DO PTAS WITH ENVIRONMENTAL PROVISIONS REDUCE GHG EMISSIONS? DISTINGUISHING THE EFFECTIVENESS OF CLIMATE-RELATED PROVISIONS

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Do PTAs with environmental provisions reduce GHG emissions? Distinguishing the effectiveness of climate-related provisions

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Abstract

This paper assesses the effectiveness on climate change mitigation of the environmental-related commitments contained in preferential trade agreements (PTAs). The starting question is does any PTA with environmental provisions reduce emissions? Because of a lack of detailed data on PTAs, the academic literature on the role of PTAs with environmental provisions (PTAwEP) in global climate governance remains limited. A novel and detailed database identifying nearly 300 different types of environmental provisions from more than 680 PTAs since 1947 allows us to distinguish the PTAs with climate-related provisions (PTAwCP) from those with provisions related to other environmental issues. Using panel data covering 165 countries over the period 1995 to 2012, controlling for endogeneity issues, our main result shows that PTAwCP statistically reduce the emissions while the effect of PTAs with provisions related to other environmental issues remains a negative but not significant on emissions. Our results suggest that it is rather the specific climate-related provisions in PTAwEP that positively affect the environmental quality. Thus, to be effective in terms of mitigating climate change, PTAwEP should contain climate-related commitments.

Keywords: Preferential trade agreements, Climate-related provisions, Environmental policy, Greenhouse gases, Global warming, Climate change.

JEL Classification: F13, F18, Q51, Q54

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1. Introduction

The impact of international trade on the environment has been the subject of numerous studies. One strand of this literature is how trade flows affect the environment. Since the first analysis of the overall impact of trade on the environment (Grossman and Krueger, 1991), the influence of trade on environmental quality has been investigated repeatedly (e.g., Antweiler et al., 2001; Cole and Elliot, 2003; Copeland and Taylor, 2005; Frankel and Rose, 2005; Grether et al., 2009; Levinson, 2009; Managi et al., 2009; Lovely and Popp, 2011; Brunel and Levinson, 2016; Nemati et al., 2016). Another way to study the multiple and complex relationships between trade and the environment is to assess the effect of preferential trade agreements (PTAs) on pollutant emissions. Studies published so far suggest that this effect depends on whether environmental provisions are included in the agreement (e.g. Baghdadi et al., 2013; Zhou et al., 2017; and Martínez-Zarzoso and Oueslati, 2018).

The effects of trade liberalized by PTAs on environmental quality appear to occur through three mechanisms: (1) a scale effect, whereby increased economic activity leads *ceteris paribus* to increased emissions; (2) a composition effect, or changes in specialization and hence emission patterns; (3) a technological effect, leading to cleaner production processes through increased income and technology transfer.[1]

Since the Uruguay Round (concluded in the mid-1990s), the world economy has seen an increase in the number of PTAs. At 124 before 1995, the number of PTAs has increased rapidly, reaching 646 notifications at the end of 2016 (Sorgho, 2018). The most common goal of PTAs is to reduce

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[1] For a recent discussion and a literature review on the subject, see Cherniwchan et al. (2017).

if not eliminate tariffs, quotas and other restrictions on goods and services traded between the partner nations. However, more recent PTAs include, in addition to wide-ranging economic and commercial rules, a full-length chapter devoted entirely to environmental protection with precise and enforceable obligations, in particular commitment to maintaining environmental standards, the right to enact environmental legislation, address climate change issues and implementation of multilateral environmental agreements (Morin et al. 2017).

How effectively PTAs mitigate climate change continues to be debated. Some critics argue that PTAs ultimately weaken national environmental standards, that environmental provisions (EPs) are mere “fig leafs” included to sanitize the trade agreements in the eyes of the public and legislators (Berger et al., 2017) or even tools of “green protectionism” against cheaper products from developing countries. The proponents of PTAs insist on the potential of EPs for improving environmental protection, making the agreements more compatible with environmental and climate policies (Berger et al., 2017), playing a role in articulating new environmental norms (Morin et al., 2017), exporting environmental policies (Jinnah and Lindsay, 2016), dealing with trade-related aspects of climate change mitigation such as border-tax adjustments on pollutant-emitting production processes, fossil fuel subsidies, and trade in carbon credits (Morin and Jinnah, 2018). Through EPs, PTAs can help spread cleaner technologies that improve production standards and decrease greenhouse gas (GHG) emissions. The PTA with EPs is thus viewed as potentially contributing to climate-oriented governance (e.g., OECD, 2007; Whalley, 2011; Leal-Arcas, 2013; Gehring et al., 2013; van Asselt, 2017). By systematically including climate-related provisions in its PTAs, a government signals its position on climate change issues. Indeed, a positive relationship has been observed between international obligations on specific environmental issue areas and domestic environmental legislation in these same areas (see George and Yamaguchi, 2018; Brandi et al., 2019). A government signing a PTA with EPs sends a signal to businesses operating in its jurisdiction that incorporation of international commitments on the environment or climate into domestic law may be imminent and that they should therefore act early to adopt environmentally friendly technologies and practices. This is one way that PTAs with EPs (PTAwEP) can lead to lower emissions of pollutants and hence improvement of the quality of the environment.

Empirical research on the contribution of PTAs to global climate-driven governance remains scant (Morin and Jinnah, 2018). Indeed, to the best of our knowledge, few empirical studies have investigated the environmental effects of PTAs as opposed to the effect of trade openness.[2] The first empirical study of the impact of PTAs on the environment (Ghosh and Yamarik, 2006) was followed by only three articles on the effects of PTAs with EPs on pollution levels or environmental outcomes (Baghdadi et al., 2013; Zhou et al., 2017; and Martínez-Zarzoso and Oueslati, 2018). We describe their findings in detail in Section 2 below.

The expected improvement in environmental quality by reduction of emissions following the signing of PTAs is based on the presumption that EPs in the agreement will encourage trading partners to apply and enforce more stringent environmental regulations (Martínez-Zarzoso, 2018). However, the effects estimated in previous studies are averages for all types of agreements, which may include very different EP emphasis, for example biodiversity, desertification, hazardous waste, forestry, GHG emissions, or ozone depletion, while others only mention the environment in the investment chapters (see OECD, 2007). This raises the question of whether all EPs or only

[2] Other articles (e.g., Yu et al., 2011; Stern, 2007; Logsdon and Husted, 2000; Grossman and Krueger, 1991) focus on the environmental effects (e.g., energy consumption) of a specific trade agreement (e.g., the North American Free Trade Agreement - NAFTA) at the national level (e.g., United States or Mexico).

those with climate-related provisions (CPs) have an impact on GHG emissions. The intention of CPs is clearly to address climate change by mitigating GHG emissions. Since fine details on PTA provisions are difficult to obtain, distinguishing the specific role of climate-related provisions from the overall impact of PTAs with EPs in mitigating GHG emissions has not been attempted until now. This is the main contribution of the present article.

A novel and detailed database ("TRade and ENvironment Database" – TREND) identifying nearly 300 different types of environmental provisions from more than 680 PTAs since 1947 allows us to establish per country and per year the number of signed PTAs with EPs containing climate-related provisions. We distinguish two types of agreement: (i) those with climate-related provisions, and (ii) those with provisions related to other environmental issues. Making this distinction allows us to assess whether there is a causal relationship between climate-related commitments included in PTAs and GHG emissions from the signatory countries.

Our main finding is that after controlling for scale, technological and composition effects and considering income, trade and PTA endogeneity, PTAs with climate-related provisions (PTAwCP) are associated statistically with reductions in per capita GHG emissions, namely carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Furthermore, it is specifically the CPs included in the PTA that have a positive impact on environmental quality. This evidence suggests that to be effective in terms of climate change mitigation, the environmental provisions negotiated in PTAs should contain specific climate-related commitments.

The rest of this article is structured as follows: In section 2, we review the published literature on the relationship between PTAs and environmental quality. The heterogeneous nature of environmental provisions contained in PTAs is discussed in section 3. Our analytical framework and data are presented in section 4, followed by the estimation strategy and results in section 5. Our concluding remarks appear in section 6.

2. Literature review

In this section, we summarize the main published literature on the effect of PTAs on the environment. The principal findings of these studies along with their data and empirical strategies are summarized in Table 1. Our investigation is based on this literature.

Estimations of environmental degradation that could result from PTAs have been proposed based on an empirical model that considers trade and economic growth and distinguishes direct and indirect effects on the environment (Ghosh and Yamarik, 2006). The effect of increasing trade and growth is considered indirect. Based on measurements of atmospheric suspended particulate matter, SO_2, NO_2 and CO_2, deforestation, energy depletion and water pollution associated with resource consumption as proxies of environmental degradation and using OLS in combination with the instrumented variable technique to estimate the endogeneity of GDP and trade for 151 countries in 1995, PTAs appear to have an indirect effect but no direct effect on pollution. However, the cross-sectional data used in this study do not allow consideration of dynamics or controls for unobserved country-specific and time-invariant factors. Nor do they allow distinction between PTAs with or without EPs. This could explain the ambiguous results obtained.

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Table 1. Summary of studies of the impact of PTAs on the environment

Authors	Variables studied	Data and source	Environmental indicators	Empirical strategy	Main results
Martínez-Zarzoso and Oueslati (2018)	- Summed number of trading partners (*j*) that each country (*i*) has in its PTA - Types of EPs are not distinguished	- Cross section of countries (mainly 23 OECD + 6 BRIICS) from 1999 to 2011 - Extending to 173 countries over the period 1990–2011 - PTAs from the WTO	- Particulate matter with a diameter < 2.5 (PM2.5) - Sulfur dioxide (SO_2) - Nitrogen dioxide (NO_2) - Carbon dioxide (CO_2) - Nitrogen oxide (NO_x)	- Endogeneity of income, trade, RTA - OLS combined with instrumented variables - Difference GMM	- Countries signing PTAs with EPs have lower PM2.5, SO_2, NO_x and CO_2 - PM2.5 of the partners in a PTA with EPs tend to converge.
Zhou et al. (2017)	- As a dummy: equal to 1 if country *i* has a PTA in effect in year t, otherwise 0 - Types of EPs are not distinguished	- Panel data for 136 countries from 2001 to 2010 - Information on PTAs from the WTO database	- Particulate matter with a diameter < 2.5 (PM2.5)	- Endogeneity of GDP, trade openness and PTA addressed - PSM approach combined with DiD - OLS combined with instrumented variables	- PTAs without EPs tend to worsen PM2.5 - PTAs with EPs lead to lower PM2.5 - Convergence of PM2.5 between PTA contracted parties
Baghdadi et al. (2013)	- Summed number of trading partners (*j*) that each country (*i*) has in its PTA - PTAs with EPs or not are distinguished - Types of EPs are not distinguished	- Cross-section of 182 countries over the period 1980 to 2008 - PTA data from De Sousa (2012) and WTO website	- Carbon dioxide	- Endogeneity of trade, income growth and RTA addressed - Propensity score matching approach is combined with DiD techniques	- PTAwEP reduce domestically CO_2 - Not the case in PTAw/oEP - CO_2 of the pairs of countries belonging to a PTA with EPs tend to converge. - CO_2 seem to diverge for participation in PTAs that do not include EPs
Ghosh and Yamarik (2006)	- The current number of PTA signatories - PTAs with or without EPs are not distinguished	- Cross-sectional data for 162 countries in 1990 - Only 17 PTAs are considered	- Particulate matter (PM) - Sulfur dioxide (SO_2) - Nitrogen dioxide (NO_2) - Carbon dioxide (CO_2) - Deforestation, - Energy depletion - Water pollution	- OLS estimation - Instrumenting of endogeneity of trade and income	- No direct effect of PTAs on environment - PTA impact on the environment via trade and income

Later studies (Baghdadi et al., 2013; Zhou et al., 2017; Martínez-Zarzoso and Oueslati, 2018) were built on the modelling strategy described above, first by treating trade, GDP growth and PTA membership as endogenous variables, and secondly by assuming that if a direct positive effect of PTAs on the environment does exist, it should be found empirically only for agreements that include specific environmental provisions in the main text or in environmental appendices. The empirical estimations in these articles also distinguished between PTAs with environmental provisions from those without such provisions. They showed that a direct positive effect on the environment does exist in the latter case.

