0873]
2011.year	-0.139	-0.181	-0.180	-0.185
	[0.105]	[0.111]	[0.111]	[0.112]
2012.year	-0.129	-0.169	-0.168	-0.172
	[0.102]	[0.108]	[0.108]	[0.108]
Constant	-1.232	-1.479	-1.487	-1.488
	[1.566]	[1.699]	[1.692]	[1.717]
Observations	1,172	1,168	1,168	1,168
R-squared	0.295	0.273	0.273	0.271
Number of id	173	172	172	172
R2_within	0.295	0.273	0.273	0.271

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

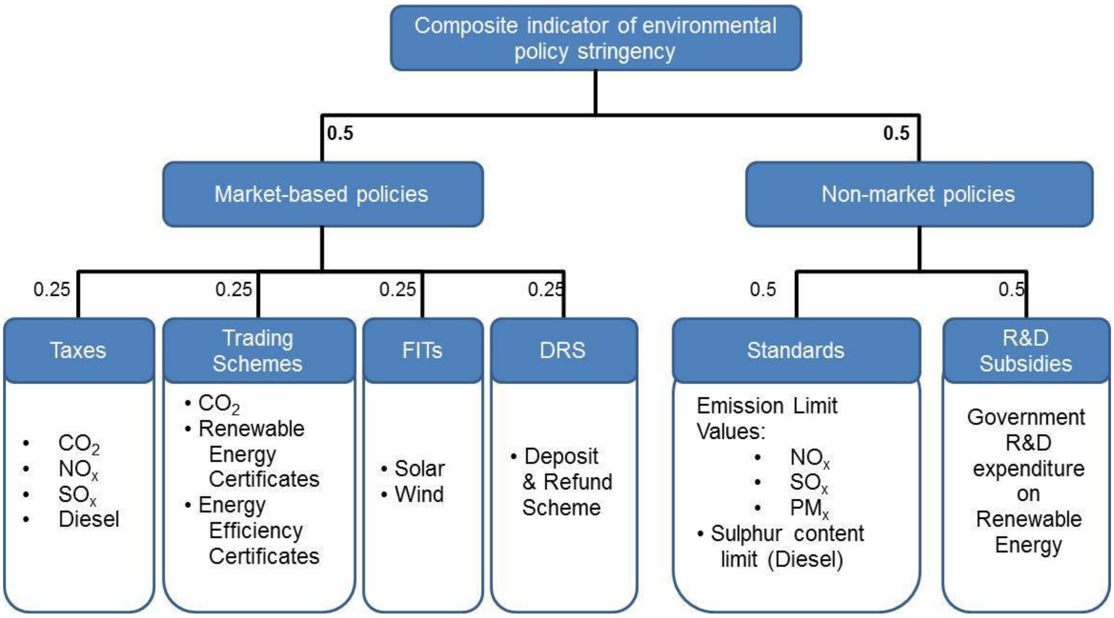
FIGURES

Figure 1. Population weighted concentrations of PM2.5 for selected countries



Note: The figures are population weighted mean exposure. Source: OECD Green Growth Headline Indicators.

Figure 2. Economy-Wide EPS indicator



Source: Botta and Kozluk (2014).

APPENDIX

A. 1. Growth Empirics and Gravity Model estimations

A.1.1 Growth empirics

As emphasized by Frankel and Rose (2005), trade flows, regional agreements, pollutants' emissions and environmental regulations may affect income. Therefore, we predict real income with a number of variables, namely lagged income per capita ($GDPcap_{i,t-1}$), conditional convergence hypothesis), population (pop), investment per income (I/GDP) and human capital formation. The latter is approximated by the rate of school enrolment (at primary, School1, and secondary level, School2). The predicted values (linear projection) of this equation are used to calculate $GDPcap_{it}$ and $GDPcap_{jt}$.

