Environmental provisions in preferential trade agreements: their impact on trade

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Environmental provisions in preferential trade agreements: their impact on trade

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Contents

List of abbreviations

- CUs: Customs unions
- DTAs: Deep trade agreements
- EPs: Environmental provisions
- EOs: Environmental objectives
- FD: First differencing
- FE: Fixed effect
- FTA: Free trade agreement
- GHGs: Greenhouse gases
- ITPD-E: The International Trade and Production Database for Estimation
- IVs : Instrumental variables
- MFN: Most favored nation
- NTPs: Non-trade provisions
- PTAs: Preferential trade agreements
- RTAs: Regional trade agreements
- TREND : Trade and Environment database
- VIFs: Variance inflation factors
- WB: World Bank
- WBDTA database: The World Bank Deep Trade Agreement database
- WDI: World development indicator
- WTO: World trade organization

1 Introduction

The number of preferential trade agreements (PTAs) has skyrocketed in recent years, becoming a central element to understand the globalized economy we are living in today. According to the latest update of the DESTA database (Dür et al. (2014)), that is the most comprehensive database on PTAs, whereas there were barely more than 100 PTAs active in the 90's, more than 600 additional have been signed since then. Furthermore, in recent years, PTAs have evolved in complexity and scope, encompassing various aspects beyond mere tariff reductions, such as regulatory cooperation, intellectual property rights, labor standards, or environmental issues. The scientific research about the impact of these non-tariff barriers, and more precisely about the effect of the environmental provisions (EPs) on trade of signing countries is still in its early stages.

This will thus be the core subject of this master thesis as it raises several important questions. Indeed, amid a context of ever-growing ecological concern, growing trade and environmental protection are more often seen as two irreconcilable goals rather than potential allies to tackle an ecological transition while fostering the economy. As more EPs are introduced in PTAs, one can wonder if those two objectives could not be achieved hand in hand, that is if environmental provisions could simultaneously enhance trade and fight climate change. Furthermore, developing countries which are more in need of economic development to deal with their poverty level while also being generally smaller polluters, are worried that EPs could serve as a form of green protectionism for developed countries.

This article addresses these important questions using a novel mix of databases looking at the effects of environmental provisions included in PTAs on the trade level of partner countries. The following of this study is structured as follows: Section 2 takes a look at the relevant aspects of the literature on PTAs and the hypotheses drawn from it, section 3 explains the model we used and its assumptions as well as the different databases we merged. Section 4 displays our empirical findings, some robustness checks, and a discussion about them, while section 5 offers concluding remarks.

2 Literature review

This section presents first of all a definition of PTAs, before going through a brief history of PTAs development and the reasons for their proliferation, followed the literature common understanding of the welfare effects of PTAs to understand the importance of this subject. Then, we will explore the development of deep trade agreements and their effects. Next, we will dive into the reasons for the inclusion of EPs in PTAs as well as their assessed effects on the environment to evaluate their relevance. Subsequently, we will discuss the effect these EPs have on trade, and we will finish with our hypotheses as a way to introduce our research question.

2.1 PTA definition

In the literature of international economics and law, the term "Preferential Trade Agreement" serves as a generic term that includes various forms of reciprocal agreements between trading partners such as customs unions (CUs), regional trade agreements (RTAs), or free trade agreements (FTAs). This definition diverges from the World Trade Organization's one (WTO), describing the PTAs as agreements that offer unilateral (that is, non-reciprocal) trade preferences, such as, for instance, the Generalized System of Preferences schemes that allows preferential tariffs for developing countries exporting towards developed ones. This research adopts the definition prevalent in international economics and law, using "PTA" to encompass all forms of trade agreements, be they regional or cross-regional.

Additionally, the term "Deep Trade Agreement" (DTA) is employed to denote PTAs that incorporate provisions designed to enhance economic integration between trading partners, beyond simply reducing tariffs. More precisely, following the definition of Mattoo et al. (2020), a DTA can be defined as an international agreement seeking to control three, partially overlapping, groups of policy areas:

- Core Policy Areas: These areas seek to set up five fundamental economic integration rights: the unrestricted (or less restricted) movement of goods, services, people, capital, and ideas. The policy domains directly impacting these flows include areas such as tariffs, export taxes, investments, visa and asylum policies, capital movement, and intellectual property rights.

- Regulatory and Supportive Policy Areas in DTAs: these policies support economic integration by limiting government intervention. Government actions that restrict international trade can occur both at the border and internally, often through regulatory means. Relevant policies concerning these areas include, among others, customs regulations, rules of origin, technical barriers to trade (TBT), sanitary and phytosanitary measures (SPS), subsidies, and competition policies.