Baghdadi et al. (2013) analyzed the impact of PTAs with and without EPs on CO_2 emissions. They focus on per capita GDP and trade endogeneity, and the PTA variable. To consider endogeneity, instrumental variables were used, whereas matching combined with the difference-in-difference (DiD) method was used for PTA. The sample covered 182 countries over the period of 1980 to 2008. It was thus found that PTAs reduce CO_2 emissions domestically and lead to a convergence of CO_2 emissions across pairs of countries if they include EPs.

In another comparison of PTAs with and without EPs (Zhou et al., 2017), PM2.5 concentrations were examined, which were arguably a better indicator of pollution than gross CO_2 emissions.[3] Covering 136 countries over a period of 10 years, this empirical analysis focused on instrumental variables such as GDP endogeneity, trade openness, PTA, and the convergence of PM2.5 concentrations by combining DiD with propensity score matching to consider the potential selection bias of PTAs with environmental provisions. It was thus shown that PM2.5 concentrations

[3] PM2.5 is defined as fine inhalable particles with diameters generally 2.5 micrometers or smaller.

increase where PTAs without environmental provisions are signed but decrease when such provisions are included, and that concentrations converge between the signatory countries.

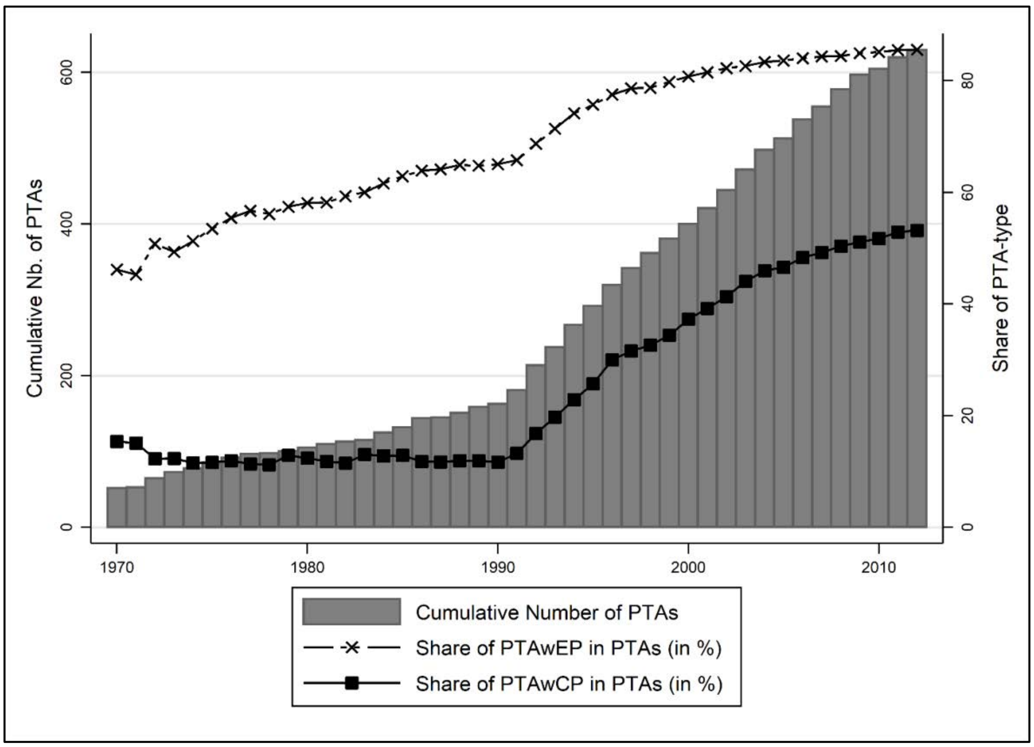
The effect of environmental provisions in PTAs on particulate concentrations in 173 countries from 1990 to 2011 has been analyzed using an instrumental approach to deal with the endogeneity of the variables (Martínez-Zarzoso and Oueslati, 2018). Based on a previous model (Baghdadi et al., 2013) with controls for national environmental regulations, it was again found that PTAs with environmental provisions were associated with lowering of PM2.5 concentrations and other emissions (SO_2, NO_x and CO_2), and as was found for CO_2 emissions (Baghdadi et al., 2013), PM2.5 concentrations tended to converge in the pairs of countries that were participating in a PTA with environmental provisions.

The summary in Table 1 allows us to compare the approaches adopted in the different studies and to see how the analyses evolved. The first article introduced the idea of the existence of an effect of PTAs on the environment. The next three articles improved the analysis by distinguishing the effects of agreements with and without environmental provisions. However, the types of EPs were not distinguished. In our analysis, we allow for the possibility that climate change provisions have their own specific effects.

3. Heterogeneity of PTAs with environmental provisions

In previous studies of the effect of PTAs on environmental quality, the EPs included in the agreements were very heterogeneous, some being very detailed whereas others described only general objectives. Such detail is provided systematically in the Trade & Environment Database (TREND) created and managed within a Canada Research Chair in International Political Economy at Laval University in Canada.[4] This database is based on the Design of Trade Agreements (DESTA) project, a PTA compilation used in numerous previous studies but which only specifies the presence or not of environmental provisions. We were thus able to identify provisions related to the climate change issues *versus* other environmental issues.

Figure 1. Growth in the number of preferential trade agreements worldwide



Source: Authors, created with data from "TRade and ENvironment Database" – TREND.
Note: PTAwEP means PTAs with environmental provisions; PTAwCP means PTAs with climate-related provisions. The term "cumulative PTAs" means the number of PTAs effective in year *t* (including existing agreements and agreements that became effective in year *t*).

[4] TREND is a free access database. Since 2018, the complete dataset has been available here and a dyadic version is now available here. For more information on TREND, see Morin, Dür and Lechner (2018). Moreover, in collaboration with the German Development Institute (DIE), an online analytical tool has been created to allow users to explore the TREND database: www.TRENDanalytics.info. For more information on the DESTA Project and access to its database: https://www.designoftradeagreements.org/

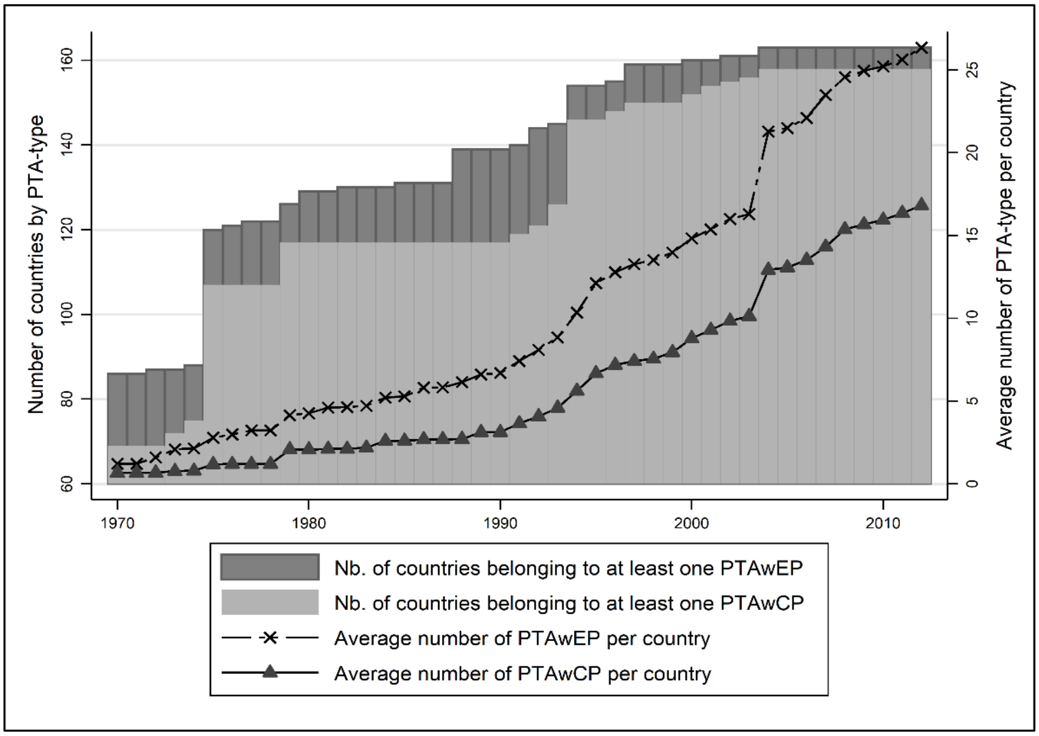
Examination of TREND reveals nearly 300 different types of environmental provisions contained in 730 PTAs from 1947 to 2018. Due to the limited availability of emissions data, we narrowed our study to the period 1995 to 2012.[5] Among the 630 PTAs signed up to 2012, 539 included at least one EP. In terms of emphasis, these EPs were grouped into eight categories: biodiversity, water, waste, fisheries, forest, dessert, ozone, and climate change, as found previously (Morin and Jinnah, 2018). Among the 539 agreements, 335 (62%) contained at least one provision addressing the question of climate change.

As Figure 1 shows, since 1970 the share of bilateral and regional PTAs negotiated with comprehensive environmental elements has increased. In 1970, more than 50 per cent of all PTAs contained EPs. By 2012, this had passed 85 per cent. Some included provisions addressing climate change. This type of provision was not common prior to 1990, appearing in about 18 per cent of the total number of PTAs then signed. By 2012, this share had reached about 55 per cent.

In this article, we analyze the impact of different types of PTA with EPs on putative climate change mitigation, based on reductions of GHG emissions including CO_2, CH_4 and N_2O, the emissions believed most responsible for global warming, a major element of climate change. This is the first article to focus explicitly on the climate-related provisions included in PTAs and hence to distinguish between these and environmental provisions other than climate-related. We are thus investigating whether the effects on GHG emissions attributed to PTAs with EPs in previous studies are due to specific national commitments on climate change.

[5] For data on GHG emissions, we use the Emissions Database for Global Atmospheric Research (EDGAR), release EDGAR v4.3.2 (1970 - 2012) of March 2016: http://edgar.jrc.ec.europa.eu [Accessed June 05, 2018].

