Are RTA Agreements with Environmental Provisions Reducing Emissions?

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Abstract

This paper investigates whether RTAs with environmental provisions affect relative and absolute pollution levels. In order to do so, the determinants of carbon dioxide emissions convergence are estimated for a cross-section of 182 countries over the period 1980 to 2008. A propensity score matching approach is combined with difference-in-differences techniques to effectively isolate the effect of the Regional Trade Agreement (RTA) variable. The usual controls for scale, composition and technique effects are added to the estimated model and the endogeneity of income and trade variables is modelled using instruments. The main results indicate that the CO_2 emissions of the pairs of countries that belong to an RTA with environmental provisions tend to converge and are lower in absolute terms, whereas this is not the case for RTAs without environmental provisions. As regards specific agreements, we find that emissions converge more rapidly for NAFTA than for EU-27 and Euro-Med countries. We find consistent evidence that only RTAs with environmental harmonization policies affect relative and absolute pollution levels.

Keywords: regional trade agreements, environmental provisions, convergence, CO2 emissions, matching, difference-in-differences

JEL Classification: F 18, O13, L60, Q43

I. Introduction

One of the most controversial debates in trade policy concerns the impact of trade liberalization on the environment. Trade liberalization can be implemented unilaterally, with a single country reducing its trade barriers against all its trading partners, or regionally, with a group of countries forming a Regional Trade Agreement (RTA) to eliminate trade barriers among them. The latter form of trade liberalization has been predominant since the early 1990s and there is increasing interest in assessing the effects stemming from this new regionalism. Not only direct trade and income effects are important, but also the impact on the environment. In this respect, it is important to distinguish between RTAs with environmental provisions (EPs) and RTAs that do not include any harmonization in environmental standards as part of the agreements.

After two decades of research, it is commonly accepted that the effects of trade liberalization on the environment are complex. They can be classified as scale, composition and technique effects and there may also be interaction between them (Copeland and Taylor, 2003). Most of the recent literature has used changes in trade openness as a proxy for trade liberalization (Frankel and Rose, 2005) and many studies have focused on the effects of NAFTA on the environment (Grossman and Krueger, 1991; Stern, 2007). Contrary to expectations, early findings pointed to positive effects. Surprisingly, few studies have been devoted to other regional trade agreements and to the best of our knowledge no studies have used RTAs as a trade policy variable that could influence pollution levels. This is precisely the strategy we propose in this paper to investigate the effects of trade on the environment, that is, by directly including an RTA variable in an emissions equation. Moreover, we hypothesize that the effect should be different for RTAs with and without EPs, only the former agreements being likely to have a direct effect on pollution levels or on convergence, whereas the latter should not have an effect once we control for changes in trade openness. One problem related to estimating RTA effects is that countries possibly select into trade agreements, which could generate endogeneity bias. In a different context, Badinger (2008), who specified an RTA variable in a productivity equation, addressed the endogeneity issue using an instrumental variable approach. The main shortcoming of this approach in our context is the difficulty in finding adequate instruments that are exogenous to the model. Hence, we will propose an alternative strategy.

In this paper we depart from the previous literature in two important aspects. First, we specifically investigate whether RTAs with EPs have a direct "harmonization" effect on pollution. We will therefore be able to determine whether signing an RTA with EPs leads governments to impose guidelines that affect relative and absolute pollution levels and whether this induces pollution convergence. Second, the identification strategy is based on the use of matched samples and difference-in-differences estimation techniques to better isolate these harmonization convergence rules. In addition, we follow the recent literature to correctly account for the complex effects of income and openness on pollution levels. In particular, the underlying control variables, namely openness and income levels, are instrumented away (Frankel and Romer, 1999; Frankel and Rose, 2005), since both might be influenced by RTA formation. Finally, results for specific agreements are also presented and compared.

The main results show evidence of RTAs with environmental provisions statistically explaining 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 or absolute pollution levels, indicating that controlling for bilateral trade levels and overall openness, the trade policy variable does not have a direct effect on emissions convergence for this type of agreements.

The paper is organized as follows. Section 2 states the main theoretical prediction and Section 3 reviews the main empirical literature. Section 4 describes the empirical strategy and the data, variables and main results are presented in Section 5. Finally, Section 6 concludes.

II. Regional Integration and Emission Convergence: Theoretical Predictions

1. Trade and the Environment

The negotiations for the North American Free Trade Agreement (NAFTA) were followed by fears regarding its impact on the environment. Indeed, the literature on trade and environmental quality began to emerge in this period. Grossman and Kruger (1991) was the first paper to decompose the total impact of trade on the environment into three different effects, namely scale, technique and composition effects.

The scale effect is assumed to have a negative impact on the environment. According to general belief, trade liberalization leads to an expansion in economic activity and, all other things being equal (composition and techniques of production), the total amount of pollution will then increase (for example, economic growth due to trade raises the demand for energy and boosts transportation, which is one of the main emitting sectors). It is worth noting that this pass-through between trade and the environment assumes a positive effect of trade liberalization on economic growth[4]. The income effects of trade are linked to the literature on the Environmental Kuznets Curve (EKC), which assumes an inverted U-shaped relationship between per capita income and pollution: Pollution increases in the early stages of development until it reaches a turning point and then declines (Copland and Gulati, 2006).[5] However, it is nowadays generally accepted that an EKC for CO_2 does not exist for most economies (Carson, 2010).

The second pass-through between trade and the environment is the so-called technique effect. Holding the scale of the economy and the mix of goods produced constant, a reduction in the intensity of emissions – measured in terms of emissions by unit of output - results in a decline in pollution. Three main arguments are behind this effect. First, increased trade promotes the transfer of modern (cleaner) technologies from developed to developing countries. Second, if trade raises income, individuals may demand higher environmental quality (if the latter is a normal good). Third, according to the Porter-hypothesis (Porter and van der Linde, 1995), increased globalization will increase competition. In order to stay competitive, firms have to invest in the newest and most efficient technologies. Thus, more stringent environmental policy can increase international competitiveness. In summary, the technique effect has a positive impact on the environment.

Third, comparative advantage is also an important factor that could explain the relationship between trade and the environment. The economy will pollute more if it devotes more resources to the production of pollution-intensive goods, holding the scale of the economy and emission intensities constant. The composition effect –also referred to as the trade-composition or trade-

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[4] A large body of literature provides empirical evidence of the positive effect of openness (see for example Dollar (1992), Ben-David (1993), Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999) or Rodriguez and Rodrik (2003) for a critical review).

[5] The Environmental Kuznets Curve relates to the work by Kuznets (1955), who found a similar inverted U-shaped relationship between income inequality and GDP per capita (Kuznets, 1955).

induced composition effect– is caused by changes in trade policy. Through trade liberalization, countries specialize in the sectors where they enjoy a comparative advantage. Among the sources of comparative advantage, we find classical factor endowment differences or unit cost differences and those based on differences in institutions or regulations between countries. On the one hand, the *Factor Endowment Hypothesis* (FEH) states that environmental policy has no significant effect on trade patterns, factor endowments determining trade instead. This implies that relatively capital-abundant countries will export pollution-intensive goods, since most pollution-intensive goods are capital-intensive. On the other hand, the *Pollution Haven Hypothesis* (PHH) states that differences in environmental regulations are the main motivation for trade and that trade liberalization causes pollution-intensive industries to relocate from high income countries with stringent environmental regulations to low income countries with lax environmental regulations (Taylor, 2004). Hence, with trade liberalization, high income countries will specialize in the production of clean goods and pollution in these countries will decline, while low income countries will specialize in producing dirty goods and their level of pollution will increase.

In general, we expect countries to differ in both factor endowments and environmental policy. High-income countries tend to be capital-abundant and also have stricter environmental regulations than low-income countries. On the one hand, the North could become a dirty-good importer (as it has stricter environmental policy) and, on the other hand, it might become a dirty-good exporter (due to being capital-abundant). The interaction between these two effects determines the pattern of trade. If pollution haven motives are more important than factor endowment motives, the North will import dirty goods from the South. On the contrary, trade could cause the North to specialize in the production and exportation of pollution-intensive goods when factor endowment differences dominate regulatory differences, despite having the stricter environmental regulations (Copeland and Taylor, 2003).

In summary, according to previous literature we could expect comparative advantage to be determined jointly by differences in regulatory policy and factor endowments. If the PHH dominates, following a liberalization process between a developing and a developed country, per-capita emissions will tend to converge. If FEH motives dominate, per-capita emissions should diverge.