- Social and consumer welfare policies: These policies seek to enhance social and consumer welfare by controlling the practices of exporters. Areas such as environmental

standards and labor regulations impose obligations on exporters to safeguard social and consumer interests. Additionally, policies regarding competition, state-owned companies, and subsidies not only address actions that hinder economic integration but also target distortionary practices that reduce economic efficiency.

2.2 Brief overview of PTAs development

PTAs have been out there for a long time now. The first agreement ticking most cases of the PTA's definition seems to be, according to the World Trade Organization (2011), the Anglo-French Trade Agreement of 1860, also known as the Cobden-Chevalier Treaty. This treaty sought to lower tariffs reciprocally between both countries and also included a strong most favored nation (MFN) clause. The MFN clause is a fundamental principle in modern international trade, it aims to promote non-discrimination among trading partners. It is a commitment stating that every favorable treatment granted to a trading partner will also be made available to all other trading partners.

This treaty paved the way for implementing other MFN trade treaties in Europe. Since then, some periods of recessions like the panic of 1873-1877 and the great depression (1929-1939) saw the number of new PTAs introduced reduced whereas periods of economic openness like the post-war boom saw the number of new PTAs surging. Yet, the popularity of PTAs is rather recent and most PTAs have been signed over the last thirty years. Whereas there were only 100 active PTAs in the mid-nineties, their number currently stands at more than 700 today according to DESTA, the most comprehensive dataset on PTAs out today (Dür et al. (2014)).

2.3 Determinants of PTAs

Baccini (2019) made a recent review of the literature on the determinants of PTAs, their proliferation, and their effects. He split the determinants for joining a PTA into two groups: macro reasons for PTA formation and micro reasons.

Concerning the macro foundation of PTA formation, Baier and Bergstrand (2004) found three central components of PTA determinants. First, countries between which transportation costs are minimal are more likely to establish a PTA. This principle is taken from Krugman et al. (1991) theory on natural trading partners. Second, larger countries, in terms of GDP, sign PTAs more easily. Agreements between substantial economies enhance trade volumes significantly more than those between smaller nations, and they also result in a more considerable increase in real income due to the expansion of demand. Third, when countries have similar economic sizes (adjusted for GDP), they derive greater utility benefits from PTAs. Empirical data strongly indicates that economic factors such as proximity, GDP, and economic size similarity not only correlate significantly with PTA formation but also accurately forecast over 80% of current PTAs.

What remains unexplained is politics. Indeed, Baccini (2019) regrouped evidence supporting that democratic nations have more incentives to sign PTAs than autocratic ones. The theory is based on a signaling game. There exist two types of leaders, good ones implementing policies enhancing people's welfare, and bad ones implementing selfish policies. Voters cannot observe the leaders' type. In democracies, leaders must increase the voters' welfare in order to stay in power. However, voters' welfare is influenced either by policies undertaken by the leaders, or by exogenous shock beyond leaders' control. If an exogenous negative shock happens, voters will not trust leaders, be they of good or bad type. Thus, PTAs can serve as a signal for good leaders to show voters their true type. Indeed, PTAs reduce good prices through tariff reduction, but mostly, PTAs commit the country to international agreements on which next leaders cannot easily renegotiate. This signal game only works in democracies where leaders are pressured by recurrent and fair elections. Empirical findings support this theory with a correlation between the formation of PTAs and democratic pair countries being significantly positive and robust to dataset and model specifications.

Baccini (2019) also reports other political determinants of PTAs, such as the newness of leaders in democratizing countries, or the fact that a PTA is more easily signed if competing countries have formerly signed some as well.

Alongside with macro determinants of PTA formation also exist micro determinants. Briefly, at the industry level, Baccini (2019) relates that industries with large economies of scale and high intra-industry trade, benefit better from lower tariffs and are thus more prompted to support the development of PTAs. Also, tariffs on intermediate goods are liberalized faster than those on finished goods, emphasizing the role of global value chains[1] in preferential trade liberalization.

2.4 The welfare effect of PTAs

In order to understand the potential benefits of PTAs, let's take a look at their effects. Their primary purpose is to promote economic cooperation and liberalize trade between participating countries, with the overall goal being to foster trade between participating countries, which should increase the population's welfare of trading countries. Although the welfare effect of PTAs implementation is, as usual for welfare measures, rather complicated to determine, a few studies addressed the issue, largely simplifying the welfare definition.

Among others, Caliendo and Parro (2015) have looked at the welfare effect of the reduction in tariffs from the NAFTA (North American Free Trade Agreement) for the concerned nations (i.e. Mexico, Canada, and the U.S.). They found a positive welfare effect for Mexico and the U.S. but a negative one for Canada. However, they noticed an increase in real wages for the three countries as well as an increase in the volume of trade. For his part, Trefler (2004) looked at

[1] Following the definition of the OECD, global value chains refer to the different stages of production of a good across multiple countries, each stage adding some value to the product.

the effect of the Canada-U.S. free trade agreement (the predecessor of NAFTA) on Canadians. He distinguished the short-term transition costs and the potential long-term efficiency profits. He concludes that the implementation of the Canada-U.S. agreement led to a significant loss of employment in the short run (up to 12% in the most affected sector). In contrast, Trefler found that this PTA enhanced significantly labor productivity (up to 15% for some industries) sometimes thanks to the reduction of low-productivity factories. He also noticed that this particular PTA generated more trade than it diverted[2].