Figure 2. Distribution of PTAs with environmental and climate-related provisions



Source: Authors, created with data from "TRade and ENvironment Database" – TREND.
Note: PTAwEP means PTAs with environmental provisions; PTAwCP means PTAs with climate-related provisions.

Figure 2 shows the evolution of the average numbers of signed PTAs with environmental and climate-related provisions. The number of countries participating in agreements that include at least one climate change provision is clearly increasing, which presumably reflects increasing awareness of the climate change issue. Conspicuous jumps occurred in 1975 and 1994, the former due likely to the Generalized System of Preferences, adopted in 1968 under the auspices of the UNCTAD, which provided a formal system of exemption from the more general rules and resulted in the USA and other industrialized countries signing PTAs preferentially with developing nations (Sorgho and Tharakan, 2018). The second jump may have been by the structural change of the multilateral trading system brought about by the creation of the World Trade Organization in 1995. Since 2008, nations participate on average in at least 15 PTAs with CPs, versus less than 5 in 1995.

Many PTAs address climate change issues explicitly with clauses more specific and restrictive than those found in multilateral environmental agreements. More than 50 agreements include innovative climate provisions more specific and enforceable than those proposed in the Kyoto Protocol or the Paris Agreement. As mentioned above, there is evidence of a positive and significant direct link between signing PTAs with many comprehensive EPs and introducing more environmental legislation nationally (see George and Yamaguchi, 2018; Brandi et al., 2019).[6]

4. Analytical framework and data

4.1. Analytical framework

To estimate the potential impact of climate change commitments on the environment, we used the following empirical model:

$$\log\left(Em_{it}^{g}\right)=\begin{bmatrix}\alpha_0+\alpha_1\log\left(Em_{it-1}^{g}\right)+\alpha_2\log\left(Open_{it}\right)+\alpha_3\log\left(Popdens_{it}\right)\\ +\alpha_4\log\left(GDPcap_{it}\right)+\alpha_5 Reg_{it}^{pta}+FE_t+FE_i+\varepsilon_{it}\end{bmatrix} \qquad (1)$$

where Em_{it}^{g} denotes per capita emissions of each pollutant (g = CO_2, CH_4, or N_2O) from country *i* at period *t.* A dynamic model of the evolution of environmental quality is obtained using a first-order autoregressive process as given in (1). Since *"...changes in explanatory variables, such as trade openness, at a specific point in time would also influence emissions after the current period. This indicates that there is an adjustment process and that the short- and long-term effects of trade*

[6] In principle, the relationship between environmental or climate-related provisions and national environmental legislation could be bidirectional. A country with stronger environmental protection is more likely to integrate EPs into its trade agreements. However, the empirical methodology adopted here allows us to control for this.

on emissions are different" (Managi et al. (2009) p. 354), studies on the relationship between trade and emissions are presumed to require an autoregressive model. Furthermore, the Prob>F associated with the Wooldridge test for autocorrelation is < 0.05 in our case, suggesting rejection of the null hypothesis (see Wooldridge, 2002).[7] The error term in period (t) is related to the error of the previous (t-1) period. The dependent variables therefore display a first-order autocorrelation, and the lag (t-1) of the dependent variable (i.e., Em^{g}_{it-1} for the per capita emissions from country *i* at period *t-1*) must be included in the model. The dependent variable and its lag are measured in kilograms of each emission per capita.

As well established in the empirical literature on trade policy and environment (e.g., Copeland and Taylor, 2005; Frankel and Rose, 2005; Managi et al., 2009; Baghdadi et al., 2013; Zhou et al., 2017; Cherniwchan et al., 2017; Martínez-Zarzoso and Oueslati, 2018), our model controls for scale, technique, and composition effects to assess the effect of climate provisions on GHG emissions. It thus includes the usual determinants of emissions such as population density, per capita GDP, and trade openness.

The variable ($Open_{it}$), defined as the sum of trade (exports + imports) divided by GDP, captures some of the potential direct effect of trade openness on environmental quality. It serves as proxy for the composition effect, and its effect on environmental quality could be either positive or negative. The variable $\left(Popdens_{it}\right)$ accounts for the population density, measured as the average number of inhabitants per square kilometer (km^2) in country *i* in year *t*. Population density is a

[7] It consists to compute the Wooldridge's test for first order serial correlation of residuals in panel models. The null hypothesis (H0) is: "No serial correlation of order one".

proxy for the 'scale effect' and is expected to have a negative impact on the environment. Since an economy of scale exists for pollutant emissions, a higher number of inhabitants per km² can lead to lower emissions per capita.[8] The control variable $\left(GDPcap_{it}\right)$, defined as GDP per capita in constant US dollars in country *i* in year *t*, serves as a proxy for the 'technological effect'. Time-fixed effects $\left(FE_{t}\right)$ are added to capture linear time-trend effects (see Martínez-Zarzoso and Oueslati, 2018) and country fixed effects $\left(FE_{i}\right)$ to control for country-associated time-invariant factors. The term ε_{it} represents measurement error.

The 'interest' variable Reg_{it}^{pta} measures the willingness of country i (in year *t*) to deal with climate change, its coefficient being proportional to the effect of the PTA on emissions. It is defined as the total number of PTAs with environment-related commitments or with specific climate-related commitments of country *i* in year *t.* Instead of using a simple dummy variable to specify environmental versus climatic provisions (as in Zhou et al., 2017), we consider multi-commitments through these different PTAs as a proxy of the willingness of a country to deal with climate change issues. The number of environmental or climate provisions is thus incorporated into estimations by equation 1 as described previously (Ghosh and Yamarik, 2006). In other studies, the interest

[8] The relationship between population density and pollutant concentration is not defined clearly in the literature. The sign of this correlation depends on the type of pollutant and the formula used for calculating the population density (number of inhabitants per km^2 or land area per capita in km^2). For example, analyzing the effect of population density (as population per km^2) on urban air pollution in Germany, Borck and Schrauth (2021) find that the NO_2 concentration increases with population density while the O_3 concentration decreases. Measuring the population density as land area per capita, Baghdadi et al. (2013) find an insignificant coefficient for the relationship between population density and per capita emissions of CO_2.

variable is weighted using the number of trading partners (j) with which country (i) has signed a PTA (Baghdadi et al., 2013; Martínez-Zarzoso and Oueslati, 2018).

4.2. Data description

The sources of the dataset constructed for this study and the statistics for the covariates used are summarized in Table 2 and Table 3. The 164 countries are listed in Appendix C.[9]

Table 2. Descriptive statistics for variables used into our main model (equation 1)

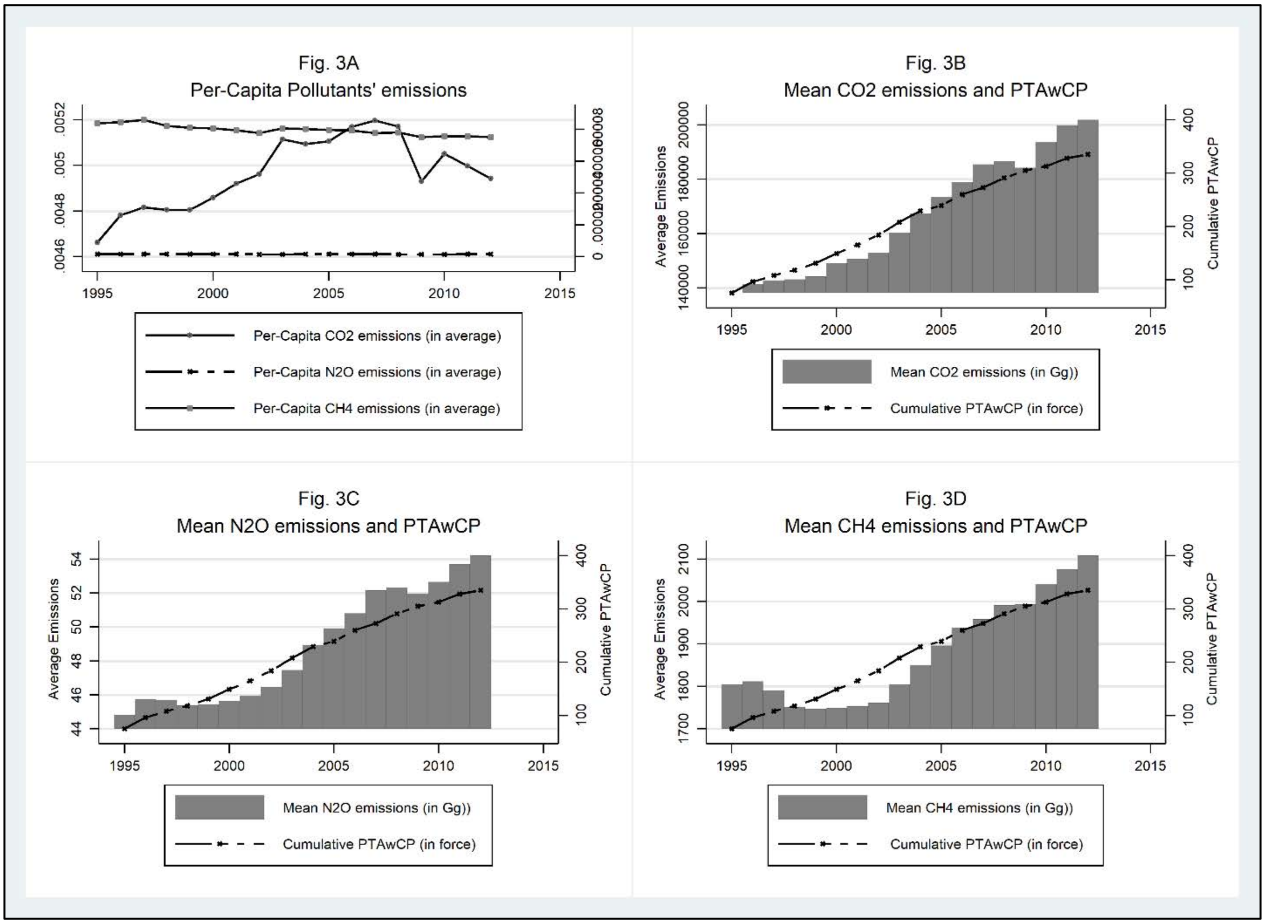
	Obs.	Mean	S.D.	Min.	Max.	Source
Emissions of CO_2 in gigagrams	2952	166337.4	686148.9	13.791	9918456	EDGAR
Emissions of CH_4 in gigagrams	2952	1878.82	5462.892	0.0700	66296.83	
Emissions of N_2O in gigagrams	2952	48.84334	156.3949	0.0017	1762.989	
Nb. of PTAs with environmental provisions	2952	19.07205	23.73095	0	100	TREND
Nb. of PTAs without environmental provisions	2952	2.413131	2.746141	0	15	
Nb. of PTAs with climate change provisions	2952	11.60438	12.68798	0	62	
Nb. of PTAs without climate change provisions	2952	7.467677	11.64987	0	46	
Area in square kilometers (km^2)	2952	780958.7	2048573	316	$1.71e^{+07}$	WDI
Population	2952	$3.77e^{+07}$	$1.35e^{+08}$	17255	$1.35e^{+09}$	

Source: Data are from the European Union Emissions Database for Global Atmospheric Research (EDGAR), the World Bank World Development Indicators (WDI), and the Université Laval TRade and ENvironment Database (TREND). S.D. is standard deviation.