One issue that has been overlooked by the theoretical literature is that trade policy negotiations have been increasingly accompanied by environmental policy measures. Those policy measures are planned in most cases to avoid the potential trade effects that could emerge as a consequence of differences in regulations. In particular, a number of recently signed RTAs include EPs that can directly affect the levels of emissions in the countries involved. This pass-through could be considered an additional explanation of the trade-environment relationship. In what follows, we focus on the link between regional integration and emissions and the differences encountered between specific agreements with respect to environmental provisions.

2. Regional Integration and the Environment

In the specific case of regional integration agreements (RTA), the scope of the agreement is particularly important. More specifically, when countries sign an RTA, not only tariff dismantling is planned, but also cooperation in other areas, namely the protection of the environment and cross-border investments are sometimes included, among other issues. Focusing on environmental issues addressed in trade agreements, the proponents of RTAs with EPs have mainly been developed countries, namely the United States, Canada, the EU and New Zealand. Developing countries have instead tended to address environmental issues in separate side agreements[6]. The main differences between the type of EPs included in RTAs refer to the basis for their enforcement. On the one hand, NAFTA and the EU mainly opt for legally binding provisions, whereas New Zealand opted for a nonbinding approach. On the other hand, the binding dispute resolution found in US RTAs is in the form of compensation and also suspension of concessions, whereas only the former, compensation,

[6] Anuradha (2011).

is typical of EU agreements. In what follows we will describe the main particularities of three agreements, namely NAFTA, the EU and Euro-Med in relation to the environmental issues they address.

In the case of NAFTA, in order to address public concerns about its environmental impact, a side agreement on the environment was signed. The North American Agreement on Environmental Cooperation (NAAEC) stipulates that "… each Party shall ensure that its laws and regulations provide for high levels of environmental protection and shall strive to continue to improve those laws and regulations"[7]. The NAAEC stands out for the commitment of the three governments to account internationally for the enforcement of their environmental laws. Moreover, in order to avoid a race to the bottom in environmental regulation between the three countries, the North American Commission for Environmental Cooperation (CEC) was created in 1994. The CEC pays a crucial role in promoting regional environmental cooperation and provides the basis for promoting mitigation policies that address the possible negative environmental effects of market integration and proactive policies that enhance its beneficial effects[8]. Despite all the progress made in terms of institutional framework, the three NAFTA countries have failed to develop an international consensus on how to integrate environmental considerations into their respective trade policies. Trade policy decisions in the 2000s are still more influenced by economical considerations than by environmental concerns[9]. Perhaps another reason for such little progress is that race-to-the-bottom and pollution-haven scenarios have generally not materialized. It is also worth noting that out of the three NAFTA members, Mexico has probably benefited the most from the Agreement, which facilitated progress in pesticide control and pollution prevention and invested in Mexico's enhanced

[7] North American Agreement on Environmental Cooperation between the government of Canada, the government of the United Mexican States and the government of the United States of America, part 2: Obligations, article 3: levels of protection. http://www.sice.oas.org/trade/nafta/Env-9141.asp#TWO.

[8] One of the three principal bodies of the CEC is the Joint Public Advisory Committee (JPAC), which launched in 2005 a strategic plan for the period 2006-2010 based on three working principals, namely transparency, outreach and engagement and three main pillars (information for decision making, capacity building and trade and the environment).

[9] Ten Years of North American Environmental Cooperation, Ten-year Review and Assessment Committee (TRAC, 2004).

environmental management capacities. However, the impact of these initiatives can hardly be assessed since the effectiveness of these efforts has not been tracked and no baseline was established to systematically measure capacity development effects.

In what follows we focus on two additional selected RTAs, namely the European Union (EU) and Euro-Med agreements, and describe the climate policies that have been included in each. Starting with the EU, an important number of climate-related initiatives have been taken within the framework of this agreement since the early 1990s. Such initiatives include the first Community strategy to reduce CO_2 emissions and improve energy efficiency in 1991 (materialized into a Directive to promote electricity from renewable energy, voluntary commitments by car makers to reduce CO2 emissions by 25 percent and proposals on the taxation of energy products) and the European Climate Change Programme (ECCP), launched by the Commission in 2000. While one of the most important initiatives of the ECCP I (2000-2004) was the EU Emissions Trading System, the ECCP II explored other options to reduce Greenhouse Gas Emissions (GHG), such as carbon capture and storage. In 2007, an integrated approach to climate and energy policy was launched with the commitment to convert the EU into a low carbon economy. With this aim, a number of climate and energy targets have been set for 2020. The three main targets, known as the “20-20-20” targets are: a reduction in EU greenhouse gas emissions of at least 20 percent below 1990 levels; a 20-percent share of EU energy consumption to come from renewable resources; and a 20-percent reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

As regards EU-Mediterranean climate policy, three initiatives are worthy of mention in the context of the Euro-Mediterranean Partnership. First, the DG Environment LIFE-Third Countries programme, which provided technical assistance and co-financed around 3,506 environmental and conservation projects in the Mediterranean region during the period 1992 to 2006. Second, the Short and Medium-Term Priority Environmental Action Programme (SMAP), which constitutes the common basis for environmental actions related to policies and funding at regional and national level and was financed by the MEDA programme (2000-2006). Finally, the “Horizon 2020” initiative launched by the Commission in 2005 and aimed at reducing pollution by 2020. This initiative targets Mediterranean countries covered by European Neighbourhood Policy (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestinian Authority, Syria and Tunisia), EU Member States and the accession countries, which must also apply EU environmental legislation. Existing environmental instruments will be used to fulfil the commitments agreed upon under the Barcelona Convention. In particular, this common initiative will finance projects to reduce pollution, include capacity-building measures such as the development of legislation and institutions to protect the environment and will also include monitoring and managing the initiative. It is worth noting that according to the WTO, only two of these countries have environmental provisions in their interim agreements with the EU, namely Tunisia and Jordan. However, as we have described above, since 2005 the EU has financed a number of projects that target environmental issues in most of the Mediterranean countries.

These institutions and mechanisms, created in the case of NAFTA, the EU and Euro-Med agreements illustrate the possible policy responses to the potential effects of regional integration on the environment. In particular, there could be two effects at work depending on the type of agreement. First, in case of agreements that do not include environmental provisions, country members, and especially southern countries, can adopt lax environmental legislation to gain competitiveness once trade barriers are eliminated, or to attract multinationals and favor a relocation of economic activity from the developed partner. This relocation of “dirty” activities leads to convergence in the level of emissions. Second, regional integration that includes environmental provisions can lead to the harmonization of rules and standards, which could also lead to convergence in emissions. The first effect will result in the South having a comparative advantage in dirty industries with respect to the North, once trade barriers are dismantled. However, holding constant the volume of trade between countries in the South and the North, the direct effect on emissions convergence should not be present. Conversely, RTAs with environmental provisions could indeed have a direct effect on emissions convergence, holding constant bilateral trade, openness and income levels. This is precisely what we hypothesize and will test in the empirical part of the paper. Table A.1 in the Appendix lists the RTAs in force by type and distinguishes between agreements with environmental provisions and those without. We define RTAs with environmental provisions as those that according to the Regional Trade Agreements Information System (RTA-IS) of the World Trade Organization (WTO) cover the topic “environment”.

III. Trade, Regional Integration and Emissions: a Survey

After describing the theoretical mechanisms and the environmental provisions of selected RTAs, this section briefly surveys the econometric studies dealing with the link between trade, regional integration and the environment.