Even though some rather debatable positive conclusions might be drawn about the welfare effect of PTAs, welfare is a complex topic and hardly definable. Conversely, the effect on trade is much easier to compute and should, in principle, regarding the primary purpose of PTAs, be positive. Several studies have tried to assess the effect of PTAs on trade flows, and reached roughly the conclusion that PTAs enhance trade among signing partners (Dür et al. (2014); Baccini et al. (2017); Egger et al. (2011); Eicher and Henn (2011); Baier and Bergstrand (2007); Berger et al. (2020)). Using different methodologies and data, they all suggest that PTAs have a significant effect on trade flows for contracting countries.

For instance, Dür et al. (2014), while introducing a new database (the DESTA database), have looked, among other things, at the average effect of PTAs on trade and found a positively significant effect of about 30%. This number even goes up to around 65% when including five-year and ten-year lags. Baier and Bergstrand (2007) have, on their side, looked at the trade effects of PTAs using country-pair fixed effects and exporter- and importer-fixed. He observed that PTAs more or less double the trade flow between participating countries.

Finally, one can also cite Baier et al. (2014) who have looked at the effect of PTAs on both the intensive margin of goods and their extensive margin. The intensive margin of goods focuses on the quantity or value of trade in products that were already exchanged between two countries, whereas the extensive margin of goods looks at the range of exchanged goods and thus the entry or exit of goods in trade flows. They found that, what they call EIAs (standing for "Economic Integration Agreements") which refer basically to the same thing as the definition of PTAs we use, have a significant and positive impact on both the intensive and the extensive margin of goods.

In short, there is a clear consensus on the positive effects of PTAs on the level of trade among contracting parties which is their primary purpose. One can however wonder what the reasons are for the development of deep trade agreements (DTAs) that has been seen over the past years and its impacts. This is the topic we will explore in the following section.

[2]According to the WTO, trade diversion in the context of PTAs refers, for a country, to the switch in trade flows from an optimal non-member supplier towards a less efficient supplier participating in a PTA

2.5 Deep trade agreements expansion

Deep trade agreements, as defined earlier, are PTAs not only addressing at-the-border issues such as tariff reduction, but also behind-the-border matters, for example, environmental provisions, workers' rights, intellectual property rights, or competition policies. There is no clear-cut threshold above which a PTA can be considered as deep, however, it has been clearly assessed that PTAs have become deeper and deeper over time, thus including always more behind-the-border provisions (see Mattoo et al. (2020); Dhingra et al. (2018); Dür et al. (2014)).

The main reason to specifically address the issue of the deepness of PTAs is that the effect of these agreements on trade cannot be seen as dichotomous, that is, either a PTA is signed or it is not. Indeed, all agreements do not serve the same purpose nor do they all have the same effects. Therefore, one can use the depth of an agreement, i.e. to which extent one agreement goes beyond simply addressing at-the-border issues, as a way to account for this variation in ambitions and commitments.

A subsequent question is thus, when we account for this design specification, do deeper PTAs mean stronger positive trade effects for the participating countries? One could indeed expect that countries which are more profoundly tied would have greater incentives to expand their trade with each other. This is effectively what many studies have found (Baccini et al. (2017); Brandi et al. (2020); Dür et al. (2014); Berger et al. (2020)). For instance, Dür et al. (2014) have used their at-that-time newly introduced database, DESTA, to create two versions of a depth variable. They found, as expected, using both variables, a significant and positive effect of depth on trade flows.