Average emissions of pollutants began to accelerate in the year 2000, with CO_2 (Fig. 3B), and N_2O (Fig. 3C) increasing proportionally to the number of agreements containing climate provisions, while CH_4 (Fig. 3D) remained less than proportional to the number of these agreements. However, no clear pattern of the possible causal relationship between GHG emissions per country and the number of climate provision PTAs signed emerges conclusively from Figure 3.

[9] The study was implemented using a data panel of 164 countries over 18 years (164 x 18 = 2,952 observations).

Figure 3. Evolution of greenhouse gas emissions and PTAs with climatic provisions



Source: "TRade and ENvironment Database", and Emissions Database for Global Atmospheric Research (EDGAR).
Note: PTAwCP means PTAs with climate-related provisions. The term "cumulative PTAwCP" means the number of PTAwCP in effect in year *t* (including new agreements having become effective in that year).

Figure 3 shows that N_2O pollution per capita is more stable than CO_2 and CH_4 emissions and that per capita emissions of CH_4 have declined since 1997. The per capita CO_2 emissions began to decrease in 2008 after increasing until 2007. Between 1995 and 2000, average emissions per country were relatively stable despite the large number of PTAs with climate provisions, suggesting that this type of PTA is not the only determinant of GHG emissions.

Gross domestic product (GDP), land area and population data are from World Development Indicators (WDI).[10] PTA with climate provisions data are from the TRade and ENvironment Database. A previous definition of PTA (Morin and Jinnah, 2018) was used with manual coding of climate provisions. The elements of these provisions are described in Appendix B

5. Estimation strategy and results

5.1. Pre-treatment for the endogeneity problem

As emphasized in the literature, the variables "GDP" and "trade openness" may be determined endogenously together with environmental regulation (e.g., Martínez-Zarzoso and Oueslati, 2018; Zhou et al., 2017; Baghdadi et al., 2013; Managi et al., 2009; Frankel and Rose, 2005).[11] In addition, covariates such as trade (trade openness) and production (GDP) may contribute simultaneously to regulatory stringency and our dependent variable "pollutant emissions" (Brunel and Levinson, 2016). We therefore first define these using a set of instrumental variables.

An income equation (2) derived from the growth-empirics literature was used to instrument GDP for each country, based on predicted values of income (GDP_{it}). An OLS model was run to regress GDP on overall trade $\left(Trade_{it}\right)$, investment $\left(Inv_{it}\right)$ calculated as the stock of inward foreign

[10] All values are in 2005 constant US dollars.

[11] The correlation matrix in Table A1 suggests that all explanatory variables in equation 1 are not exogenous, e.g., "per capita GDP", and "trade openness" are highly correlated with our interest variable (number of PTA with CP).

direct investment, population (Pop_{it}) and human capital $\left(Sch_{it}\right)$ approximated by school enrolment. With an error term (υ_{it}), the income equation is given by:

$$\log\left(GDP_{it}\right)=\left[\omega_0+\omega_1\log\left(Trade_{it}\right)+\omega_2\log\left(Inv_{it}\right)+\omega_3\log\left(Pop_{it}\right)+\omega_4\log\left(Sch_{it}\right)+FE_t+\upsilon_{it}\right] \qquad (2)$$

Data on Foreign direct investments (FDIs) are from the UNCTAD database.[12] School enrollment data[13] are from the WDI database. The variable $Trade_{it}$ represents the sum of exports and imports over all its trade partners *j* for a country *i* at time *t*: $Trade_{it}=\sum_j Export_{ijt}+\sum_j Imports_{ijt}$. Trade data are from the UN COMTRADE database. After using equation 2, GDP is predicted for each country in year *t* (denoted GDP_{it}).[14]

To the estimate national "trade openness", we ran a pair-wise gravity model (equation 3) that predicts aggregate bilateral trade, an instrumentation approach that addresses the above-mentioned endogeneity and simultaneity problems (e.g. Milllinet and Roy, 2016). The value of $Open_{it}$ is calculated by dividing the predicted total trade by the predicted GDP in year *t*. Predicted total trade ($\widehat{T}_{it}$) also comes from equation 3. The gravity approach to instrumenting the "trade openness" variable has been described previously (e.g., Baghdadi et al., 2013; Frankel and Romer, 1999). A

[12] See UNCTAD Stat: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?sCS_ChosenLang=fr [Accessed June 5, 2018].

[13] Average educational attainment was computed as described in Barro and Lee (2013) as an index ranging from 0 to 1 where 1 represents 16 years of education.

[14] As the predicted values of GDP directly obtained from the OLS estimation (equation 2) are in logarithmic form, we transform them by taking their exponential in order to have the predicted values needed.

PPML gravity model predicts bilateral trade between two partners based on GDP, population, and geographical distance between them [15]. Dummy variables indicating common borders and language are also used.

$$T_{ijt} = \begin{bmatrix} \eta_0 + \eta_1 \log\left(dist_{ij}\right) + \eta_2 \log\left(GDP_{it}\right) + \eta_3 \log\left(GDP_{jt}\right) + \\ \eta_4 \log\left(Pop_{it}\right) + \eta_5 \log\left(Pop_{jt}\right) + \eta_6 CB_{ij} + \eta_7 CL_{ij} + FE_t + \pi_{ijt} \end{bmatrix} \tag{3}$$

Where T_{ijt} denotes bilateral trade (exports *plus* imports) between partners *i* and *j* during period *t.* GDP and population (*Pop*) values were obtained from the WDI database. Gravity dummy variables are defined as follows: CB_{ij} equals to 1 if the countries share a common border, otherwise 0; CL_{ij} equals to 1 if the countries share a common official language, otherwise 0. Border and linguistic status as well as distance were obtained from the *Centre d'Études Prospectives et d'Informations Internationales* (CEPII) database. Time fixed effects $\left(FE_t\right)$ factor represents the trend over time, and π_{ijt} is an error term. Predicted bilateral trade $\widehat{T}_{ijt}$ values are aggregated to obtain predicted total trade $\widehat{T}_{it}$ for each country in year *t,* in other words: $\widehat{T}_{it} = \sum \widehat{T}_{ijt}$.

[15] The PPML estimator has been suggested to compensate for heteroscedasticity and the zero problem frequently encountered in trade data (Silva and Tenreyro, 2006). In our case, unlike the OLS model, the PPML gravity model gives the predicted values in directly usable (not logarithmic) form.

Table 3. Descriptive statistics of variables used in the treatment of the endogeneity problem

	Obs.	Mean	S.D.	Min.	Max.	Source
Total imports (yearly)	2952	376483.9	3852653	0	$1.78e^{+08}$	COMTRADE
Total exports (yearly)	2952	383011	4102908	0	$1.88e^{+08}$	
Stock FDI - at current prices (in millions of $US)	2952	67770.03	251437.1	0.26	3915538	WDI
Pop. at age 15+ with secondary schooling (in %)	2952	23.92534	15.49427	0.68	71.8	
GDP in US dollars	2952	$2.76e^{+11}$	$1.13e^{+12}$	$7.66e^{+07}$	$1.62e^{+13}$	
Bilateral distance (in km)	2952	7234.95	4185.477	213.126	19475.95	CEPII
Dummy for sharing a common official language	2952	0.135017	0.341799	0	1	
Dummy for sharing a common border (contiguity)	2952	0.020875	0.142991	0	1	

Source: The UNCTAD database (COMTRADE), World Bank World Development Indicators (WDI), Université Laval TRade and ENvironment Database (TREND), and *Centre d'Études Prospectives et d'Informations Internationales* (CEPII). S.D. is standard deviation.

The additional variables used to treat the endogeneity problem are presented in Table 3. The results obtained using equations 2 and 3 are reported in Tables A2 and A3 (Appendix A). All estimated coefficients are statistically significant with the expected sign (based on the literature). In addition, based on R^2 for both equations, the variables used in the models explain more than 80% of the observed variance. These statistics show that the correct covariates were chosen.

Finally, instead of their observed values, we used the instrumented variables "trade openness" and "per capita income", that is, predicted income per capita ($GDPcap_{it}$) calculated as predicted GDP divided by the population, and predicted "trade openness" ($Open_{it}$) calculated as predicted total trade divided by predicted GDP, by which equation 1 becomes:

$$\log\left(Em_{it}^{g}\right)=\left[\begin{array}{l}\alpha_0+\alpha_1\log\left(Em_{it-1}^{g}\right)+\alpha_2\log\left(Open_{it}\right)+\alpha_3\log\left(Popdens_{it}\right)\\+\alpha_4\log\left(GDPcap_{it}\right)+\alpha_5 Reg_{it}^{pta}+FE_t+FE_i+\varepsilon_{it}\end{array}\right] \quad (4)$$

5.2. Estimation methods and results

Environmental quality was modeled using two dynamic panel methods. Instead of a first-difference generalized method of moments (GMM) estimator (proposed by Arellano and Bond (1991) and used by Martínez-Zarzoso (2018) and Martínez-Zarzoso and Oueslati (2018)), we used the system GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998), which contains an additional set of level moment conditions as well as difference moment conditions to estimate dynamic panel data, whereas the difference GMM estimator uses moment conditions from the estimated first differences of the error term. Our benchmark results are system GMM estimates that compensate for heteroskedasticity.[16] The difference estimator is inadequate when model errors are heteroskedastic (see Windmeijer, 2005) and when time-invariant regressors are used (see Blundell and Bond, 1998).[17] This could explain the unexpected findings of statistically significant negative coefficients for PTAs without environmental provisions (Martínez-Zarzoso, 2018; Martínez-Zarzoso and Oueslati, 2018).[18] When the endogenous variable is very persistent or follows an almost random path, these instrumented variables become weak predictors of

[16] The White test for heteroscedasticity shows a chi-square probability of less than 0.05, meaning that the null hypothesis of constant variance can be rejected with 95% confidence, and implies the presence of heteroscedasticity in the residuals. We also report estimations using the difference GMM approach. The results are similar even though estimates are slightly higher than those of the system approach (see Table A4).

[17] Windmeijer (2005) proposes using the two-step GMM estimator (a first-step estimation to obtain the estimation error covariance matrix) to correct for model error heteroskedasticity. In the case of time-invariant regressors in the model, the system GMM estimator rather than the difference GMM estimator is proposed (see Arellano and Bover, 1995; Blundell and Bond, 1998).

[18] See also Baghdadi et al., 2013 and Zhou et al., 2017.

endogenous changes, making the Arellano-Bond difference GMM unsuitable (Blundell and Bond, 1998).