$$\ln(GDPcap)_{it} = \alpha_i + \delta_1 \ln(\mathrm{Pop})_{it} + \delta_2 \ln(GDPcap)_{i,t-1} + \delta_3 \ln\left(\frac{I}{GDP}\right)_{i,t} + \delta_4 \mathrm{n}_{it} + \delta_5 \ln(School1)_{it} + \delta_6 \ln(\mathrm{School2})_{it} + \mathrm{u}_{it} \quad \text{(A.1)}$$

where n_{it} is the growth rate of population and u_{it} is a random term that is assumed to be independently and identically distributed and with a constant variance. Model (A.1) is estimated using panel-data estimation techniques, mainly assuming that the country-unobserved heterogeneity (time invariant factors that determine GDP per capita and differ by country) is modelled using fixed effects (a different intercept for each country)[12].

The income equation is taken from Baghdadi et al. (2013). The main difference between the model specified in (A.1) and the income equation in Frankel and Rose (2005) and Ghosh and Yamakita (2008) is that the Frankel and Rose (2005) also include openness as an explanatory variable and Ghosh and Yamakita (2008) include in addition to openness, an RTA variable. We relegate openness and trade policy factors to the error term (unexplained part of the income model), since we are

[12] The model with country fixed effect is preferred to a random effects model because the error term is correlated with the unobserved heterogeneity and hence does not provide consistent estimates.

interested in predicting changes in GDP per capita that are explained by factors different from trade and trade policy. In this way, we obtain a "pure" scale effect that does not include the indirect effect of trade in income[13].

A.1.2 Gravity model with geographical determinants

The predicted multilateral openness and the bilateral trade variables used in models (1) and (2) above are obtained from a gravity model of trade, which is estimated using a large panel-dataset on pair-wise trade flows. The standard gravity model states that trade between countries is positively determined by their size (GDP, population and land area) and negatively determined by geographical and cultural distance. The geographical variables are exogenously determined and hence are suitable instruments for trade (Frankel and Romer, 1999). We follow Badinger (2008)'s specification of the gravity model, in which bilateral openness is regressed on countries' populations (Pop_{it}, Pop_{jt}), land area ($Area_{ij}=Area_i*Area_j$), distance (D_{ij}), a common border dummy (Adj_{ij}), a common language dummy ($Lang_{ij}$) and a landlocked variable (Landlok= sum of a landlocked dummy of countries *i* and *j*). Two other variables are included in order to be consistent with the theoretical model: a measure of similarity of country size ($Landcap_j/Landcap_j$) and remoteness from the rest of the world (*Remote*).[14]

$$\ln(Trade_{ijt} / GDP_{it}) = {}_i + {}_j + {}_t + {}_1 \ln Pop_{it} + {}_2 \ln Pop_{jt} +$$
$$+ {}_3 \ln Dist_{ij} + {}_4 Area_{ij} + {}_5 Lang_{ij} + {}_6 Adj_{ij} + {}_7 Landlok_{ij}$$
$$+ {}_8 \ln(Landcap_i / Landcap_j) + {}_9 \mathrm{Re}mote_{ij} + {}_{ijt} \qquad \text{(A.2)}$$

Finally, from equation (A.2) the exponent of the fitted values across bilateral trading partners is aggregated to obtain a prediction of total trade for each country and year.

[13] The indirect effect of trade and RTAs on income per capita could also be obtained in a separate exercise by including the prediction of the gravity model and the RTA variable in equation (3).

[14] $Remote_{ij} = 0.5\, D_{ij}^{CC}\{[\ln(\sum_{k=1,k\neq j}^{N} Dist_{ik}/(N-1))] + [ln(\sum_{k=1,k\neq i}^{N} Dist_{kj}/(N-1))]\}$.