Antweiler et al. (2001), a widely cited study, extends the work of Grossman and Krueger (1991) and develops a theoretical model based on the decomposition of the effect of trade on the environment into scale, composition and technique effects. They estimate and sum these effects to explore the overall impact of increased trade on the environment, thereby allowing for pollution haven and factor endowment motives. Their results show that trade intensity per se is not significant. However, when interacted with country characteristics, the estimated effect is positive, statistically significant and small. When they add up the estimates of scale, technique and composition effects, they find that increased trade causes a decline in sulfur dioxide concentrations concluding that freer trade seems to be good for the environment. Dean (2002) uses a simple Heckscher-Ohlin model of international trade with endogenous factor supply that can be affected by trade policy. It consists of a two-equation system that captures the effect of trade liberalization on the environment through two channels: its direct effect on the composition of output (the composition effect) and its indirect effect via income growth (the technique effect). The author finds that a fall in trade restrictions has a direct negative effect on environmental quality via the composition effect and an indirect positive effect via the technique effect, the latter outweighing the former, suggesting that trade is good for the environment. Cole and Elliot (2003) rely on Antweiler et al. (2001) to empirically test for the effects of trade on emissions per capita, emission intensities and concentration levels for different air and water pollutants. They find that results depend on how the dependent variable is measured (concentrations versus emissions) and also vary by pollutant. Frankel and Rose (2005) use an EKC framework to estimate the effects of trade on pollution concentration levels. They consider per capita income and its square, trade, institutional quality[10] and land area as regressors. They take into account the endogeneity of income and trade, the former by adding lagged values of income and the latter by using instrumental variables derived from the gravity model of bilateral trade. Their results show that controlling for endogeneity does not affect the earlier findings. They find that trade has a positive impact on air quality, but do not find evidence of a 'race to the bottom' driven by trade or support for the PHH. One shortcoming of this paper is that it uses a cross-section approach instead of a panel data approach, as most recent papers do. This means the study has a possible weakness, since they do not control for unobserved heterogeneity that is time-invariant. More recently, Managi et al. (2009) combine the specification derived from Antweiler et al. (2001) and the use of instrumental variable estimations to correct for the endogeneity of income and trade. They find that trade has a beneficial effect on the environment depending on the pollutant and the country. OECD countries benefit from trade, whereas trade increases emissions in the case of Non-OECD countries. In addition, the net effect of an increase in international trade flows is also likely to be determined by the subsequent change in trade patterns (composition effect) in which connectivity may play a crucial role (Bensassi *et al*., 2011).

In this paper we will follow the strategy employed in Managi et al. (2009) to correct for the endogeneity of income and trade in the emissions equation, but in addition we include RTAs with environmental provisions as a policy variable that could also affect emissions directly.

Stern (2007) is, to the best of our knowledge, the only study that addresses the link between regional integration and emissions convergence. The author uses data from 1971 to 2003 to investigate whether or not entry into NAFTA has led to a convergence in energy use and emissions of pollutants in Mexico, the United States and Canada. Results show strong evidence of convergence

[10] This variable is proxied by an indicator for democracy (polity), which ranges from -10 (strongly autocratic) to +10 (strongly democratic) and is taken from the Polity IV project.

for all intensity indicators across the three countries towards a lower level. Although intensity initially rises for some variables in Mexico, it eventually begins to fall after NAFTA comes into force. Per capita measures for two pollutants (sulfur and NOx) also show convergence, but this is not the case for energy and carbon. The latter variables drift moderately upwards. The state of technology in energy efficiency and sulfur abatement is improving in all countries, although there is little, if any, sign of convergence and NAFTA has no effect on the trend of technology diffusion. According to these results, Mexico's technology is improving at a slower rate than its two northern neighbors.

IV. Empirical Strategy

IV.1. Model Specification

First, along the same lines as Stern (2007), we aim to explore whether emissions converge for countries involved in an RTA. In particular, we distinguish between agreements with and without EPs. We depart from Stern (2007) by adopting matching and difference-in-differences estimation techniques that allow us to control for the endogeneity of the RTA variable in the emissions equation and by using instrumental variables to address the endogeneity of other control variables. Second, we will also examine the direct effect of RTAs on absolute pollution levels to be able to infer whether convergence is towards a lower or higher level of emissions.

Our starting point is a simplified version of the determinants of emissions. Per-capita emissions depend on population, land area per capita, per-capita GDP and an openness ratio. These variables are assumed to control for scale, technique and composition effects[11]. Given that all the well-established theories linking environment with income and openness indicate that double causality could bias the results, we will control for the endogeneity of income and openness.

In order to test for the convergence of emissions, we estimate a log-linear emissions equation in relative terms in which the dependent variable is the log of CO_2 emissions of country *i* relative to country *j* in period t (Em_{it}/Em_{jt}). The estimated model is given by,

[11] Our model considers the main factors affecting emissions in line with Martínez-Zarzoso and Maurotti (2011) and Frankel and Rose (2005).

$$Y_{ijt} = \left|\ln\left(\frac{Em_{it}}{Em_{jt}}\right)\right| = \alpha + \varphi_1 \left|\ln\left(\frac{Pop_{it}}{Pop_{jt}}\right)\right| + \varphi_2 \left|\ln\left(\frac{Landcap_{it}}{Landcap_{jt}}\right)\right| \varphi_3 \left|\ln\left(\frac{GDPcap_{it}}{GDPcap_{jt}}\right)\right| +$$

$$+\varphi_4 \left|\ln\left(\frac{Open_{it}}{Open_{jt}}\right)\right| + \varphi_5 \ln Biltrade_{ijt} + \beta\, RTA_{ijt} + \varepsilon_{\,ijt} \qquad (1)$$

where i and *j* refer to countries, and t to the year. Y_{ij} represents the pollution emissions gap between a pair of countries *i, j*. 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, $GDPcap_{it}$ ($GDPcap_{jt}$) is GDP per capita at constant US dollars in country *i* (*j*) in year t. $Open_{it}$ ($Open_{jt}$) refers to the openness ratio measured as the sum of exports and imports divided by gross domestic product. Since GDPcap is endogenously determined, we use a set of instrumental variables for income taken from the growth literature. Openness is endogenous too. Consequently, we use a second set of instrumental variables for this variable based on the estimation of a gravity model of trade using a large dataset on pair-wise trade, in particular we use Badinger's specification of the 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. A detailed explanation is given in Section IV.2 below.

The absolute value of each relative term is considered in order to have only one interpretation of an increase in the value of the variable, since any increase (decrease) implies divergence (convergence) between both countries. For example, an increase in the left-hand-side variable in equation (1) means that there is divergence in the emissions of countries. Two bilateral variables, namely bilateral trade between countries *i* and *j* and the variable RTA_{ijt}[12], are added to the basic specification: $Biltrade_{ijt}$ is the amount of trade (exports and imports) between countries *i* and *j* in year t and RTA_{ijt} is a dummy variable taking a value of 1 if countries are involved in a regional trade agreement in the considered year and zero otherwise. The sign of β allows to test for the convergence hypothesis. A positive sign means that the emissions gap between a pair of countries

[12] RTA_{ijt} will be denoted as RTA for the sake of simplicity.

that have an RTA increases, whereas a negative sign suggests convergence in the emissions gap of countries linked by an RTA.

In order to assess the effect of RTAs accurately, it has to be isolated from any other variables that might impact pollution-level convergence as a result of RTAs. For instance, relative per-capita GDP, trade openness and bilateral trade variables might be influenced by RTAs. We also address RTA endogeneity due to self-selection into agreements.

Next, the strategy we use to examine the direct effect of RTAs on absolute pollution levels is to estimate Equation (1) above in absolute terms. The estimated equation is given by,

$$\begin{aligned} &\ln(Em_{it}) = \delta + \gamma_2 \ln(Pop_{it}) + \gamma_3 \ln(Landcap_{it}) + \gamma_4 \ln(GDP_{it}) + \gamma_5 \ln(Open_{it}) + \\ &+ \phi\ RTA_{it} + \mu_{it} \\ &where\ RTA_{it} = \sum_j RTA_{ijt} * Em_{jt} \end{aligned} \quad (2)$$

where Em_{it}, the natural logarithms of emissions in country *i* at time *t*, is the dependent variable. The independent variables are the same as in Equation (1) in absolute terms, namely population, land per capita, GDP per capita and multilateral openness in country *i* at time *t*, and RTA_{it} is generated as a weighted average using emissions in the partner countries as weights.

IV.2. Endogeneity issues

As emphasized by Frankel and Rose (2005), trade flows, regional agreements, pollutants' emissions and environmental regulations may affect income. Therefore, we instrument income with a number of variables, namely lagged income (conditional convergence hypothesis), population, investment and human capital formation. The latter is approximated by the rate of school enrolment (at primary and secondary level). The predicted values of this equation are used to calculate $GDPcap_{it}$ and $GDPcap_{jt}$. We use a second set of instrumental variables for the openness ratio and the bilateral trade variable based on the estimation of a gravity model of trade using a large 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 the Badinger's (2008) specification of the gravity model. Real bilateral openness is regressed on population, land area, distance, a common border dummy and a landlocked variable (which is the 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 ($\left|\ln(Area_i) - \ln(Area_j)\right|$) and remoteness from the rest of the world (*Remote*).[13] Finally, the exponent of the fitted values across bilateral trading partners is aggregated to obtain a prediction of total trade for a given country.