Using the system GMM, the lagged dependent variable (Em_{it-1}^{g}) and the variables related to a PTA (Reg_{it}^{pta}) are considered as endogenous variables while "population density", time dummy variable (years 1996 to 2012) and the lagged differences of the endogenous variables are considered as instruments.[19] All GMM estimations are carried out using the xtabond2 package in Stata (see Roodman, 2009). Specific instrumental variables are validated using the Hansen test of over-identifying restrictions (results are reported in GMM estimates tables).[20] For robustness, we also report estimates using the panel data method of Baier and Bergstrand (2007) as implemented by Martínez-Zarzoso and Oueslati (2018).

Instrumental variable estimation proposed by Anderson and Hsiao (1982) as a solution when the strict exogeneity assumption is violated was later found to be asymptotically inefficient by Arellano and Bond (1991), who proposed a more efficient estimation procedure using moment conditions in which lags of the dependent variable and first differences of the exogenous variables are instruments for the first-differenced equation. This empirical strategy allows us to determine if the effects of PTAs with climatic provisions are found similar regardless of whether system GMM or

[19] The excluded instruments are population density and time dummy variables, which are also included in the GMM specification (see Roodman, 2009). Our system GMM estimation reproduces fundamentally a version of regression 4 proposed in Table 4 of Blundell and Bond (1998). (Roodman, 2009, p. 43)

[20] Under the null hypothesis, all instruments are uncorrelated with the error term, the test has a large sample $\chi 2$ (r) distribution where r is the number of over-identifying restrictions, that is, the number of excluded instruments minus the number of endogenous variables. Rejection of the null hypothesis means that the instruments used are valid.

panel data techniques are used to query them.[21] After using instrumental variables to address the endogeneity of the income and trade variables, both estimation methods allow us to address potential endogeneity and reverse causality[22] of our target variable directly in the environmental impact model. Results are reported for the following three specifications:

- 1: the effects of all PTAs with environmental provisions (PTAwEP)
- 2: the effects of PTAs with climate-related provisions (PTAwCP)
- 3: the effects of PTAs with and without climate provisions, simultaneously.

Given that in the Specification 1 we introduce simultaneously PTAwEP and PTAs without environmental provisions (PTAw/oEP), this specification allows us to compare our results to previous studies, even if these used a measure of the PTA-effect which is slightly different. In these previous studies, the measure is a weighted average of the PTAs where the weights are the emissions. Specifications 2 and 3 are our main contributions. These seek to show that the impact of environmental provisions on climate change issues is heterogeneous, by separating agreements with and without climate-related provisions and then isolating the impact of the latter on GHG emissions and testing for sensitivity by including both types conjointly. In all three specifications, we add the PTAw/oEP which is expected to have a positive sign. PTAwEP and PTAwCP are both

[21] The test for fixed effects suggests including time and country in the model. Based on the associated Prob>F being < 0.05, the null hypothesis that the coefficients for all years or all countries jointly equal zero is rejected. Time and country are therefore introduced as fixed effects in the robustness estimation. However, only the time effect will be included in the GMM estimation since our system GMM model considers unobserved country-specific components.

[22] In other words, if we know that accumulating PTAs with EPs may lead to a cleaner environment, a country seeking to improve its environmental quality may also be eager to negotiate such agreements.

expected to have a positive sign. The sign for PTAs without climate-related provisions (PTAw/oCP) is expected to be either significantly positive, or negative but not significant.

Table 4. Results of system GMM estimates of the impact of trade agreements on greenhouse gas emissions

	Specification 1			Specification 2			Specification 3		
	CO_2 em.	CH_4 em.	N_2O em.	CO2 em.	CH_4 em.	N_2O em.	CO_2 em.	CH_4 em.	N_2O em.
Lag of per capita emissions	0.8862*** (0.0062)	0.8892*** (0.0061)	0.7627*** (0.0112)	0.8904*** (0.0058)	0.8822*** (0.0064)	0.7380*** (0.0120)	0.8880*** (0.0056)	0.8846*** (0.0058)	0.7409*** (0.0101)
Trade openness (instrumented)	0.00009 (0.0002)	0.0001* (0.0000)	0.00009 (0.0000)	0.00007 (0.0000)	0.0001** (0.0000)	-0.00007 (0.0000)	0.0001 (0.0002)	0.0003** (0.0001)	0.0004** (0.0002)
Number of PTAs w/o EPs	0.0194*** (0.0017)	0.0206*** (0.0011)	0.0255*** (0.0021)	0.0187*** (0.0013)	0.0158*** (0.0008)	0.0270*** (0.0018)	0.0126*** (0.0022)	0.0029* (0.0015)	0.0083*** (0.0024)
Number of PTAs with EPs	-0.0016*** (0.0001)	-0.0024*** (0.0000)	-0.0019*** (0.0001)	–	–	–	–	–	–
Number of PTAs w/o CPs	–	–	–	–	–	–	0.0004 (0.0004)	0.0029*** (0.0003)	0.0023*** (0.0004)
Number of PTAs with CPs	–	–	–	**-0.0034*** (0.0001)**	**-0.0027*** (0.0019)**	**-0.0039*** (0.0002)**	**-0.0024*** (0.0002)**	**-0.0035*** (0.0001)**	**-0.0032*** (0.0002)**
Pop. density (inhabitants/km²)	-0.0016* (0.0008)	-0.0258*** (0.0000)	-0.0576*** (0.0030)	0.00003 (0.0008)	-0.0279* (0.0019)	-0.0620*** (0.0032)	-0.0023*** (0.0008)	-0.0304*** (0.0017)	-0.0631*** (0.0026)
Per-capita GDP (instrumented)	0.0240*** (0.0018)	0.0076*** (0.0011)	0.0036*** (0.0013)	0.0187*** (0.00185)	0.0059*** (0.0012)	0.0010 (0.0014)	0.0246*** (0.0018)	0.0116*** (0.0012)	0.0151*** (0.0015)
Constant	-1.1387** (0.4507)	-0.4230 (0.3493)	-1.9154** (0.8460)	-1.1236*** (0.3903)	-0.8046* (0.4207)	-2.1954** (1.0455)	-1.1649** (0.4599)	-0.9014** (0.3934)	-3.0158*** (1.1023)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.994	0.990	0.983	0.995	0.991	0.979	0.995	0.992	0.967
Nb. of observations	2773	2773	2773	2773	2773	2773	2773	2773	2773
Nb. of countries	164	164	164	164	164	164	164	164	164
AR (1)	-7.18***	-5.30***	-3.41***	-7.33***	-5.21***	-3.34***	-7.10***	-5.31***	-3.32***
AR (2)	-0.73	-0.25	-0.58	-0.79	-0.26	-0.60	-0.75	-0.15	-0.60
Hansen Test (Prob.)	0.248	0.195	0.146	0.217	0.156	0.242	0.145	0.118	0.328

Notes: Bootstrapped standard errors, in parentheses, are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals. Asterisks indicate significance (***1% level, **5%, and *10%). The variables "trade openness" and "per capita GDP" are instrumented as predicted values. Time fixed effects are not reported. EP means environmental provisions. CP means climate-related provisions. Variables of interest: PTAs with CP = PTA – PTA without EPs – PTAs without CPs = PTAs with EPs – PTA without CPs.

The GMM results are shown in Table 4 and the fixed-effect general least squares robustness test results are shown in Table 5. As reported in Tables 4, results on AR-tests (i.e., the non-significance of the hypothesis of no second-order autocorrelation) show that there is no serial correlation in the error term and our GMM estimations are valid. All Hansen tests are statistically insignificant with $p < 1$. The null hypothesis (H0) cannot be rejected. The instruments used to address the endogeneity of the PTA variable are also valid. The coefficient of the lagged dependent variable using GMM lies between that obtained with fixed effects and OLS.[23] These results overall confirm that the use a dynamic model for our discussion of the impact of climate-related provisions is justified.

Regarding the control variables, the lagged emissions terms are statistically significant with a positive sign and their values are less than unity in all specifications. Except for CO_2 in specification 2, the "population density" coefficients estimated for CH_4 and N_2O are significant with the expected sign in all specifications. All estimated "per capita GDP" coefficients are significant with the expected sign, except for N_2O in specification 2 where it is non-significant. Higher per capita income has a positive impact on GHG emissions, confirming the strong correlation between economic output and air pollution.

Except for the negative and insignificant coefficient for N_2O in specification 2, all estimated "trade openness" coefficients have the expected sign. The positive coefficient indicates that openness to trade tends potentially to increase GHG emissions. However, trade openness does not appear to have a statistically significant impact on national CO_2 emissions. Moreover, its impact on N_2O emissions is inconclusive: only in specification 3 is the coefficient positive and significant. The

[23] We thank the Editor for this suggestion.

non-significant effect of "trade openness" might be indicating that the effects of PTAs with environmental or climate provisions on trade are ambiguous. This echoes with Brandi et al. (2020) who found that a participation to PTAwEP could be potentially harmful for the trade of some products, and while at the same time increase the trade of other products.

We controlled for the effects of PTAs without EPs when estimating the effects of EPs. The effect of EPs on CO_2 emissions has been estimated by considering their presence and absence in separate estimations (Baghdadi et al., 2013). When considering them jointly in the same estimation, a significant coefficient (-0.004) has been found for EPs, while another insignificant (-0.001) has been found in their absence (Martínez-Zarzoso and Oueslati, 2018). We found coefficients of -0.0016 for EPs and 0.019 for PTAs without EPs (Table 4).

A positive coefficient for PTAs without EPs is intuitive since these agreements would be expected to increase trade between countries without constraining emissions. In previous studies (Martínez-Zarzoso and Oueslati, 2018; Zhou et al., 2017; Baghdadi et al., 2013), the environmental effect of PTAw/oEP was inconclusive: it was either positive but no significant or significantly negative.

Specification 2, with estimated coefficients of -0.0034 for CO_2 emissions, -0.0027 for CH_4 emissions, and -0.0039 for N_2O emissions under agreements with climate provisions, yields results similar to those of specification 3, in which effects of PTAs with and without CPs were assessed separately in the same equation.[24] These results indicate, *ceteris paribus*, that entering into a PTA

[24] Since PTAs with CPs and those without CPs are two disjoint sets constituting the set of PTAs with EPs, climate-related provisions are in fine environmental provisions, and PTAs without CPs are PTAs with EPs but not climate-focused, in summary: with EP = with CPs + without CPs. Thus, PTAs without CPs = with EPs – with CPs.

with CPs reduces per capita emissions on average by 0.24 – 0.34% for CO_2 (399.21 – 565.54 Gg), by 0.27 – 0.35% for CH_4 (5072.81 – 6575.87 Mt), and by 0.32 – 0.39% for N_2O (156.29 – 190.48 Mt).[25] Moreover, in specification 3, the coefficients for PTAs with EPs other than climate-related are positive and statistically significant, except for CO_2 emissions. Climate-related provisions in PTAs thus can be expected to have an overall positive impact on environmental quality. It also underlines that a PTA with EP not targeting climate change issues specifically leads to an increase in pollutant emissions per capita, and for CH4 in the same amount as a PTAw/oEP.

Robustness was tested by running equation 4 using the fixed effects-GLS method (Baier and Bergstrand, 2007).[26] The results shown in Table 5 were obtained for the three specifications described above.

[25] Yearly average emissions per country are 166,337.4 Gg of CO_2, 1878.82 Gg of CH_4 and 48.84 Gg of N_2O. To convert to grams or to metric tons: 1 gigagram (Gg) = 10^9 grams (g) = 10^3 metric tons (Mt).