Where D_{ij}^{CC} is a common continent dummy. This variable will then be equal to zero if countries are on the same continent. Remote is then the log of the average value of the mean distances of countries i and j from all other countries.

$$\widehat{Open}_{it} = \sum_j \exp\left[\ln(\widehat{trade_{ijt}}/GDP_{it})\right] \quad \text{(A.3)}$$

Both, the bilateral prediction and the aggregated bilateral prediction are used as regressors in the environment-damage model (2) and later is also used in model (1). By using these predicted values we are able to isolate the part of trade that is explain exclusively by geographical, cultural and time-invariant country-specific factors. Other policy changes that could also explain trade variations are relegated to the unexplained part of the model (error term).

A. 2. Commitment Index of EPs in RTAs and list of RTAs with EPs

Table A2.1. Indicators and criteria of Environmental commitment in RTAs

Environmental commitment in RTAs			
Environmental provisions	**Commitment criteria**	**BREADTH OR DEPTH**	**weighting adjusted**
1. General			**15.0**
1.1. Preamble	Does the Preamble refer to environment and/or sustainable development?	B	3.0
1.2 Chapter	Is there a specific chapter to environmental or sustainable development issues?	B	7.0
1.2 Side agreement	Is there a specific side agreement devoted to environmental or sustainable development issues, or environmental cooperation?	B	5.0
2. Exceptions			**5.0**
2.1. GATT/GATS	Does the agreement incorporate the general exceptions for environmental matters of GATT Article XX and/or GATS Article XIV?	B	2
2.2. Other	Are environmental issues identified as an exception to one or more specific commitments (e.g. investment, procurement, financial services, SPS measures, technical standards)?	B	3
3. Environmental law			**15.0**
3.1. High levels of environmental protection	3.1.1. Is their a provision relating to laws and policies that provide for high levels of environmental protection?	B	1.5
	3.1.2. Does the provision provide a binding commitment?	*D*	*1.5*
3.2. Non-derogation from environmental law	3.2.1. Does the provision aim that parties do not derogate from their environmental laws in order to encourage trade or investment, or in any other manner affecting trade or investment?	B	1.5
	3.1.2. Does the provision provide a binding commitment?	*D*	*1.5*

3.3. Improvement of environmental law	3.3.1. Do the parties agree in the provision to strive to improve their levels of environmental protection?	B	1.5
	3.1.2. Does the provision provide a binding commitment?	*D*	*1.5*
3.4. Effective enforcement of environmental law	3.4.1. Do the Parties agree to effectively enforce their environmental laws, in so far as they affect trade or investment?	B	1.5
	3.1.2. Does the provision provide a binding commitment?	*D*	*1.5*
3.5. Access to remedies	3.5.1. Do the Parties commit to provide effective access to remedies for violations of their environmental laws?	B	1.5
	3.1.2. Does the provision provide a binding commitment?	*D*	*1.51*
4. Public participation			**9.00**
4.1. General	Does the agreement provide for public participation in implementing its environmental provisions?	D	3.00
4.2. Mandatory nature	*Are requirements for public participation mandatory?*	*D*	*3.00*
4.3. Public submissions	Is there a mechanism for public submissions on non-enforcement of environmental laws?	D	3.00
5. Dispute settlement			**6.00**
5.1. Consultation process	Is there a specific consultation process for environmental issues?	D	1.50
5.2. Dispute settlement	Is there an arbitration procedure for disputes not settled by consultation?	D	1.50
5.3. Binding	*Is the dispute settlement binding?*	*D*	*1.50*
5.4. Environmental expertise	Must the arbitration panel include members with environmental expertise?	D	1.50
6. Partnership and co-operation			**5.00**
6.1. General	6.1.1. Does the agreement provide for cooperation on environmental matters?	B	1.00
	6.1.2. Is the use of cooperation binding?	*D*	*1.00*
6.2. Cooperation mechanism	Does it establish a specific mechanism for environmental cooperation?	B	1.50
6.3. Cooperation activities	Are the details of environmental cooperation activities defined?	B	1.50
7. Specific environmental issues	**(included in the main RTA or in a cooperation agreement)**		**30**
7.1. Environmental goods and services	7.1.1. Does the agreement include provisions on environmental goods and/or services?	B	0.5
	7.1.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.2. Renewable energy	7.2.1. Does the agreement include provisions on renewable energy?	B	0.5
	7.2.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.3. Energy conservation	7.3.1. Does the agreement include provisions on energy conservation?	B	0.5
	7.3.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.4. Climate change	7.4.1. Does the agreement include provisions on climate change?	B	0.5
	7.4.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*