The endogeneity of the RTA variable is addressed using matching techniques. These techniques provide a simple way to deal with the selection induced by RTAs. Baier and Bergstrand (2004) give evidence that country pairs involved in RTAs tend to share common economic and geographic characteristics. Few studies use matching techniques to deal with the endogeneity of RTAs. Egger et al. (2008) used a difference-in-differences panel matching estimator to examine primarily the effect of RTA formation on changes in shares of intra-industry trade. Baier and Bergstrand (2009) provide the first cross-section estimates of long-run treatment effects of free trade agreements (FTA) on members' bilateral international trade flows using nonparametric matching econometrics. Their findings show that matching estimators provide plausible estimates of the average treatment effects of an RTA on the trade of members that actually form one. We follow a similar methodology to match pairs of countries that have an RTA with similar pairs of countries that are not linked by any RTA.

After obtaining the matched samples for each year, we use a difference-in-differences estimator to evaluate the effect of the treated RTA variable on emissions convergence.

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

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.

The effect of an RTA on the outcome[14] (Y_{ij} which is the pollution emissions gap) of a pair of countries is defined as the difference between the pollution emissions gap of a pair of countries after enforcing an RTA and the outcome that these countries would have achieved without an RTA. Put differently, the impact of an RTA is measured by the change in the pair of countries' outcome, which is attributable to the RTA only.

The difference-in-differences (hereafter DID) approach is well suited to dealing with this issue (Meyer, 1994; Heckman et al., 1997). Considering the RTA process as a natural experiment, the DID method evaluates the average effect of the treatment (here the RTA) on treated units (pairs of countries linked by an RTA and denoted by RTA). The idea is that comparing the outcome of a pair of countries before and after an RTA is not satisfactory because we do not have a counterfactual (outcome variable for the pair of countries if they had not entered the RTA). In order to control for this skew, the DID method compares the difference in outcome before and after the RTA for participating countries to that for a control group. The latter comprises pairs of countries that have never been part of an RTA. These countries are referred to hereafter as $NRTA$.

Formally, let Y_{ijt}^{1} be the outcome in period t for a pair of countries i, j which have been a member of an RTA. We denote Y_{ijt}^{0} the outcome for the same country pair assuming it was not linked by an RTA. The effect of the RTA for this pair i, j is then measured by $Y_{ijt}^{1} - Y_{ijt}^{0}$.

The average impact of the RTA is described by $E(Y_{ijt}^{0}|T = 1)$. Unfortunately, we cannot observe the outcome for the same pair of countries both as a participant and as a nonparticipant in an RTA. In other words, we cannot ascertain the outcome of the event of nonparticipation for a pair of countries that signed a trade agreement or conversely. In order to overcome this difficulty, we compare the evolution of the groups RTA and NRTA over time, assuming that they would have been identical in the absence of an RTA:

$$E(Y_{ijt}^{0}|RTA = 1, t = 1) - E(Y_{ijt}^{0}|RTA = 1, t = 0)$$

[14] We follow Bertrand and Zitouna (2008) in this section and adapt their empirical strategy to RTAs.

$$= E(Y_{ijt}^0|RTA = 0, t = 1) - E(Y_{ijt}^0|RTA = 0, t = 0) \quad (3)$$

The terms $t = 0$ and $t = 1$ refer respectively to the period before and after the RTA. Hence, the missing counterfactual value could be replaced by the state of country pairs before the agreement, adjusted to take into account the growth in aggregate outcome:

$$E(Y_{ijt}^0|RTA = 1, t = 1) = E(Y_{ijt}^0|RTA = 1, t = 0) + m_t \ (4)$$

Where $m_t = E(Y_{ijt}^0|RTA = 1, t = 1) - E(Y_{ijt}^0|RTA = 0, t = 0)$ denotes the DID estimator that assesses the impact of an RTA on participating countries. We obtain it by regressing data pooled across the treatment (country pairs with RTA) and the control group (country pair without RTA). The estimating equation is given by,

$$Y_{ijt} = \alpha + \beta_1 RTA_{ij} + \beta_2 After_t + \beta_3 \left(Effect\_RTA_{ijt}\right) + \varphi X_{ijt} + \delta_t + \epsilon_{ijt} \quad (5)$$

RTA is a dummy variable taking a value of 1 for treated country pairs and 0 otherwise. It controls for differences in constant outcome Y_{ijt} between treated pairs of countries and the control group. We define the dummy variable $After$ as taking a value of 1 in the post-RTA years and 0 otherwise for both RTA and non-RTA countries. This dummy variable controls for time effects on outcome Y_{ijt}. Finally, the term $Effect\_RTA_{\,ijt}$ is an interaction term between RTA_{ij} and $After_t$. Its coefficient, β_3, represents the DID estimator of the effect of an RTA on the treated group. A vector of the characteristic ratio of a country's pair is included to control for differences in observable attributes between the treated and control group. The vector X_{ijt} represents the ratio of some observable features of a pair of countries i, j at time t. These observables are population, land area per capita, GDP per capita, openness ratios and bilateral trade as presented in equation (1). δ_t denotes time-specific dummies that control for factors common to all countries. ϵ_{it} is an idiosyncratic error term that is assumed to be independent and identically distributed. We also estimate a panel data version of model (5) for the emission levels given by,

$$\ln(Em_{it}) = \delta_{ij} + \lambda_1 RTA_{it} + \gamma X_{it} + \theta_t + \omega_{it} \qquad (6)$$

Next, we explain how the choice of the comparison group is made. Intuitively, the DID method does not provide valid estimations when the comparison group differs greatly from the treated pairs of countries over the pre-RTA period. In order to solve this problem, we combine the DID estimation with the matching method (Blundell and Costa Dias, 2000)[15]. Propensity score matching techniques identify a control group without marked differences in characteristics compared to treated pairs of countries. Failure to account for the selection problem would bias the estimated impact of an RTA. It may lead to correlation between the RTA variable and the error term in the outcome equation. This would be the case when the agreement decision is not a random process, but due to observable characteristics associated to a given trading pair of countries, such as distance, which also influences the post-liberalization outcome. The propensity score method therefore controls for selection on the basis of observed characteristics. Furthermore, matching pairs of countries directly could require comparing the groups RTA and NRTA across a large number of observable pre-liberalization characteristics. The propensity score method reduces the dimensionality issue by capturing all the information from these characteristics on a single basis (Rosenbaum and Rubin, 1983). In particular, it measures the probability of signing the agreement according to a vector of pairwise variables. The estimation of this probability value is as follows:

We use propensity score matching (PSM) to construct a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics. Participants are then matched on the basis of this probability, or propensity score, to non participants. We estimate a probit model given by,

[15] The matching method is a nonparametric method. No particular specification is assumed.

$$P(RTA_{ij} = 1) = F(\ln(RGDP_{ij}), \ln(Dis_{ij}), Contiguity_{ij}, Common\ language_{ij}) \quad (7)$$

where $RGDP_{ij}$ denotes the sum of the real GDP of countries *i* and *j* .

Dis_{ij} denotes the great circle distance between countries *i* and *j*.

$Contiguity_{ij}$ takes a value of one for countries that share a border and zero otherwise.

$Common\ language_{ij}$ takes a value of one for countries that have the same official language.

Once the propensity scores are estimated, observations from the treated group and the control group are matched. Each treated pair of countries is associated with a pair of control countries endowed with a similar propensity score[16]. We apply this econometric methodology to match pairs of countries linked and not linked by an RTA (with and without EPs) during the period 1980-2008.

The validity of PSM depends on two conditions:

(a) Conditional independence (namely, that unobserved factors do not affect participation).

(b) Sizeable common support or overlap in propensity scores across the participant and nonparticipant sample.

The assumption of common support or overlap condition for matching on the propensity score is that the estimated score is smaller than unity throughout. This condition ensures that treatment observations have comparison observations "nearby" in the propensity score distribution (Heckman, Lalonde, and Smith, 1999). The probability model provides us with an estimate of the propensity score $p(Z)$. In our case, the latter is to be interpreted as the likelihood of entering an RTA, conditional on the observables. Next, we have to ensure that the treated units (new RTA members) and the control units (the comparable subgroup of nonmembers) are similar with respect to every observable Z. Thus, balancing tests will be conducted to verify whether the average propensity score and mean Z are the same[17].

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[16] We use the "calliper" matching method to select the control pairs of countries.

[17] A balancing score test and a T-test were conducted to check the differences within bands of the propensity score between treated and untreated country pairs.

We base our choice of explanatory variables in the probability model on Baier and Bergstrand (2004). These authors show that gravity variables, namely GDP and distance, are the main determinants of the formation of RTAs:

(i) Distance is used as a proxy for transport costs: two countries that are geographically close will have lower transport costs. The lower the transport costs between countries, the more each country can consume the other country's varieties, enhancing trade creation regionally and the formation of RTAs.

(ii) Incomes are used as a proxy of the economic size of the participating countries.