[26] We ran a model with time dummy variables where the disturbance term is first-order autoregressive, as described previously (Martínez-Zarzoso and Oueslati, 2018). The Stata command used is *xtreg* for AR(1) with inclusion of the lagged dependent variable as explanatory variable. To choose between fixed effects and random effects for estimation, the Hausman test was used, which tests the null hypothesis of no correlation between errors and regressors. The p value was lower than 0.05. In specification 3, CO_2 emissions gave a p value of 0.0000, meaning that the null hypothesis should be rejected and that a fixed effects model should be used.

Table 5. Results of fixed effects-GLS regression with AR (1) disturbances

	Specification 1			Specification 2			Specification 3		
	CO_2	CH_4	N_2O	CO2	CH_4	N_2O	CO_2	CH_4	N_2O
Lag of per-capita emissions	0.8277*** (0.0031)	0.8831*** (0.0023)	0.7945*** (0.0051)	0.8240*** (0.0029)	0.8828*** (0.0024)	0.7934*** (0.0049)	0.8224*** (0.0028)	0.8790*** (0.0024)	0.7880*** (0.0054)
Trade openness (instrumented)	0.0001* (0.0000)	0.00006 (0.0000)	0.0004*** (0.0000)	0.00032*** (0.0000)	0.00008 (0.0000)	0.0001 (0.0000)	0.0003*** (0.0001)	0.00002 (0.0000)	0.0003*** (0.0000)
Number of PTAs without EPs	-0.0012*** (0.0000)	-0.0006*** (0.0000)	-0.0015*** (0.0000)	0.0108*** (0.0005)	0.0043*** (0.0004)	0.0138*** (0.0006)	0.0028*** (0.0006)	-0.0147*** (0.0005)	-0.0079*** (0.0006)
Number of PTAs with EPs	0.0117*** (0.0006)	0.0040*** (0.0004)	0.0151*** (0.0006)	–	–	–	–	–	–
Number of PTAs without CPs	–	–	–	–	–	–	0.0032*** (0.0001)	0.0022*** (0.0001)	0.0023*** (0.0001)
Number of PTAs with CPs	–	–	–	**-0.0024*** (0.0000)**	**-0.0013*** (0.0000)**	**-0.0028*** (0.0001)**	**-0.0041*** (0.0001)**	**-0.0024*** (0.0000)**	**-0.0039*** (0.0001)**
Pop. density (inhabitants/km²)	-0.0763*** (0.0040)	-0.0732*** (0.0038)	-0.1301*** (0.0036)	-0.1056*** (0.0039)	-0.0919*** (0.0032)	-0.1498*** (0.0037)	-0.1067** (0.0047)	-0.0941*** (0.0037)	-0.1586*** (0.0038)
Per capita GDP (instrumented)	0.0087*** (0.0008)	0.0026*** (0.0007)	0.0060*** (0.0006)	0.0079*** (0.0007)	0.0023*** (0.0006)	0.0050*** (0.0004)	0.0076*** (0.0010)	0.0012 (0.0008)	0.0059*** (0.0005)
Constant	-6.5788*** (0.2098)	-8.3765*** (0.1595)	-13.544*** (0.1554)	-6.5415*** (0.2111)	-8.3542*** (0.1604)	-13.458*** (0.1550)	-6.4405*** (0.2118)	-8.3059*** (0.0016)	-13.332*** (0.1544)
Fixed effects: Country and Time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.998	0.9960	0.993	0.998	0.996	0.993	0.998	0.996	0.993
Nb. of observations	2,934	2,934	2,934	2,934	2,934	2,934	2,934	2,934	2,934
Nb. of countries	164	164	164	164	164	164	164	164	164

Notes: Bootstrapped standard errors, in parentheses, are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals. Asterisks indicate significance (***1% level, **5%, and *10%. The variables "trade openness" and "per capita GDP" are instrumented as predicted values. Time fixed effects are not reported. EP means environmental provisions. CP means climate-related provisions. Variables of interest: PTAs with CP = PTA – PTA without EPs – PTAs without CPs = PTAs with EPs – PTA without CPs.

Regarding the PTA variables in the specification 3, except for CH_4 and N_2O emissions associated with agreements not containing environmental provisions (for which we obtained negative and significant coefficients),[27] these results resemble those in Table 4. The fixed effects-GLS estimates for specification 3 support the idea that climate-related commitments led to lowering of per capita emissions of GHG. The estimated coefficients were again negative and statistically significant, -0.0041 for CO_2 emissions, -0.0024 for CH_4 and -0.0039 for N_2O.

4. Concluding remarks

This study investigates whether climate-related commitments in international trade agreements contribute to mitigation of per capita greenhouse gas emissions, specifically CO_2, CH_4 and N_2O, believed responsible for global warming, a major element of climate change. It also answers the question of whether all trade agreements with environmental provisions have an impact on GHG emissions, and how effective they are in terms of emissions reduction, which has not been studied previously because of the scantness of detailed data on PTAs.

Running a simplified model of environmental quality to assess the effect of climate provisions on GHG emissions, controlling for scale, technological and composition effects, and considering income endogeneity and trade variables using instrumental variables with data on 164 countries from 1995 to 2012, we find climate provisions to be associated statistically with reduced GHG

[27] This could be due to the inability of the fixed-effects GLS method to consider country-specific unobservable factors such as domestic regulations in effect. Using the same estimator, Martínez-Zarzoso and Oueslati (2018) cite the missing data for domestic environmental regulation to explain the significant and negative coefficient for PTAw/oEP.

emissions. This confirms that by enforcing the climate-related commitments in their PTAs, governments could potentially contribute to mitigation of global warming.

Our results show that the negative effect of environmental provisions on GHG emissions found in previous studies is driven by the specific climate-related provisions included in these PTAs. They indicate that countries participating in recent PTAs reduce their per capita emissions on average by 0.24–0.34% for CO_2, 0.27–0.35% for CH_4, and 0.32–0.39% for N_2O. Moreover, the effect of climate-specific provisions is stronger than that of provisions covering a range of environmental factors not necessarily related to climate change. The effect of PTAs without climate provisions is positive in the GMM results and significant for CH_4 and NO_2. This is an important result, since it implies that a PTA with EP not focused specifically on climate change can lead to greater per capita GHG emissions or the same methane emissions as under PTAs without EPs. Our robustness analysis confirms the GMM results with some variation in the coefficient magnitudes.

The evidence presented here suggests that to be effective at mitigating climate change, a PTA should contain climate-related commitments. Environmental provisions, though well-intentioned, are not relevant to the reduction of greenhouse gases unless they specifically address these emissions. Our analysis is the first to provide evidence that signing a PTA with climate provisions could play an important role in climate-oriented governance by committing countries to continue emissions abatement efforts. Such commitment should strengthen national regulations related to climate change issues and orient policy towards climate-friendly legislation that affects or modifies the behavior of economic actors, both producers and consumers and thereby substantially mitigates GHG emissions. This is a possible explanation for the empirical results we obtained in this paper. Empirical testing of this hypothesis is a possible direction for future work. This will require data on national legislations related to environment/climate protection to identify countries that have honored their international commitments with domestic legislation.

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Appendix

Appendix A

Table A1. Partial Correlation Matrix

	CO2 per capita	CH4 per capita	N2O per capita	Trade openness	GDP per capita	Nb. of PTAwCP	Nb. of PTAw/oCP	Nb. of PTAwEP	Nb. of PTAw/oEP	Pop. Density
CO2 per capita	1									
CH4 per capita	0.718***	1								
N2O per capita	0.262***	0.215***	1							
Trade openness	0.162***	0.0823***	-0.00752	1						
GDP per capita	0.641***	0.292***	0.343***	0.103***	1					
Nb. of PTAwCP	0.179***	-0.0974***	0.240***	0.103***	0.539***	1				
Nb. of PTAw/oCP	0.198***	-0.0819***	0.273***	0.0863***	0.532***	0.501***	1			
Nb. of PTAwEP	0.209***	-0.0609**	0.295***	0.0633***	0.497***	0.977***	0.973***	1		
Nb. of PTAw/oEP	0.253***	0.0298	0.185***	0.0131	0.370***	0.598***	0.712***	0.669***	1	
Pop. Density	0.0883***	-0.0655***	-0.0479**	0.399***	0.149***	0.0176	-0.0163	0.00142	-0.0669**	1

Notes: *$p < 0.05$; **$p < 0.01$; *** $p < 0.001$. PTAwEP are PTAs with environmental provisions; PTAwCP means PTAwEP containing climate-related provisions; PTAw/oCP means with EP but no provision related to climate change. As shown the partial correlation matrix, PTAwCP and PTAw/oCP are both highly correlated with PTAwEP (r^2 close to 1). However, the effects of PTAwEP, PTAwCP and PTAw/oCP are not the same. The test of equality of regression coefficients on PTAwEP and PTAwCP in specification 1 and 2 respectively gives a p value much smaller than 0.05, meaning that the null hypothesis that PTAwEP and PTAwCP are statistically equal is rejected.

Table A2. Results of the income equation (2)

Dependent variable: Income ("GDP")	
Trade (exports *plus* imports)	0.0302*** (0.0044)
Investment stock	0.5958*** (0.0117)
Population	0.4377*** (0.0136)
Human capital ratio	0.3310*** (0.0236)
Constant	12.6771*** (0.2096)
Fixed effects (time)	Yes
R-squared	0.89
P value (F test of overall significance)	0.0000
Observations	1,816

Notes: Standard error is in parentheses. ***significant at the 1% level. Time fixed effects are not reported. R^2 is high (89%): the observed variance is explained almost entirely by the variables used in the model. The p value (Fisher test of overall significance) is very small: model 2 provides a better fit than the intercept-only model. These statistics show that the adequacy of the equation. The set of explanatory variables fits with model.

Table A3. Results of the gravity equation (3)

Dependent variable: bilateral trade ("exports *plus* imports")	
Log distance (between trading partners)	–0.7079*** (0.0245)
Log population (exporter)	0.0979*** (0.0260)
Log population (importer)	0.0979*** (0.0260)
Log GDP (exporter)	0.7941*** (0.0211)
Log GDP (importer)	0.7941*** (0.0211)
Common language (between trading partners)	0.3288*** (0.0753)
Common border (between trading partners)	0.5132*** (0.0886)
Constant	-25.45718*** (0.6359)
Fixed effects (time)	Yes
R-squared	0.82
P value (F test of overall significance)	0.0000
Observations	487,080

Notes: Standard error is in parentheses. ***significant at the 1% level. Time fixed effects are not reported. R^2 is high (82%): the observed variance is explained almost entirely by the variables used in the model. The p value (Fisher test of overall significance) is very small: model 3 provides a better fit than the intercept-only model. These statistics show that the adequacy of the equation. The set of explanatory variables fits with model.