7.5. Biodiversity	7.5.1. Does the agreement include provisions on biodiversity/ecosystems?	B	0.5
	7.5.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.6. Invasive species	7.6.1. Does the agreement include provisions on invasive species?	B	0.5
	7.6.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.7. Air quality	7.7.1. Does the agreement include provisions on air quality?	B	0.5
	7.7.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.8. Water quality or water resources	7.8.1. Does the agreement include provisions on water quality or resources?	B	0.5
	7.8.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.9. Soil quality	7.9.1. Does the agreement include provisions on soil quality?	B	0.5
	7.9.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.10. Marine pollution	7.10.1. Does the agreement include provisions on marine pollution?	B	0.5
	7.10.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.12. Fisheries resources	7.12.1. Does the agreement include provisions on fisheries resources?	B	0.5
	7.12.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.13. Forest resources	7.13.1. Does the agreement include provisions on forest resources?	B	0.5
	7.13.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.14. Illegal timber	7.14.1. Does the agreement include provisions on illegal timber?	B	0.5
	7.14.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.15. Desertification	7.15.1. Does the agreement include provisions on desertification?	B	0.5
	7.15.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
7.16. Other issues	7.16.1. Does the agreement include provisions on any other specific issues?	B	0.5
	7.16.2. Do they provide for concrete, enforceable actions (going beyond examples of possible cooperation)?	*D*	*1.5*
8. Implementation mechanism			**5.0**
8.1. Implementation body	Does the agreement establish a specific environmental body responsible for implementing its environmental provisions?	D	3
8.2. Responsibilities	Are the responsibilities of this environmental body defined in detail?	D	2
9. Multilateral environmental agreements			**10**
9.1. General MEAs	9.1.1. Is there a provision relating to existing obligations in MEAs?	B	4

	9.1.2. Is the MEA provision a binding commitment?	*D*	*3*
9.2. Specific MEAs	9.2.1. Are these specific MEAs listed individually?	D	3
		Total	**100**

Note: B indicate the items that are used to calculate the *breadth* component of the index and D denotes the items used to calculate the *depth* component.

Table A2.2 List of RTAs with environmental provisions

RTA Name	year
Common Market for Eastern and Southern Africa (COMESA)	1994
North American Free Trade Agreement (NAFTA)	1994
Colombia - Mexico	1995
Canada - Chile	1997
EU - Tunisia	1998
Chile - Mexico	1999
Economic and Monetary Community of Central Africa, CEMAC	1999
EU - South Africa	2000
US - Jordan	2001
Canada - Costa Rica	2002
EFTA-Jordan	2002
EU - Jordan	2002
EC (25)+ Enlargement	2004
EFTA-Chile	2004
EU-Egypt	2004
US - Chile	2004
US - Colombia	2004
US - Singapore	2004
Japan - Mexico	2005
Japan - Mexico	2005
US - Australia	2005
Chile - China	2006
Guatemala - Chinese Taipei	2006
Japan - Malaysia	2006
Korea, Republic of - Singapore	2006
Trans-Pacific Strategic Economic Partnership	2006
US - Bahrain	2006
US - Morocco	2006
Chile - Japan	2007
EFTA-Egypt	2007
Japan - Thailand	2007
Chinese Taipei - Nicaragua -	2008
EU-CARIFORUM	2008
Japan - Asean	2008
Japan - Brunei Darussalam	2008