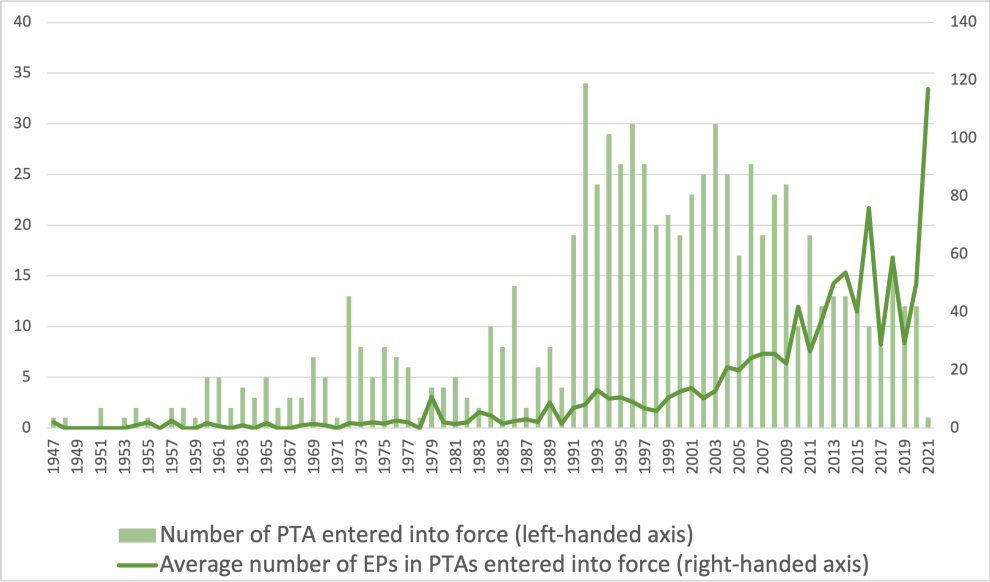
Once we have looked at the design of PTAs, questions arise concerning specific provisions, and particularly, the reasons for the inclusion of environmental provisions (EPs) in PTAs as well as their effects on the concerned environmental outcomes. Furthermore, one might rightfully question oneself regarding the effect of these EPS on trade. These interrogations will be addressed in the following sections.

2.6 The inclusion of EPs in PTAs

As PTAs became deeper and deeper, they also included quite logically more and more EPs as shown in Figure 1. There exist several reasons for this sharp increase of included EPs over the past twenty years. Three main reasons often come back in the literature (Brandi et al. (2020); Morin et al. (2018); Blümer et al. (2020)). The first one is a political argument assuming that the insertion of EPs in PTAs is exploited as a way to gain support from political parties and non-state players that are crucial to foster trade liberalization and would not allow trade agreements without such EPs. Plus, there is also a huge demand from citizens to make PTAs greener.

A second idea explains that PTAs can be used as a diplomatic tool to enhance environmental standards in other countries. Indeed, PTAs tackle a much broader range of issues compared

Figure 1: Average number of EPs per PTA



Source: Own computation based on the TREND database presented in section 3.2.1

to negotiation focused only on ecological matters, and can thus allow for some compromises between issue areas in order to be more efficient on environmental subjects. Thirdly, from an economic point of view, it is widely assumed that greener countries may wish to motivate competing countries to level up their environmental considerations by decreasing differences in regulations about the environment using PTAs. From this last argument arises the question of potential green protectionism from developed countries towards developing countries with less stringent environmental regulations. Indeed "greener" countries could use EPs in order to limit the competition from "browner" countries in certain industries while asking for strict environmental rules that some companies in such "browner" countries could not comply with. This issue will be addressed in a future section.

On top of that, Morin et al. (2019) had a look at the way newly introduced EPs are diffused in future PTAs. They found that contrary to what they expected the characteristics of the country emitting new PTAs do not matter for their diffusion. More specifically, neither being a large economic power introducing new EPs yields to these EPs being more frequently included in future PTAs, nor being a credible environmental-friendly country. However, EPs that are first introduced in a PTA with countries from different continents, that is EPs being approved by a large variety of countries, are more likely to be accepted by a wider range of countries.

On the contrary, the content of the provisions matters more. For instance, they found that

EPs that have to do with partners' regulatory spaces encounter a larger diffusion as well as EPs strictly considering environment protection or EPs about policy coherence. Interestingly, EPs that try to level the playing field in environmental standards tends not to diffuse more, probably due to their offensive interest from greener countries being economically more powerful, and thus not suitable to the greatest number.

2.7 The effect of EPs on the environment

Once we know why EPs are included in PTAs, an interesting question to investigate is whether they fulfill their presumed goal, that is to tackle the climate change issues. Indeed, this is a critical matter since this addresses the core relevance of including such provisions in preferential agreements. Even if a few authors have found some potential evidences that EPs might be window-dressing used to hide the protectionist interest of developed countries (Lechner (2016); Ederington and Minier (2003), this does not conflict with the potential of EPs to serve environmental interests. This later issue has been broadly studied in the literature with sometimes conflicting results (Abman et al. (2021); Baghdadi et al. (2013); Martínez-Zarzoso and Oueslati (2018); Sorgho and Tharakan (2022); Zhou et al. (2017); Joseph et al. (2023).

Most authors nevertheless found positive effects of EPs on environmental objectives (EOs). For instance, Abman et al. (2021) looked at the effect of the inclusion of EPs aiming at preserving biodiversity or limiting deforestation on the level of forest loss in 193 countries. They used a new dataset on the content of PTA from the World Bank (WB) combined with estimations of deforestation loss taken from satellite-based data, and found a significant reduction in forest loss for PTAs including such EPs. More accurately, they reached the conclusion that the forest loss occasioned by RTAs is fully offset by the inclusion of EPs on forest and biodiversity.