Table A4. Results of difference GMM estimates

	Specification 1			Specification 2			Specification 3		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Lag of per capita emissions	0.8129*** (0.0474)	0.7616*** (0.0548)	0.5804*** (0.1155)	0.6994*** (0.0754)	0.7546*** (0.0549)	0.4639*** (0.1161)	0.8341*** (0.0443)	0.7568*** (0.0540)	0.4628*** (0.1158)
Trade openness (instrumented)	0.0068 (0.0067)	0.0030 (0.0040)	0.0068 (0.0055)	0.0256 (0.0158)	0.0005 (0.0035)	0.0072 (0.0069)	0.0040* (0.0024)	0.0008 (0.0036)	0.0085 (0.0080)
Number of PTAs without EPs	0.0580*** (0.0141)	0.0408*** (0.0118)	0.0582*** (0.0156)	0.0422*** (0.0112)	0.0153* (0.0079)	0.0462*** (0.0143)	0.0311** (0.0148)	0.0214 (0.0131)	0.0708*** (0.0215)
Number of PTAs with EP	-0.0036*** (0.0008)	-0.0029*** (0.0008)	-0.0040*** (0.0010)	–	–	–	–	–	–
Number of PTAs without CPs	–	–	–	–	–	–	-0.0002 (0.0023)	-0.0013 (0.0019)	-0.0049 (0.0036)
Number of PTAs with CP	–	–	–	**-0.0062*** (0.0013)**	**-0.0022** (0.0009)**	**-0.0058*** (0.0016)**	**-0.0027** (0.0011)**	**-0.0020** (0.0010)**	**-0.0050*** (0.0018)**
Pop. density (inhabitants/km²)	0.0280 (0.0601)	-0.0390 (0.0534)	-0.1036 (0.0986)	0.0241 (0.0826)	-0.0881 (0.0645)	-0.1167 (0.0863)	-0.0259 (0.0430)	-0.0868 (0.0649)	-0.1209 (0.0902)
Per-capita GDP (instrumented)	0.0100 (0.0121)	0.0182* (0.0104)	0.0114 (0.0135)	0.0337** (0.0145)	0.0204* (0.0122)	0.0091 (0.0165)	0.0152 (0.0160)	0.0184 (0.0127)	0.0041 (0.0166)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.653	0.762	0.254	0.608	0.733	0.665	0.599	0.699	0.559
Nb. of observations	2,448	2,448	2,448	2,448	2,448	2,448	2,448	2,448	2,448
Nb. of countries	164	164	164	164	164	164	164	164	164
AR(1)	-7.93***	-4.72***	-3.38***	-6.21***	-4.54***	-3.08***	-8.16***	-4.53***	-3.03***
AR(2)	-0.46	0.28	-0.53	0.41	0.31	-0.56	-0.43	0.30	-0.62
Hansen Test (Prob)	0.239	0.182	0.337	0.998	0.218	0.288	0.639	0.229	0.307

Notes: Standard errors, in parentheses, are robust to heteroskedasticity and arbitrary patterns of autocorrelation within individuals. Asterisks indicate significance (***1% level, **5%, and *10%). The variables "trade openness" and "per capita GDP" are instrumented as predicted values. Time fixed effects are not reported. EP means environmental provisions. CP means climate-related provisions. Variables of interest: PTAs with CP = PTA – PTA without EPs – PTAs without CPs = PTAs with EPs – PTA without CPs.

Appendix B

Categorization of provisions related to climate-oriented governance

(1) PTA provisions related directly to climate change refer to the following concepts:

Promotion of renewable energy; promotion of energy efficiency; cooperation on climate-oriented governance; reduction of GHG emissions; adaptation to climate change; ratification or implementation of the Kyoto protocol; ratification or implementation of UNFCCC; harmonization of climate regulation

(2) PTA provisions related indirectly to climate change refer to the following concepts:

Exception for the conservation of resources; cooperation on environmental matters; should not lower environmental protection; technical assistance; enforcement of environmental measures; public awareness of the environment; improvement of environmental protection; trade in environmental goods; exception to protection against expropriation; air pollution; participation in the adoption of environmental measures; capacity building related to environmental protection; evidence-based environmental measures; assistance related to natural disasters; domestic impact assessment of environmental policies; investment in environmental research; monitoring the state of the environment; differentiated responsibility principle

Source: Provisions encoded in "TRade and ENvironment Database" – TREND

Appendix C

List of countries considered in this study

Albania	Congo	Iran	Namibia	Swaziland
Algeria	Costa Rica	Iraq	Nepal	Sweden
Angola	Croatia	Ireland	Netherlands	Switzerland
Argentina	Cuba	Israel	New Zealand	Syria
Armenia	Cyprus	Italy	Nicaragua	Taiwan
Australia	Czech	Ivory Coast	Niger	Tajikistan
Austria	Denmark	Jamaica	Nigeria	Tanzania
Azerbaijan	Djibouti	Japan	Norway	Thailand
Bahamas	Dominica	Jordan	Oman	Togo
Bahrain	Dominican Rep.	Kazakhstan	Pakistan	Trinidad and Tobago
Bangladesh	Egypt	Kenya	Palau	Tunisia
Barbados	El Salvador	Korea	Panama	Turkey
Belarus	Equatorial Guinea	Kuwait State	Paraguay	Turkmenistan
Belgium	Eritrea	Kyrgyzstan	Peru	Uganda
Belize	Estonia	Lao	Philippines	Ukraine
Benin	Ethiopia	Latvia	Poland	United Arab Emirates
Bhutan	Finland	Lebanon	Portugal	United States of America
Bolivia	France	Lesotho	Puerto Rico	Uruguay
Bosnia and Herzegovina	Gabon	Liberia	Qatar	Uzbekistan
Botswana	Gambia	Lithuania	Romania	Venezuela
Brazil	Georgia	Luxembourg	Russia	Vietnam
Brunei	Germany	Macedonia	Rwanda	Yemen
Bulgaria	Ghana	Madagascar	Sao Tome and Principe	Zambia
Burkina Faso	Great Britain	Malawi	Saudi Arabia	Zimbabwe
Burundi	Greece	Malaysia	Senegal	
Cambodia	Grenada	Mali	Seychelles	
Cameroon	Guatemala	Malta	Sierra Leone	
Canada	Guinea	Mauritania	Singapore	
Cape Verde	Guinea-Bissau	Mauritius	Slovakia	
Central African	Haiti	Mexico	Slovenia	
Chad	Honduras	Moldova	South Africa	
Chile	Hungary	Mongolia	Spain	
China	Iceland	Morocco	Sri Lanka	
Colombia	India	Mozambique	Sudan	
Comoros	Indonesia	Myanmar	Suriname	

Appendix D

List of PTAs with environmental provisions including climate change provisions (CCP)

Trade agreements with climate change provisions	Date of entry into effect	Direct CCP	Indirect CCP
GATT	1947	0	1
France-Tunisia Customs Union Convention	1955	0	1
EC	1957	0	1
Yaoundé I	1963	0	1
Canada-US Automotive Products Trade Agreement (APTA)	1965	0	1
Australia-New Zealand Free Trade Agreement	1965	0	1
Yaoundé II	1969	0	1
EC-Turkey Additional Protocol	1970	0	1
Caribbean Community (CARICOM)	1973	0	1
Lomé I	1975	0	1
Australia-Papua New Guinea	1976	0	1
Lomé II	1979	1	1
Tokyo Codes	1979	0	1
Economic Community of Central African States (ECCAS-CEEAC)	1983	1	1
Australia-New Zealand (ANZCERTA)	1983	0	1
Lomé III	1984	1	1
Israel-US	1985	0	1
Canada-US	1988	0	1
Lomé IV	1989	1	1
EC-Hungary	1991	1	1
EC-Poland	1991	1	1
EC-San Marino	1991	0	1
African Economic Community	1991	1	1
Australia-Papua New Guinea	1991	0	1
Caribbean Community (CARICOM)-Venezuela	1992	0	1
Central European Free Trade Agreement (CEFTA)	1992	0	1
Czech-Slovak Republic EFTA	1992	0	1
Czech Republic-Slovakia	1992	0	1
EC Maastricht	1992	0	1
EFTA-Romania	1992	0	1
European Economic Area (EEA)	1992	1	1
Faroe Islands-Norway	1992	0	1
Faroe Islands-Switzerland	1992	0	1
Finland-Latvia	1992	0	1
North American Free Trade Agreement (NAFTA)	1992	0	1
Faroe Islands-Finland	1992	0	1
Bulgaria-EC	1993	1	1
Bulgaria-EFTA	1993	0	1
Common Market for Eastern and Southern Africa (COMESA)	1993	1	1
Czech Republic-EC	1993	0	1

Czech Republic-Slovenia	1993	0	1
EC-Romania	1993	1	1
EC-Slovakia	1993	1	1
Economic Community Of West African States (ECOWAS)	1993	1	0
Slovakia-Slovenia	1993	0	1
Central American Common Market (CACM) Protocol of Guatemala	1993	0	1
Bolivia-Mexico	1994	0	1
Caribbean Community (CARICOM)-Colombia	1994	0	1
Commonwealth of Independent States (CIS)	1994	0	1
Costa Rica-Mexico	1994	0	1
EC Maastricht (15) Enlargement	1994	0	1
Economic and Monetary Community of Central Africa (CEMAC)	1994	1	0
Group of Three	1994	0	1
Hungary-Slovenia	1994	0	1
Israel-PLO	1994	0	1
Kazakhstan-Ukraine	1994	0	1
Moldova-Romania	1994	0	1
Romania-Slovakia	1994	0	1
Ukraine-Uzbekistan	1994	0	1
WTO Agreements	1994	0	1
Bulgaria-Czech Republic	1995	0	1
Bulgaria-Slovakia	1995	0	1
Czech Republic-Lithuania	1995	0	1
EC-Estonia Europe Agreement	1995	1	1
EC-Israel Euro-Med Association Agreement	1995	1	1
EC-Latvia Europe Agreement	1995	1	1
EC-Lithuania Europe Agreement	1995	1	1
EC-Tunisia Euro-Med Association Agreement	1995	1	0
EC-Turkey	1995	0	1
EFTA-Estonia	1995	0	1
EFTA-Latvia	1995	0	1
EFTA-Lithuania	1995	0	1
EFTA-Slovenia	1995	0	1
Georgia-Ukraine	1995	0	1
Bolivia-MERCOSUR	1996	0	1
Bulgaria-Slovenia	1996	0	1
Canada-Chile	1996	0	1
Canada-Israel	1996	0	1
Chile-MERCOSUR	1996	0	1
Czech Republic-Estonia	1996	0	1
Czech Republic-Israel	1996	0	1
Czech Republic-Latvia	1996	0	1
EC-Morocco Euro-Med Association Agreement	1996	1	0
EC-Slovenia Europe Agreement	1996	1	1