Other Variables that are associated to a higher probability of forming RTAs are contiguity and common language, as proxies for trade facilitation.

V. Data, Stylized Facts and Main Results

1. Data and Stylized Facts

The RTA data are taken from De Sousa (2012) and the WTO website[18]. Distance, common language, contiguity and landlocked dummies come from CEPII[19]. Bilateral trade flows are from the UN-COMTRADE database and income, investment, land area, population, school enrolment and emissions data are from the World Development Indicators (World Bank, 2009). The sample covers 182 countries listed in Table A.2 and the period dating from 1980 to 2008.

The main variables used in the emissions equation are per capita real gross domestic product (GDPcap); carbon dioxide emissions (Em) as a proxy for the level of pollution and environmental degradation; the openness ratio (Open), which is calculated as exports plus imports over GDP; total population (Pop), land area per capita in square kilometers (Landcap), bilateral trade (Biltrade) and the RTA variable that takes a value of one if a pair of countries participate in the same RTA (with or without EP) and zero otherwise. The date the RTA enters into force is taken into account when

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[18] WTO web site (http://www.wto.org/english/tratop_e/region_e/region_e.htm). Programs for constructing data on RTAs are available at http://jdesousa.univ.free.fr/data.htm.
[19] www.cepii.fr.

building this variable. All variables, apart from RTA, are transformed by taking natural logarithms, such that the associated coefficients in the estimated model can be interpreted as elasticities. Table A.3 in the Appendix shows the summary statistics for the described variables.

As shown by Baier and Bergstrand (2009), closer countries with a similar level of wealth are more likely to join a free trade agreement. Table (1) reveals that the means of (ln) distance, sum of (ln) gross domestic products and language and adjacency differ between countries linked by an RTA and pairs of countries without an RTA. Countries linked by RTAs tend to be closer and richer. Moreover, they are more likely to have common borders and share the same language than the rest[20].

Table 1. Summary of covariate means

Figures (1) and (2) show some differences in the bilateral distances between pairs of countries involved and not involved in RTAs. Figure (1) shows that pairs of countries with an RTA are closer together than those without an RTA. The kernel densities function of (ln) bilateral distances for non-RTA pairs of countries is more centered to the right in relation to the kernel density function of (ln) bilateral distances for RTA pairs of countries.

Figure 1. Kernel density of the log of bilateral distance for pair-wise countries with and without an RTA

Figure (2) shows that country pairs with an RTA tend to be larger economically. The Kernel density function for countries with an RTA is centered to the right in comparison to pairs without one.

Figure 2. Kernel density of the sum of the log of GDPs pair-wise countries with and without an RTA

2. Main Results

The matching was implemented for each single year. Country pairs for each year in which there was at least one agreement (year by year) are matched with country pairs without an agreement using propensity matching scores and then a dataset was created with the matched data[21].

Based on the pooled cross-section data, Table A.4 in the Appendix displays the efficiency of the matching procedure for RTAs. The balancing property is verified[22] and the reduction in bias[23] is drastic when the bias is initially high. Thus, this method provides a valid group of countries to which we will compare changes in target countries' performance.

In order to illustrate the estimations used for the matching, the first column of Table 2 shows the results from pooled cross-section estimations for the determinants of the decision to enter into an RTA for all country pairs (equation 4). It supports the stylized facts and shows that economic characteristics and geographic conditions are the main determinants of the decision to join an RTA for the whole sample. Column 2 (Table 2) shows that the same set of factors are statistically significant for the selected (matched) sample (Results in Table 2 are obtained for all RTAs).

Table 2. Determinants of RTAs

Next, Equation (5) is estimated using OLS with time dummies and panel data. The main results are shown in Table 3. Columns (1) and (2) show the results for all RTAs for the matched sample and for the whole sample, respectively. Next, columns (3) and (4) show the same two sets of results for RTAs with EPs and columns (5) and (6) for RTAs without EPs. Time effects are included in order to capture time trends that may affect emissions and are common for all countries.

[21] The Stata command *pscore* is used to check that the balancing property is satisfied (number of blocks between 5 and 8) and the command *psmatch2* with a calliper (0.01) is used for the matching (years with matching and common support satisfied: 1981, 1983, 1986, 1991, 1992, 1993, 1994, 1995, 1996, 1997-1998 and 1999-2008).

[22] For each independent variable, the difference between target and control countries is checked by employing a T-test on the differences within bands of the propensity score.

[23] The bias could be defined as the difference of the sample mean in the treated and non treated sub-samples divided by the square root of the average of the sample variances in the treated and non treated groups.

Table 3. Emissions pollution gap and economic integration

Looking at the results for the matched sample, the coefficient of the target variable (Effect_RTA) is negative and statistically significant only when RTAs with EPs are considered (column 3). Countries involved in RTAs with EPs converge in terms of CO_2 emissions after the agreements have come into force. This negative sign can be interpreted as supporting evidence for emission convergence. Our preferred specification, with the difference-in-differences and matching techniques, displays a coefficient of about -0.20. Hence, the gap in emissions per capita between countries involved in an RTA with EP is around eighteen percent (=exp(-0.197-1)*100) lower than for countries without an RTA. We have to underline the fact that the effect of RTA participation is positive and statistically significant for agreements that do not include environmental provisions, indicating that emissions seem to diverge due to RTA participation in agreements that do not include EPs (column 5, Table 3).

The results obtained for the whole sample (without matching) indicate that the RTA effect is smaller for the RTAs with EPs (estimated coefficient is statistically significant and equal to -0.037 versus -0.20 in the matched sample). However, for the RTAs without EP the effect was not statistically significant at conventional levels supporting no convergence in pollution levels.

With respect to the control variables, our results for the matched sample show that population and gross domestic product per capita ratios are positively related to the emissions gap. These variables are used as control variables and are assumed to capture the scale and technique effect respectively. Convergence in the scale of the economy as well as in technology is positively correlated to convergence in emissions of CO_2 for pairs of countries. As regards the land ratio, countries that have a more similar land allocation tend to have more similar emission levels. Concerning the openness ratio, the corresponding estimated coefficient is negative, indicating that greater differences in trade openness tend to reduce the emissions gap between trading partners. Conversely, bilateral trade is positively related to the emissions gap, indicating that countries that trade relatively more with each other tend to have higher emission gaps.

In a second step, similar estimations are obtained for specific agreements. Among them, The European Union, NAFTA and the Euro-Med agreements (European Union countries and southern Mediterranean countries: Morocco, Algeria, Tunisia, Egypt, Jordan and Turkey). On the one hand, the first two agreements are relevant because both specifically include EP, but in a different way, as described in Section 2 above. The latter agreement is of special interest because the EU has been providing funds for South Mediterranean countries to improve their environmental standards since the 1990s, even before the bilateral interim agreements entered into force. Estimates of equation 5 with time effects are shown in Table 4. We estimate equation (5) for the matched sample, namely the pairs of countries linked by one agreement (treated units) and pairs of similar countries (selected control group). The results shown in Table 4 indicate that the RTA effect is negative and significant for all three agreements.

Table 4. Emissions pollution gap and specific agreements

Indeed, the interaction variable that proxies the membership effects on the emissions gap displays a coefficient of (-0.51) for NAFTA, (-0.14) for the EU and (-0.25) for the Euro-Med. It is worth noting that the NAFTA agreement entails greater emission convergence than the average effect of RTAs with EPs and the same is the case for the Euro-Med. In particular, the gap in per capita emissions between NAFTA countries is around 40 percent ((exp(-0.513)-1)*100) lower than for similar countries without an RTA. Therefore, the NAFTA agreement fosters convergence of CO_2 emissions.

Table 5. Emissions and economic integration for RTAs with environmental provisions (EP)

Finally, Table 5 presents the estimates obtained when model (6) is estimated. The main results 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 environmental provisions.

VI. Conclusions

This paper examines the impact of regional integration on CO_2 emissions. We adopted a reduced-form specification linked to the emissions convergence hypothesis in which relative emissions are explained using income, population, land area, openness in relative terms, bilateral trade and a dummy for RTA agreements. The model is estimated using a difference-in-differences approach paying special attention to the potential selection induced by RTAs and to the endogeneity of the income and trade variables. A propensity matching technique is used to treat RTAs and to extract a sub-sample containing only matched pairs of countries that share similar characteristics.

Our results consistently indicate that RTAs that specifically include environmental provisions foster convergence of CO_2 emissions. In particular, the gap in emissions per capita is about eighteen percent lower for pairs of countries that have signed RTAs with environmental harmonisation policies than for the rest when the matched sample is used.