On their side, Baghdadi et al. (2013) as well as Martínez-Zarzoso and Oueslati (2018), and Zhou et al. (2017) analyzed the effect of EPs on air pollution. More precisely they considered the effect of EPs on GHGs (greenhouse gases) emissions (specifically on CO2 and PM2.5), and all found some significant reducing effects for PTAs including EPs on such emissions. Sorgho and Tharakan (2022) brought some details, precising that only specifically climate-related environmental provisions in PTAs will help to mitigate climate change while reducing GHGs emissions. Whereas PTAs including EPs not directly focused on climate change would not have any beneficial effect on climate change and could even have detrimental environmental effects compared to PTAs without any EPs.

Fernandes et al. (2023) tell a rather different story. Basing their claims, amongst others, on Joseph et al. (2023)'s rather mixed results on the effects of non-trade provisions (NTPs) on the environment, they suggest that NTPs are not the best way to achieve non-trade outcomes (NTOs). They argue linking NTOs too closely to PTAs could overload trade aspects in agreements and reduce the beneficial effects of free trade which is to lower prices through competition.

On a more positive note, following "Bastiaens and Postnikov (2017)" as well as Brandi et al. (2019), EPs could also serve as a way to foster the implementation of environmental policies domestically, especially in the developing world. Indeed, developing countries wishing to enter a preferential agreement with richer countries would have higher incentives to adopt environmental-friendly policies in order to enhance their chance of signing such agreements. This could thus also be seen as an indirect positive effect of PTAs including EPs on environmental outcomes.

2.8 The effect of EPs on trade

As introduced here above with Fernandes et al. (2023), there might be some expectations that introducing environmental provisions in PTAs could have a negative effect on trade level. However, the literature about the consequences of EPs on trade flow is rather slim, only a small number of studies have addressed the issue (Berger et al. (2020); Brandi et al. (2020); Lechner (2018)). Plus, there are actually conflicting potential effects of EPs on trade .

On the one hand, there exist EPs encouraging diminution of trade. Berger et al. (2020) present two types. First, some EPs are "offensive" in nature, and will ask signing countries for example to reduce their GHGs emissions, to augment their domestic legislation on ecological issues, or to sign international agreements on environmental matters. Such EPs could reduce the capacity of certain countries, that were previously laggards in environmental matters, to export or even to produce certain types of goods. Second, there also exist "defensive" provisions which will allow countries to restrain directly trade with other countries in the name of environmental protection or other non-trade arguments.

From these "trade-restrictive" provisions arises the potential question of green protectionism which we have already mentioned. Indeed, there is a fear from developing countries, which are usually less advanced in environmental matters, that developed countries use such EPs in order to restrict competition for different types of goods from developing countries. This topic has already received attention from some authors (Lechner (2016); Ederington and Minier (2003)). Both studies found evidence that EPs might lead to some kind of green protectionism with EPs acting like a sort of second trade barrier.

On the other hand, there exist some environmental provisions which are trade-liberalizing in nature. That is, EPs which will promote the production of environmental-friendly goods. However, even some provisions not directly oriented towards green goods can be expected to develop trade following the Porter hypothesis (Porter (1991); Porter and Linde (1995). Indeed, this theory goes against the traditional trend of seeing environmental regulations as imposing costs on businesses and reducing their competitiveness. On the contrary, it suggests that well-designed regulations can stimulate innovation, leading to more efficient production processes, improved products, and ultimately, greater economic and environmental performance.

The literature found varying results concerning these potential effects of EPs on trade. Berger et al. (2020) found a slight negative but non-robust effect of EPs on trade. Plus, they found that this negative effect only holds, but more seriously, for trade flows from developing countries towards developed countries. Brandi et al. (2020) on their side did not find any significant effect of EPs on the general level of trade, neither globally nor when they restrict exports to developing countries. Their results suggest however that EPs decrease exports of dirty goods and increase exports of green goods from developing countries. Finally, Lechner (2018) found that environmental and labor rights provisions in PTAs lead to lower FDI[3] in more polluting industries with larger low-skilled labor force, whereas greener industries relying mainly on high-skilled labor found their FDI to be increased.

2.9 Hypotheses

In line with the literature review here above, we first expect that PTAs will increase the trade level between signing countries as it has already largely been assessed. Second, although there is no clear-cut answer to the question of the effect of EPs on trade, we follow the results of Berger et al. (2020) and thus expect the environmental provisions to have a slightly negative effect on trade, that is in the opposite direction from the Porter hypothesis. Also, if EPs induce green protectionism from developed countries, we should see that EPs in PTAs regulating export from developing economies towards developed economies have an even stronger negative effect on trade. Third, the deepness level of a PTA should positively influence trade. Finally, in order to be consistent with our previous expectations, we expect that the more a PTA has legally enforceable EPs, the stronger their negative effect on trade will be.