Estonia-Slovakia	1996	0	1
Estonia-Slovenia	1996	0	1
Georgia-Turkmenistan	1996	0	1
Israel-Slovakia	1996	0	1
Kyrgyzstan-Uzbekistan	1996	0	1
Latvia-Slovakia	1996	0	1
Lithuania-Poland	1996	0	1
Lithuania-Slovakia	1996	0	1
Lithuania-Slovenia	1996	0	1
Macedonia-Slovenia	1996	0	1
Southern African Development Community (SADC)	1996	0	1
Croatia-Macedonia	1997	0	1
Croatia-Slovenia	1997	0	1
Czech Republic-Turkey	1997	0	1
EC-Jordan Euro-Med Association Agreement	1997	1	1
EFTA-Morocco	1997	0	1
Estonia-Faroe Islands	1997	0	1
Hungary-Israel	1997	0	1
Israel-Poland	1997	0	1
Latvia-Poland	1997	0	1
Mexico-Nicaragua	1997	0	1
Romania-Turkey	1997	0	1
Slovakia-Turkey	1997	0	1
Bulgaria-Turkey	1998	0	1
Central America-Dominican Republic	1998	0	1
Chile-Mexico	1998	0	1
Chile-Peru	1998	0	1
Estonia-Hungary	1998	0	1
Faroe Islands-Poland	1998	0	1
Hungary-Lithuania	1998	0	1
Israel-Slovenia	1998	0	1
Latvia-Turkey	1998	0	1
Slovenia-Turkey	1998	0	1
Bulgaria-Macedonia	1999	0	1
Central America-Chile	1999	0	1
Andean Community-Brazil	1999	0	1
Cuba-Uruguay	1999	0	1
Cuba-Venezuela	1999	0	1
EC-South Africa	1999	1	1
Eurasian Economic Community (EAEC)	1999	0	1
Guatemala-Mexico	1999	1	1
Hungary-Latvia	1999	0	1
Armenia-Kazakhstan	1999	0	1
Poland-Turkey	1999	0	1

Chile-Cuba	1999	0	1
EC-Switzerland Bilaterals I	1999	0	1
Bolivia-Cuba	2000	0	1
Bosnia/Herzegovina-Croatia	2000	0	1
Caribbean Community (CARICOM)-Cuba	2000	0	1
Colombia-Cuba	2000	0	1
Andean Countries-Argentina	2000	0	1
Cotonou Agreement	2000	1	1
Cuba-Ecuador	2000	0	1
Cuba-Mexico	2000	0	1
Cuba-Paraguay	2000	0	1
Cuba-Peru	2000	0	1
EC-Mexico	2000	0	1
EFTA-Macedonia	2000	0	1
EFTA-Mexico	2000	0	1
Israel-Mexico	2000	0	1
Jordan-US	2000	0	1
Mexico-Northern Triangle	2000	0	1
New Zealand-Singapore	2000	0	1
United States-Vietnam	2000	0	1
Bosnia/Herzegovina-Slovenia	2001	0	1
Bulgaria-Estonia	2001	0	1
Bulgaria-Israel	2001	0	1
Bulgaria-Lithuania	2001	0	1
Canada-Costa Rica	2001	0	1
Caribbean Community (CARICOM) revised	2001	0	1
Croatia-EC	2001	0	1
Croatia-EFTA	2001	0	1
EC-Egypt Euro-Med Association Agreement	2001	1	1
EC-Macedonia-SAA	2001	1	1
EFTA-Jordan	2001	0	1
Gulf Cooperation Council (GCC)	2001	0	1
Israel-Romania	2001	0	1
Macedonia-Ukraine	2001	0	1
Pacific Island Countries Trade Agreement (PICTA)	2001	0	1
Tajikistan-Ukraine	2001	0	1
Albania-Macedonia	2002	0	1
Bosnia/Herzegovina-Macedonia	2002	0	1
Bosnia/Herzegovina-Moldova	2002	0	1
Bosnia/Herzegovina-Serbia/Montenegro	2002	0	1
Bosnia/Herzegovina-Turkey	2002	0	1
Brazil-Mexico	2002	0	1
Bulgaria-Latvia	2002	0	1
Algeria-EC Euro-Med Association Agreement	2002	1	1

Central America-Panama	2002	0	1
Chile-EC	2002	1	1
Croatia-Macedonia (amended)	2002	0	1
Croatia-Serbia-Montenegro	2002	0	1
EC-Lebanon Euro-Med Association Agreement	2002	1	1
EFTA-Singapore	2002	0	1
GUAM Organization for Democracy and Economic Development	2002	0	1
Armenia-Estonia	2002	0	1
Japan-Singapore	2002	0	1
Pakistan-Sri Lanka	2002	0	1
Albania-Croatia	2002	0	1
Albania-Kosovo	2003	0	1
Bosnia/Herzegovina-Bulgaria	2003	0	1
Albania-Moldova	2003	0	1
Bosnia/Herzegovina-Romania	2003	0	1
Albania-Romania	2003	0	1
Albania-Serbia	2003	0	1
Bulgaria-Serbia	2003	0	1
Afghanistan-India	2003	0	1
Chile-EFTA	2003	0	1
Chile-Korea	2003	0	1
Chile-US	2003	0	1
China-Hong Kong	2003	0	1
China-Macao	2003	0	1
Economic Cooperation Organization Trade Agreement (ECOTA)	2003	0	1
Macedonia-Romania	2003	0	1
Albania-Bosnia/Herzegovina	2003	0	1
Mexico-Uruguay	2003	0	1
Moldova-Serbia	2003	0	1
Moldova-Ukraine	2003	0	1
Panama-Taiwan	2003	0	1
Romania-Serbia	2003	0	1
Singapore-US	2003	1	1
Albania-Bulgaria	2003	0	1
Australia-Singapore	2003	0	1
Bulgaria-Moldova	2004	0	1
Caribbean Community (CARICOM)-Costa Rica	2004	0	1
Central American Free Trade Agreement (CAFTA)	2004	0	1
Central American Free Trade Agreement (CAFTA)-Dominican Republic	2004	0	1
Andean Countries-MERCOSUR	2004	0	1
Croatia-Moldova	2004	0	1
EFTA-Lebanon	2004	0	1
EFTA-Tunisia	2004	0	1
India-MERCOSUR	2004	0	1

Iran-Pakistan	2004	0	1
Japan-Mexico	2004	0	1
Jordan-Singapore	2004	0	1
Macedonia-Moldova	2004	0	1
MERCOSUR-Southern African Customs Union (SACU)	2004	0	1
Morocco-Turkey	2004	0	1
Morocco-US	2004	0	1
Association of Southeast Asian Nations-China	2004	0	1
India-MERCOSUR	2004	0	1
Australia-Thailand	2004	0	1
Australia-US	2004	1	1
Bahrain-US	2004	0	1
Chile-China	2005	0	1
EFTA-Korea	2005	0	1
Guatemala-Taiwan	2005	1	1
India-Singapore	2005	0	1
Japan-Malaysia	2005	0	1
Korea-Singapore	2005	0	1
Malawi-Mozambique	2005	0	1
MERCOSUR-Peru	2005	0	1
New Zealand-Thailand	2005	1	1
Trans Pacific Strategic EPA	2005	1	1
Belize-Guatemala	2006	0	1
Albania-Turkey	2006	0	1
Agreement Secretariat Environmental Matters FTA	2006	0	1
Central European Free Trade Agreement (CEFTA)	2006	0	1
Chile-Colombia	2006	1	1
Chile-India	2006	0	1
Chile-Panama	2006	0	1
China-Pakistan	2006	0	1
Colombia-US	2006	0	1
Cuba-Mercosur	2006	0	1
D8 PTA	2006	0	1
EFTA-Southern African Customs Union (SACU)	2006	0	1
Iran-Syria	2006	0	1
Japan-Philippines	2006	1	1
Nicaragua-Taiwan	2006	0	1
Oman-US	2006	0	1
Panama-Singapore	2006	0	1
Peru-US	2006	1	1
Chile-Peru	2006	0	1
Association of Southeast Asian Nations-Korea	2006	0	1
Malawi-Zimbabwe	2006	0	1
Brunei-Japan	2007	1	1

Chile-Japan	2007	0	1
Colombia-Northern Triangle	2007	0	1
EC-Montenegro-SAA	2007	1	1
EFTA-Egypt	2007	0	1
El Salvador-Honduras-Taiwan	2007	1	1
Indonesia-Japan	2007	1	1
Israel-Mercosur	2007	0	1
Japan-Thailand	2007	1	1
Korea-US	2007	1	1
Malaysia-Pakistan	2007	0	1
Mauritius-Pakistan	2007	0	1
Panama-US	2007	0	1
Bosnia/Herzegovina-EC-SAA	2008	1	1
Canada-Colombia	2008	0	1
Canada-EFTA	2008	0	1
Canada-Peru	2008	0	1
CARIFORUM-EC EPA	2008	1	1
Chile-Ecuador	2008	0	1
China-New Zealand	2008	0	1
China-Singapore	2008	1	1
Colombia-EFTA	2008	0	1
Cote d'Ivoire-EC EPA	2008	0	1
EC-Serbia-SAA	2008	1	1
Gulf Cooperation Council (GCC)-Singapore	2008	0	1
Japan-Vietnam	2008	1	1
Montenegro-Turkey	2008	0	1
Peru-Singapore	2008	0	1
Association of Southeast Asian Nations-Japan	2008	0	1
Australia-Chile	2008	0	1
MERCOSUR-Southern African Customs Union (SACU)	2008	0	1
Belarus-Serbia	2009	0	1
Canada-Jordan	2009	1	1
Chile-Turkey	2009	1	1
China-Peru	2009	1	1
EFTA-GCC	2009	0	1
EFTA-Serbia	2009	0	1
India-Korea	2009	1	1
Japan-Switzerland	2009	1	1
Malaysia-New Zealand	2009	1	1
Serbia-Turkey	2009	0	1
Association of Southeast Asian Nations Australia New Zealand FTA	2009	1	1
Association of Southeast Asian Nations-India	2009	0	1
Chile-Turkey	2009	1	1
Albania-EFTA	2009	0	1

Canada-Panama	2010	0	1
Chile-Malaysia	2010	1	1
China-Costa Rica	2010	1	1
Costa Rica-Singapore	2010	0	1
EC Korea	2010	1	1
EFTA-Peru	2010	0	1
EFTA-Ukraine	2010	0	1
Hong Kong-New Zealand	2010	0	1
EC (28) Enlargement	2011	1	1
Chile-Vietnam	2011	1	1
Commonwealth of Independent States	2011	0	1
Costa Rica-Peru	2011	0	1
EFTA Hong-Kong	2011	1	1
EFTA Montenegro	2011	1	1
Guatemala-Peru	2011	0	1
India-Japan	2011	1	1
India-Malaysia	2011	0	1
Japan-Peru	2011	1	1
Korea-Peru	2011	1	1
Mauritius-Turkey	2011	0	1
Montenegro-Ukraine	2011	0	1
Panama-Peru	2011	0	1
Central America-Mexico	2011	0	1
Australia-Malaysia	2012	1	1
Central America-EC	2012	1	1
Colombia-Peru-EC	2012	1	1
Korea-Turkey	2012	1	1
Chile-Hong Kong	2012	0	1
Panama-US Environment	2012	0	1
Korea-US Environment	2012	1	1

Notes: Direct CCP: PTA with provisions directly related to climate change; indirect CCP: PTA with provisions indirectly related to climate change. These PTA codes refer to provisions detailed in Appendix C. Thus 1 indicates that the PTA includes direct or indirect CCP; 0 indicates that it includes neither.

Source: TREND database.