Japan - Indonesia	2008
Japan - Philippines	2008
New Zealand - China	2008
Panama - Chile	2008
Canada - EFTA	2009
Canada - Peru	2009
Chile - Colombia	2009
China - Singapore	2009
Colombia - Northern Triangle (El Salvador, Guatemala, Honduras)	2009
Japan - Switzerland	2009
Panama - Guatemala (Panama - Central America)	2009
Panama - Honduras (Panama - Central America)	2009
Panama - Nicaragua (Panama - Central America)	2009
US - Oman	2009
US - Peru	2009
New Zealand - Malaysia	2010
Canada - Colombia	*2011*
EU - Korea, Republic of	*2011*
India - Japan	*2011*
India-Malaysia	*2011*
Japan - India	*2011*
Peru - Korea, Republic of	*2011*
Turkey - Chile	*2011*
Japan - Peru	*2012*
Korea, Republic of - US	*2012*
Panama - Peru	*2012*
Peru - Mexico	*2012*
US-Panama	*2012*
EU - Colombia and Peru	*2013*
Korea, Republic of - Turkey	*2013*
Switzerland-China	*2013*
EU - Moldova	*2014*

Source: WTO RTA Database and author's elaboration. Only RTAs that entered into force until 2011 are considered in the regression analysis. The dummy rtaenvint takes the value of 1 six months after the RTA enters into force onwards, zero otherwise.

APPENDIX 3. Results for Extended Samples and Dif-GMM

Table A3.1 Results for PM2.5 (48 countries sample)

VARIABLE	(1) PM2.5	(2) PM2.5	(3) PM2.5	(4) PM2.5
Rtaenv	-0.00306***			
	[0.000880]			
W_score		-0.0105***		
		[0.00382]		
Breadth_ws			-0.0235***	
			[0.00878]	
Depth_ws				-0.0823***
				[0.0296]
Rtanenv	0.0013	-0.0002	-0.0001	-0.0002
	[0.0013]	[0.0011]	[0.0011]	[0.0011]
Ln_pop	-1.531***	-1.516***	-1.529***	-1.505***
	[0.239]	[0.238]	[0.239]	[0.238]
Ln_gdpcap	1.935***	1.977***	1.968***	1.981***
	[0.529]	[0.533]	[0.535]	[0.531]
Ln_gdpcap2	-0.120***	-0.122***	-0.121***	-0.122***
	[0.0298]	[0.0301]	[0.0302]	[0.0300]
Ln_open_pr	0.00171***	0.00169***	0.00168***	0.00169***
	[0.0004]	[0.000450]	[0.0004]	[0.0004]
Constant	3.887***	3.373**	3.630***	3.180**
	[1.311]	[1.334]	[1.331]	[1.336]
Turning point	3173.21	3302.57	3402.38	3357.16
R2-overall	0.87	0.873	0.873	0.873
R2-within	0.174	0.167	0.167	0.168
Nobs	570	570	570	570
Countries	48	48	48	48

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10. The specifications in this sample exclude the environmental stringency performance index, which is only available for 30 countries.

Table A.3.2. Robustness. Dif-GMM Estimations

	(1)
VARIABLES	PM2.5
rtaenv	-0.00468**
	[0.00218]
rtanenv	0.00280
	[0.00199]
ln_pop	0.460**
	[0.190]
lngdpcap_o	0.892***
	[0.224]
lngdpcap2	-0.0471***
	[0.0138]
ln_open_predict	0.00279
	[0.00398]
Lag.lpwm_pm25	0.435***
	[0.0676]
Long run elasticity (rtaenv)	-0.0082***
Observations	477
R-squared	0.631
Number of id	48
Hansen test (prob)	0.108

Note: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10. Ln denotes natural logarithms. The model is estimated with the variables in first differences. The Hansen test results cannot reject the validity of the instruments. Rtaenv and the lagged dependent variables considered as endogenous. The long run elasticity is calculated as the coefficient of rtaenv divided by one minus the coefficient of the lagged dependent variable (Lag.lpwm_pm25).