As regards specific agreements, our estimations indicate that the emissions pollution gap is twenty-two percent lower for pairs of countries involved in Euro-Mediterranean Agreements than for similar pairs of countries not involved in RTAs. The effect is slightly less pronounced for EU-27 pairs of countries, for which the emission gap is around thirteen percent lower than for similar non-EU-27 countries and more pronounced for NAFTA, for which the emission gap is around forty percent lower than for similar non-NAFTA countries. It is worth noting that reductions in the emissions gap stemming from an integration agreement which explicitly establishes an obligation for the parties to effectively enforce their environmental laws, like NAFTA, are larger than those related to RTAs such as the Euro-Mediterranean or EU agreements, which contain fewer and more broadly worded EPs. The main economic policy recommendation that can be derived from our results is that only regional integration processes that include environmental harmonisation policies will be able to contribute to reducing or at least controlling emissions levels.

Moreover, an agreement that prescribes monetary compensations for noncompliance with EPs seems to go hand in hand with stricter environmental regulations that are common for all its members, as in the case of NAFTA integration, and this appears to be linked to greater reductions in the abovementioned pollution gap in comparison to other agreements.

Further research concerning other pollutants is also desirable in order to ascertain whether the link between regional trade agreements and pollution convergence also exists in other cases.

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Tables

Table 1: Summary of covariate means

	Country pairs with an RTA	Country pairs without an RTA
Ln of distance	7.34	8.86
Sum of the ln of GDPs	18.64	17.31
Adjacency dummy	0.13	0.009
Language dummy	0.26	0.15

Table 2. Determinants of RTAs

	Model 1	Model 2
	All	Matched
Sum of the ln of GDPs	0.205***	0.127***
	(0.003)	(0.006)
Ln distance	-0.955***	-0.212***
	(0.007)	(0.011)
Contiguity	0.062**	0.297***
	(0.026)	(0.038)
Common language	0.102***	0.110***
	(0.015)	(0.024)
Pseudo R^2	0.395	0.032
Observations	201,558	25,629

Note: Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Emissions pollution gap and economic integration for RTAs with and without environmental provisions (EP)

VARIABLES	All RTAs		With EP		Without EP	
	Matched	All (panel)	Matched	All (panel)	Matched	All (panel)
Effect_RTA	-0.008	-0.013	-0.197***	-0.037*	0.160***	0.026
	(0.04)	(0.01)	(0.07)	(0.02)	(0.05)	(0.02)
Abs Ln population ratio	0.799***	0.706***	0.892***	0.677***	0.816***	0.694***
	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)
Abs Ln land per capita ratio	0.089***	0.025	-0.020	0.013	0.100***	0.001
	(0.01)	(0.04)	(0.01)	(0.04)	(0.01)	(0.04)
Abs Ln GDP per capita	0.079***	0.029	0.287***	0.034	0.045***	0.024
predicted ratio	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
Abs ln openness	-0.035*	0.003	0.042	0.002	-0.086***	0.011
predicted ratio	(0.02)	(0.03)	(0.04)	(0.03)	(0.02)	(0.03)
Abs Ln bilateral trade	0.183***	0.574***	0.099***	0.603***	0.170***	0.618***
predicted (ij)	(0.00)	(0.02)	(0.01)	(0.03)	(0.01)	(0.03)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.571	0.230	0.697	0.221	0.545	0.235
N	14243	68847	4986	58968	10513	63312
Log-likelihood	-20562.58	5810.605	-6204.702	4018.496	-15918.54	4406.19
Root Mean Square Error	1.026	0.222	0.843	0.226	1.102	0.226

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

Table 4. Emissions pollution gap and specific agreements

VARIABLES	Matched
Effect_EU	-0.141***
	(0.03)
Effect_Euro-Med	-0.251***
	(0.03)
Effect_NAFTA	-0.513**
	(0.22)
Abs Ln population ratio	0.798***
	(0.01)
Abs Ln land per capita ratio	0.088***
	(0.01)
Abs Ln GDP per capita predicted ratio	0.0783***
	(0.01)
Abs ln openness predicted ratio	-0.045**
	(0.02)
Abs Ln bilateral trade predicted (ij)	0.187***
	(0.00)
Constant	-2.390***
	(0.11)
Time Fixed Effects	Yes
R-squared	0.573
Observations	14243
Log-likelihood	-20539
Root Mean Square Error	1.025

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

Table 5. Emissions and economic integration for RTAs with and without environmental provisions (EP)

Effect on Total Emissions	All RTAs	RTAs with EP	RTAs without EP
RTA	-.000317*	-.00306**	-.000747
	(0.000)	(0.001)	(0.001)
Ln population	.818	.8 00	.835
	(1.213)	(1.237)	(1.225)
Ln land per capita	-.799	-.754	-.785
	(1.191)	(1.217)	(1.204)
Ln GDP per capita predicted	.830***	.833***	.829***
	(0.107)	(0.105)	(0.107)
Ln Openness predicted	-.0754	-.0812	-.0696
	(0.102)	(0.102)	(0.104)
N	2227	2227	2227
R-squared	0.707	0.712	0.707

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

Figures

Figure 1. Kernel density of the log of bilateral distance for pair-wise countries without and with an RTA

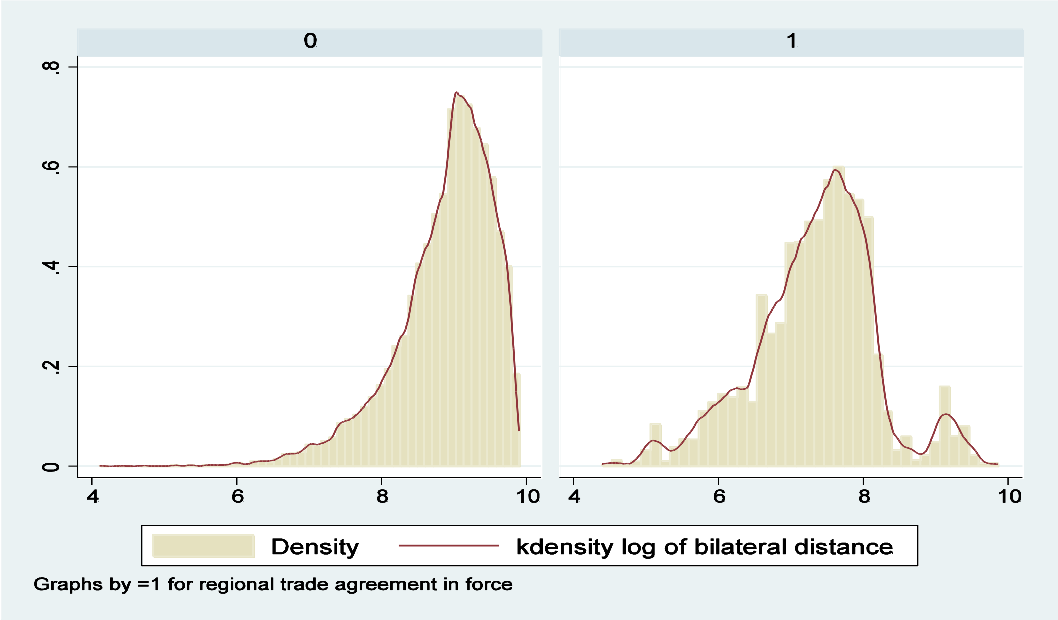
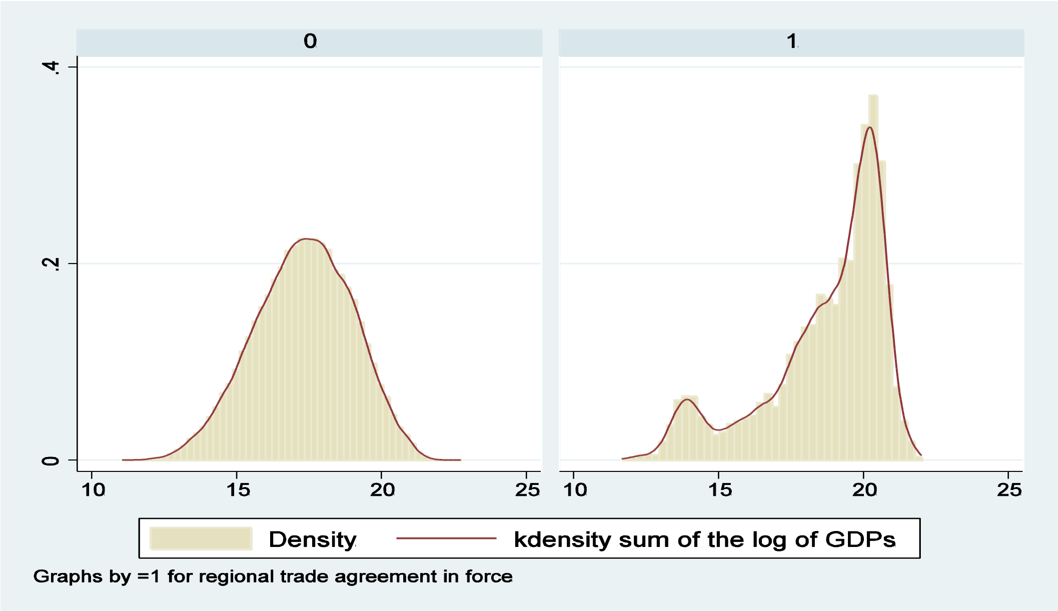