[3] Foreign Direct Investment (FDI) is, according to the OECD ilibrary, a type of international investment in which an investor from one country creates long-lasting interest at a significant degree in a company from another country.

3 Methodology & Data

3.1 Model

The purpose of this study is to test the hypothesis presented here above while using a new mix of databases in order to bring some additional evidence of the effect of the increasing number of EPs in PTAs on the level of trade between signing countries. In order to do so we used a gravity equation. This method was introduced by Tinbergen (1962) more than 50 years ago and has since then become the principal empirical tool in international trade research for examining the ex-post impacts of liberalizing agreements on bilateral flows of goods (Baier and Bergstrand (2007)).

3.1.1 Gravity equation

Standard gravity equation

The gravity model is commonly employed to study the differences in trade flows between pairs of countries based on their respective GDPs, the geographical distance between them, whether they share a language, have contiguous borders, and the existence of a free trade agreement between them. One of its common versions with cross-country data takes this form :

$$PX_{ei} = \beta_0 \left(GDP_e\right)^{\beta_1} \left(GDP_i\right)^{\beta_2} \left(DIST_{ei}\right)^{\beta_3} e^{\beta_4(LANG_{ei})} e^{\beta_5(ADJ_{ei})} e^{\beta_6(PTA_{ei})} \varepsilon_{ei} \qquad (1)$$

With PX_{ei} being the value of export from country e to country i, GDP_e (GDP_i) being the nominal gross value of GDP of country e (i), $DIST_{ei}$ being the physical distance between economic center of country e and i, $LANG_{ei}$ is a dummy variable saying whether country e and i share a common language, ADJ_{ei} is also a dummy variable saying whether country e and i share a common border, PTA_{ei} is a third dummy variable saying whether there is a PTA between country e and i, and ε_{ei} is the error term, assumed to be log-normally distributed.

Endogeneity issue

However, Baier and Bergstrand (2007) argue that this standard form of the gravity equation faces a major issue, it does not take into account the potential endogeneity of signing a PTA. Endogeneity could arise if PTA_{ei}, or, in fact, any other explanatory variable, is correlated in any way to the error term ε_{ei}. If PTA_{ei} is indeed endogenous, then equation (1) could seemingly largely under- or over-estimate the effect of PTA on trade. Endogeneity can appear mainly due to three reasons: omitted variables, measurement error, and simultaneity (see Wooldridge (2010), pp. 54-55).

In our case, omitted variables would mean there are some variables included in the error term ε_{ei} that influence the level of export between countries e and i, and that are correlated to PTA_{ei}. One can think about some non-measurable domestic trade-related barriers that could reduce the level of trade between countries e and i, which would yield a negative ε_{ei}. On

the other hand, these domestic policies could create larger incentives for the two countries to sign a PTA, as there would be larger welfare gains for them compared with two countries that would not have such barriers in place. This would mean the intensity of the barriers would be positively correlated with the decision to join a PTA. However, the intensity of the barriers is negatively correlated with ε_{ei}. Thus, the correlation between ε_{ei} and PTA_{ei} would be negative which would yield an underestimated coefficient for PTA_{ei}.

Following Baier and Bergstrand (2007), omitted variables are the source of endogeneity impacting the most the PTA_{ei} coefficient bias. Measurement error and simultaneity might, however, also lead to some underestimation of the PTA_{ei} coefficient. In the case of simultaneity, we are concerned about the link between PX_{ei} and GDP_e or GDP_i. Although the GDP level of a country is likely to influence its level of exports, the GDP of a country is somewhat also a function of its exports, which causes GDP_e and GDP_i to be endogenous. Yet, authors like Frankel et al. (1997) have used IVs (instrumental variables) techniques in order to account for potential endogeneity of GDPs, and stated that estimators using these IVs did not change significantly. Plus, the influence of bilateral trade flows on GDPs is not so much straightforward. We will therefore consider GDP_e and GDP_i as exogenous.

Finally, if there is some measurement error in an explanatory variable, it will typically induce a negative bias for the endogenous variable. Indeed, if this measurement error is random, what we will assume, the error will simply lead to an explanatory variable less correlated with the explained variable and pull the coefficient of this explanatory variable downwards.

Panel methodologies as a solution

In order to tackle this endogeneity problem we used an OLS estimator on a panel dataset with fixed effects. Indeed, adding fixed effects allows to control for the time-invariant variables, previously contained in the error term ε_{eit}, which are correlated with PTA_{eit}. Specifically, the potential variables we talked about here above, i.e. some non-measurable domestic trade-related barriers, that we will call a_{ei}. A fixed effects model was better suited in our case than a random effect one, since random effects models ask for non-correlation between all the explanatory variables and the unobserved effect a_{ei} (see Wooldridge (2013), pp. 492), which, as explained earlier, is not what we assumed.