Figure 2. Kernel density of the sum of the log of GDPs pair-wise countries without and with an RTA



Appendix

Table A.1. List of RTA types and dates they came into force

RTA Name	Type	Date of entry into force
Andean Community (CAN)	CU	25-May-88
Armenia - Kazakhstan	FTA	25-Dec-01
Armenia - Moldova	FTA	21-Dec-95
Armenia - Russian Federation	FTA	25-Mar-93
Armenia - Turkmenistan	FTA	07-Jul-96
Armenia - Ukraine	FTA	18-Dec-96
ASEAN - China	PSA & EIA	01-Jan-2005(G) / 01-Jul-2007(S)
ASEAN Free Trade Area (AFTA)	FTA	28-Jan-92
Asia Pacific Trade Agreement (APTA)	PSA	17-Jun-76
Asia Pacific Trade Agreement (APTA) - Accession of China	PSA	01-Jan-02
Australia - New Zealand (ANZCERTA)	FTA & EIA	01-Jan-1983(G) / 01-Jan-1989(S)
Australia - Papua New Guinea (PATCRA)	FTA	01-Feb-77
Canada - Chile*	FTA & EIA	05-Jul-97
Canada - Costa Rica*	FTA	01-Nov-02
Canada - Israel	FTA	01-Jan-97
Caribbean Community and Common Market (CARICOM)	CU & EIA	01-Aug-1973(G) / 04-Jul-2002(S)
Central American Common Market (CACM)	CU	04-Jun-61
Central European Free Trade Agreement (CEFTA) 2006	FTA	01-May-07
Chile - China*	FTA & EIA	01-Oct-2006(G) / 01-Aug-2010(S)
Chile - Costa Rica (Chile - Central America)	FTA & EIA	15-Feb-02
Chile - El Salvador (Chile - Central America)	FTA & EIA	01-Jun-02
Chile - Japan*	FTA & EIA	03-Sep-07
Chile - Mexico*	FTA & EIA	01-Aug-99
China - Hong Kong, China	FTA & EIA	29-Jun-03
China - Macao, China	FTA & EIA	17-Oct-03
Common Economic Zone (CEZ)	FTA	20-May-04
Common Market for Eastern and Southern Africa (COMESA)*	CU	08-Dec-94
Commonwealth of Independent States (CIS)	FTA	30-Dec-94
Costa Rica - Mexico*	FTA & EIA	01-Jan-95
Dominican Republic - Central America - United States Free Trade Agreement (CAFTA-DR)	FTA & EIA	01-Mar-06
East African Community (EAC)	CU	07-Jul-00
EC (10) Enlargement	CU	01-Jan-81
EC (12) Enlargement	CU	01-Jan-86
EC (15) Enlargement	CU & EIA	01-Jan-95
EC (25) Enlargement	CU & EIA	01-May-04
EC (27) Enlargement	CU & EIA	01-Jan-07
EC (9) Enlargement	CU	01-Jan-73
EC Treaty	CU & EIA	01-Jan-58
Economic and Monetary Community of Central Africa (CEMAC)*	CU	24-Jun-99
Economic Community of West African States (ECOWAS)	CU	24-Jul-93
Economic Cooperation Organization (ECO)	PSA	17-Feb-92
EFTA - Chile	FTA & EIA	01-Dec-04
EFTA - Croatia	FTA	01-Jan-02
EFTA - Egypt	FTA	01-Aug-07
EFTA - Former Yugoslav Republic of Macedonia	FTA	01-May-02
EFTA - Israel	FTA	01-Jan-93
EFTA - Jordan	FTA	01-Sep-02
EFTA - Korea, Republic of	FTA & EIA	01-Sep-06
EFTA - Lebanon	FTA	01-Jan-07
EFTA - Mexico	FTA & EIA	01-Jul-01
EFTA - Morocco	FTA	01-Dec-99
EFTA - Palestinian Authority	FTA	01-Jul-99
EFTA - SACU	FTA	01-May-08
EFTA - Singapore	FTA & EIA	01-Jan-03

EFTA - Tunisia	FTA	01-Jun-05
EFTA - Turkey	FTA	01-Apr-92
EFTA accession of Iceland	FTA	01-Mar-70
Egypt - Turkey	FTA	01-Mar-07
EU - Albania	FTA & EIA	01-Dec-2006(G) / 01-Apr-2009(S)
EU - Algeria	FTA	01-Sep-05
EU - Andorra	CU	01-Jul-91
EU - Bosnia and Herzegovina	FTA	01-Jul-08
EU - Chile	FTA & EIA	01-Feb-2003(G) / 01-Mar-2005(S)
EU - Croatia	FTA & EIA	01-Mar-2002(G) / 01-Feb-2005(S)
EU - Egypt	FTA	01-Jun-04
EU - Faroe Islands	FTA	01-Jan-97
EU - Former Yugoslav Republic of Macedonia	FTA & EIA	01-Jun-2001(G) / 01-Apr-2004(S)
EU - Iceland	FTA	01-Apr-73
EU - Israel	FTA	01-Jun-00
EU - Jordan*	FTA	01-May-02
EU - Lebanon	FTA	01-Mar-03
EU - Mexico	FTA & EIA	01-Jul-2000(G) / 01-Oct-2000(S)
EU - Montenegro	FTA & EIA	01-Jan-2008(G) / 01-May-2010(S)
EU - Morocco	FTA	01-Mar-00
EU - Norway	FTA	01-Jul-73
EU – Overseas Countries and Territories (OCT)	FTA	01-Jan-71
EU - Palestinian Authority	FTA	01-Jul-97
EU - South Africa	FTA	01-Jan-00
EU - Switzerland - Liechtenstein	FTA	01-Jan-73
EU - Syria	FTA	01-Jul-77
EU - Tunisia*	FTA	01-Mar-98
EU - Turkey	CU	01-Jan-96
Eurasian Economic Community (EAEC)	CU	08-Oct-97
European Economic Area (EEA)	EIA	01-Jan-94
European Free Trade Association (EFTA)	FTA & EIA	03-May-1960(G) / 01-Jun-2002(S)
Faroe Islands - Norway	FTA	01-Jul-93
Faroe Islands - Switzerland	FTA	01-Mar-95
Georgia - Armenia	FTA	11-Nov-98
Georgia - Azerbaijan	FTA	10-Jul-96
Georgia - Kazakhstan	FTA	16-Jul-99
Georgia - Russian Federation	FTA	10-May-94
Georgia - Turkmenistan	FTA	01-Jan-00
Georgia - Ukraine	FTA	04-Jun-96
Global System of Trade Preferences among Developing Countries (GSTP)	PSA	19-Apr-89
Gulf Cooperation Council (GCC)	CU	01-Jan-03
Iceland - Faroe Islands	FTA & EIA	01-Nov-06
India – Bhutan	FTA	29-Jul-06
India – Singapore	FTA & EIA	01-Aug-05
India - Sri Lanka	FTA	15-Dec-01
Israel – Mexico	FTA	01-Jul-00
Japan - Malaysia*	FTA & EIA	13-Jul-06
Japan - Mexico*	FTA & EIA	01-Apr-05
Japan – Singapore	FTA & EIA	30-Nov-02
Jordan – Singapore	FTA & EIA	22-Aug-05
Korea, Republic of – Chile	FTA & EIA	01-Apr-04
Korea, Republic of - Singapore*	FTA & EIA	02-Mar-06
Kyrgyz Republic – Armenia	FTA	27-Oct-95
Kyrgyz Republic – Kazakhstan	FTA	11-Nov-95
Kyrgyz Republic – Moldova	FTA	21-Nov-96
Kyrgyz Republic - Russian Federation	FTA	24-Apr-93
Kyrgyz Republic – Ukraine	FTA	19-Jan-98
Kyrgyz Republic – Uzbekistan	FTA	20-Mar-98
Lao People's Democratic Republic - Thailand	PSA	20-Jun-91
Latin American Integration Association (LAIA)	PSA	18-Mar-81