A third way of estimation to treat endogeneity with panel data is estimation with first-differentiated data. Following Wooldridge (2013) (pp. 490), fixed effects (FE) are more efficient than first differencing (FD) when ε_{eit} is serially uncorrelated. However, this assumption does not always hold, and one should therefore be cautious while choosing FE. We still have chosen FE estimators for our main equation, following Berger et al. (2020) amongst others.

3.1.2 Model specification

Using a panel methodology with fixed effects, we went from Eq.(1) to the following equation which will be the baseline regression equation for this study :

$$EXPORTS_{eit} = \beta_0 + \beta_1 * EPs_{eit} + \beta_2 * PTA_{eit} + \beta_3 * DEPTH_{eit} + \beta_4 ENFORCE_{eit} + \alpha_{ei} + \alpha_{et} + \alpha_{it} + \epsilon_{eit} \quad (2)$$

With :

e**:** The index for the exporter country

i**:** The index for the importer country

t**:** The index for the year

$EXPORTS_{eit}$**:** The natural log of the value of exports from country e to country i in year t.

EPs_{eit}**:** The maximum number of environmental provisions identified in a PTA between country e and country i in year t.

PTA_{eit}**:** A dummy variable accounting for the presence of a PTA between country e and i in year t.

$DEPTH_{eit}$**:** The level of depth of the PTA if there is an ongoing PTA between country e and i in year t.

$ENFORCE_{eit}$**:** An index accounting for the general enforcement level of all the EPs in a PTA if there is one between country e and i at time t.

α_{ei}**:** Country-pair fixed effect

α_{et}**:** Exporter-year fixed effect

α_{it}**:** Importer-year fixed effect

ϵ_{eit}**:** The error term.

One can note that the only remaining explanatory variable from Eq.(1) is PTA_{eit}. Indeed, the country-pair fixed effect captures all the time-invariant bilateral characteristics from countries e and i that may be correlated with the explanatory variables, including the distance between both countries $DIST_{ei}$, whether they share a common language $LANG_{ei}$, and whether they share common borders ADJ_{ei}. Regarding the GDPs, GDP_{et} and GDP_{it}, they are respectively captured by the exporter-year fixed effect and the importer-year fixed effect, which more broadly capture every time-variant country-specific characteristics correlated with the explanatory variables. The main reason for the use of these fixed effects, as explained in the previous section, is especially their capability to control for unobserved variables correlated with the explanatory variables and solve an important part of the endogeneity problem.

3.1.3 Model assumptions

In order for our model to yield unbiased, consistent, and efficient estimates, several assumptions must be satisfied. It is useful to go through the most important ones in order to have a better understanding of the behind-the-scene underpinnings of our model. This also facilitates an understanding of the potential limitations of our results if some of these assumptions are failing.

Linearity in parameters

In order to check for the linearity assumption, we plotted the residuals of our main regression against the fitted values. One can see in Figure 2 in the Appendix that the residuals are randomly distributed around the mean, suggesting linearity.

No perfect collinearity

First, all of our variables face some variation over time. Second, as shown in the correlation matrix in Table 3 in the annex, none of our dependent variables is a perfect linear combination of another one. The assumption of non perfect collinearity is thus fulfilled. One can however note that correlation among the independent variable is still relatively high, especially between "EPs" and "depth_all", which was nonetheless expected.

Zero conditional mean

From Figure 2 one can observe no specific patterns of the residuals, which is an indicator this assumption is fulfilled. Another way to test for this assumption is to run a RESET test. Such a test has been performed manually, adding a quadratic and a cubic form of the fitted values from our standard model to our regression. We displayed the result of this modified regression in Table 5 in the annex. While the two variables are significant at the 5% significance level, none is at the 1% significance level.

Even if Figure 2 shows encouraging results, we cannot clearly reject the hypothesis from the RESET test stating our model is misspecified. This is thus something to keep in mind while interpreting our results.

Homoskedasticity of Errors

To check for Heteroskedasticity, one can perform a Breusch-Pagan Test. We performed it manually regressing the squared of the residuals from our standard regression on our 4 independent variables. The results are depicted in Table 7. In order to reject the hypothesis of heteroskedasticity, one should only have non-significant estimators. Since this is not the case in our computations, there might thus be some heteroskedasticity in our model. We will therefore use robust standard errors in order to tackle this potential heteroskedasticity.

No serial correlation

A Durbin-Watson test has been performed to check for serial correlation. The test reports a statistic of 1.2507505, suggesting positive serial correlation in the residuals of our regression model. This might be an issue. Even though our OLS estimators remain unbiased and consistent, they are no longer efficient, meaning there might be other estimators with lower variance. In order to tackle this autocorrelation problem, we have adjusted the standard errors to account for the within-country-pair correlation of the residuals.