Melanesian Spearhead Group (MSG)	PSA	01-Jan-94
Mexico - El Salvador (Mexico - Northern Triangle)	FTA & EIA	15-Mar-01
Mexico - Guatemala (Mexico - Northern Triangle)	FTA & EIA	15-Mar-01
Mexico - Honduras (Mexico - Northern Triangle)	FTA & EIA	01-Jun-01
Mexico – Nicaragua	FTA & EIA	01-Jul-98
New Zealand – Singapore	FTA & EIA	01-Jan-01
North American Free Trade Agreement (NAFTA)*	FTA & EIA	01-Jan-94
Pacific Island Countries Trade Agreement (PICTA)	FTA	13-Apr-03
Pakistan – China	FTA & EIA	01-Jul-2007(G) / 10-Oct-2009(S)
Pakistan – Malaysia	FTA & EIA	01-Jan-08
Pakistan - Sri Lanka	FTA	12-Jun-05
Panama - Chile*	FTA & EIA	07-Mar-08
Panama - Costa Rica (Panama - Central America)	FTA & EIA	23-Nov-08
Panama - El Salvador (Panama - Central America)	FTA & EIA	11-Apr-03
Panama – Singapore	FTA & EIA	24-Jul-06
Pan-Arab Free Trade Area (PAFTA)	FTA	01-Jan-98
Protocol on Trade Negotiations (PTN)	PSA	11-Feb-73
Singapore – Australia	FTA & EIA	28-Jul-03
South Asian Free Trade Agreement (SAFTA)	FTA	01-Jan-06
South Asian Preferential Trade Arrangement (SAPTA)	PSA	07-Dec-95
South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA)	PSA	01-Jan-81
Southern African Customs Union (SACU)	CU	15-Jul-04
Southern African Development Community (SADC)	FTA	01-Sep-00
Southern Common Market (MERCOSUR)	CU & EIA	29-Nov-1991(G) / 07-Dec-2005(S)
Thailand – Australia	FTA & EIA	01-Jan-05
Thailand - New Zealand	FTA & EIA	01-Jul-05
Trans-Pacific Strategic Economic Partnership*	FTA & EIA	28-May-06
Turkey – Albania	FTA	01-May-08
Turkey - Bosnia and Herzegovina	FTA	01-Jul-03
Turkey – Croatia	FTA	01-Jul-03
Turkey - Former Yugoslav Republic of Macedonia	FTA	01-Sep-00
Turkey – Israel	FTA	01-May-97
Turkey – Morocco	FTA	01-Jan-06
Turkey - Palestinian Authority	FTA	01-Jun-05
Turkey – Syria	FTA	01-Jan-07
Turkey – Tunisia	FTA	01-Jul-05
Ukraine – Azerbaijan	FTA	02-Sep-96
Ukraine – Belarus	FTA	11-Nov-06
Ukraine - Former Yugoslav Republic of Macedonia	FTA	05-Jul-01
Ukraine - Kazakhstan	FTA	19-Oct-98
Ukraine - Moldova	FTA	19-May-05
Ukraine - Russian Federation	FTA	21-Feb-94
Ukraine - Tajikistan	FTA	11-Jul-02
Ukraine - Uzbekistan	FTA	01-Jan-96
Ukraine -Turkmenistan	FTA	04-Nov-95
US - Australia*	FTA & EIA	01-Jan-05
US - Bahrain	FTA & EIA	01-Aug-06
US - Chile*	FTA & EIA	01-Jan-04
US - Israel	FTA	19-Aug-85
US - Jordan*	FTA & EIA	17-Dec-01
US - Morocco*	FTA & EIA	01-Jan-06
US - Singapore*	FTA & EIA	01-Jan-04
West African Economic and Monetary Union (WAEMU)	CU	01-Jan-00

Source: World Trade Organization. http://www.wto.org. Trade agreements tables include only agreements in our sample. PSA denotes Partial Scope Agreement, FTA denotes Free Trade Agreement, CU denote Customs Union and EIA denotes Economic Integration Agreement. *RTAs with environmental provisions.

Table A.2. List of countries

All countries				
Albania	Czech Republic	Japan	Paraguay	United Kingdom
Algeria	Denmark	Jordan	Peru	United States
Angola	Djibouti	Kazakhstan	Philippines	Uruguay
Antigua and Barbuda	Dominica	Kenya	Poland	Venezuela, RB
Argentina	Dominican Republic	Kiribati	Portugal	Vietnam
Armenia	Ecuador	Korea, Rep.	Qatar	Yemen, Rep.
Australia	Egypt, Arab Rep.	Kuwait	Russian Federation	
Austria	El Salvador	Kyrgyz Republic	Rwanda	
Azerbaijan	Eritrea	Latvia	Saudi Arabia	
Bahrain	Estonia	Lebanon	Senegal	
Bangladesh	Ethiopia	Lithuania	Seychelles	
Belarus	Fiji	Luxembourg	Sierra Leone	
Belgium	Finland	Macedonia, FYR	Slovak Republic	
Belize	France	Madagascar	Slovenia	
Benin	Gabon	Malawi	South Africa	
Bhutan	Gambia, The	Malaysia	Spain	
Bolivia	Georgia	Maldives	Sri Lanka	
Botswana	Germany	Mali	St. Kitts and Nevis	
Brazil	Ghana	Malta	St. Lucia	
Brunei Darussalam	Greece	Mauritania	St. Vincent and the Grenadines	
Bulgaria	Grenada	Mauritius	Sudan	
Burkina Faso	Guatemala	Mexico	Suriname	
Burundi	Guinea	Moldova	Swaziland	
Cambodia	Guinea-Bissau	Mongolia	Sweden	
Cameroon	Guyana	Morocco	Switzerland	
Canada	Haiti	Mozambique	Syrian Arab Republic	
Cape Verde	Honduras	Namibia	Tajikistan	
Central African Republic	Hong Kong SAR, China	Nepal	Tanzania	
Chile	Hungary	Netherlands	Thailand	
China	Iceland	New Zealand	Togo	
Colombia	India	Nicaragua	Tonga	
Comoros	Indonesia	Niger	Trinidad and Tobago	
Congo, Rep.	Iran, Islamic Rep.	Norway	Tunisia	
Costa Rica	Ireland	Oman	Turkey	
Cote d'Ivoire	Israel	Pakistan	Uganda	
Croatia	Italy	Panama	Ukraine	
Cyprus	Jamaica	Papua New Guinea	United Arab Emirates	

Table A.2. List of countries (Continued)

South Mediterranean	Europe
Algeria	Austria
Egypt	Belgium
Israel	Bulgaria
Jordan	Cyprus
Lebanon	Czech Republic
Morocco	Denmark
Tunisia	Estonia
Turkey	Finland
	France
	Germany
	Greece
	Hungary
	Ireland
	Italy
	Latvia
	Lithuania
	Luxembourg
	Malta
	Netherlands
	Poland
	Portugal
	Romania*
	Slovak Republic
	Slovenia
	Spain
	Sweden
	UK

*Romania was dropped because of missing values in the data

Table A.3. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
lCO2_ratio	61945	2.616	1.919	0	12.306
rta_ever	61945	0.226	0.418	0	1
after_rta	61945	0.940	0.237	0	1
effect_rta	61945	0.184	0.388	0	1
Abs Ln population ratio	61945	1.987	1.559	2.93E-06	10.257
Abs Ln land per capita ratio	61945	1.554	1.232	0.00004	8.342
Abs Ln GDP per capita predicted ratio	61945	1.835	1.320	0.00004	5.951
Abs Ln Openness predicted ratio	61945	0.837	0.608	7.22E-06	3.676
Abs Ln bilateral trade predicted (ij)	61945	17.147	2.005	9.435	26.579

Table A.4. Matching Statistics

		Mean			
Variable	**Sample**	**Treated**	**Control**	**Bias (%)**	**Reduction in bias (%)**
Ln distance	Unmatched	7.73373	8.8641	-197.6	57.3
	Matched	7.73373	7.9891	-84.4	
Ln $(GDP_i * GDP_j)$	Unmatched	18.648	17.311	70.4	69.4
	Matched	18.648	18.24	21.5	
Common Language	Unmatched	0.26049	0.15088	27.4	13.6
	Matched	0.26049	0.16576	23.7	
Contiguity	Unmatched	0.13524	0.00905	50.3	28.0
	Matched	0.13524	0.04435	36.2	