Normality

The normality assumption is especially a problem for samples of small size. Since our sample contains more than one million observations, following Wooldridge (2013), one can suggest that, using the Central Limit Theorem, our estimators meet the asymptotic normality, meaning they are approximately normally distributed.

3.2 Data

With this study, we wanted to bring a new mix of data sources, which, as far as we know, had not been used yet, in order to have the most detailed definition available for each of our interest variables. In order to do so, we merged four key datasets. The Trade and Environment Database (TREND), The International Trade and Production Database for Estimation (ITPDE), the World Bank Deep Trade Agreements database (WBDTA), as well as information from the World Development Indicator (WDI) database of the World Bank. In the following sections, we go through each database to see for which variables they have been used and how the data has been processed.

3.2.1 TREND

The TRade and ENvironment database (TREND) was introduced by Morin et al. (2018) and updated in 2022. It contains information about 298 different types of EPs obtained from the analysis of the full text of 775 PTAs signed between 1945 and 2019. It is to date the most detailed and comprehensive dataset on EPs. This list of agreements relies on the Design of Trade Agreements (DESTA) database, which is for its part the most comprehensive list of PTAs nowadays (Dür et al. (2014)). This database has been used to get information on the number of EPs in each PTA of our sample.

3.2.2 ITPD-E

The International Trade and Production Database for Estimation (ITPD-E) was put together by Borchert et al. (2021) and was significantly updated one year later (ITPD-E-R02)(Borchert et al. (2022)). The database provides data on international trade at the industry level throughout 4 broad sectors: agriculture, mining and energy, manufacturing and services, and covers the

period 1986-2019 for 265 countries. We merged these 4 sectors in order to have one observation for each exporter-importer pair in a given year. From this database was computed the variable $EXPORTS_{eit}$, reporting the log of the values of export in current US dollar for each exporter-importer pair each year between 1986 and 2019.

3.2.3 World Bank deep trade agreements database

The last three variables of our model, PTA_{eit}, $DEPTH_{eit}$, and $ENFORCE_{eit}$ take their value from the World Bank Deep Trade Agreements (WBDTA) database introduced by Hofmann et al. (2017) containing detailed assessments of the contents of PTAs. The database contains information on 325 PTAs introduced between 1958 and 2019 and signed by 189 different countries. The WBDTA database is twofold. On the one hand, there is a "horizontal" depth-oriented database (WBDTA-H) that contains general information about PTAs such as their date of entry into force and the participating countries, from which we obtain the values for the PTA_{eit} variable.

Most interestingly, the WBDTA-H database also categorizes, for each PTA, 14 "core" provisions that cover policy areas falling under the present mandate of the WTO (WTO-plus provisions). Additionally, it identifies 38 provisions that extend beyond the WTO mandate (WTO-extra provisions). Each of these 52 provisions (14 "WTO-plus" and 38 "WTO-extra" provisions) is also defined as "legally enforceable" or not. We built the $DEPTH_{eit}$ variable upon this range of provisions, defining the depth as the range of regulatory issues and policy areas encompassed by the agreement and the legal enforceability of these provisions.

From this data, one can create 4 different Depth variables built on two distinct aspects. The first aspect is whether we consider all the 52 provisions or only the "core" provisions being more economically relevant, defined by Mattoo et al. (2022) as the 14 "WTO-plus" provisions plus 4 of the "WTO-extra" provisions (i.e. intellectual property rights protection, movements of capital, rules on investment, and competition policy). Second, we look at whether these provisions are legally enforceable or not. We end up with 4 potential definitions of the depth that are depicted in Table 6 in the annex. We used "depth_all" for the depth variable of our main regression which is based on the set of 52 provisions, regardless of whether they are legally enforceable. We thought it was the most comprehensive version. The analysis has also been performed with the three other depth definitions as a robustness check in section 4.2.

On the other hand, the second part of the database reports "vertical depth" (WBDTA-V) for 18 fields such as labor market regulations, visa and asylum, or movement of capital, and, particularly, on Environmental laws. The chapter on environmental laws contains information on 52 EPs and especially their level of enforceability for each agreement. The index used for this enforceability can be found in Table 8 in the annex. For each agreement we computed an average level of enforceability of its environmental provisions which is resumed by the $ENFORCE_{eit}$ variable.

3.2.4 World Bank database for countries income

Finally, some information about the level of income of the exporters has been collected from the World Development Indicator (WDI) database of the World Bank. Following Berger et al. (2020), we differentiated countries into two groups: high-income countries or developed countries, and developing countries (upper-middle-income countries, lower-middle-income countries, and low-income countries). Data in the WDI was missing for the year 1986, we thus assumed the income level of countries was the same in 1987 and the year before. Also, 51 countries from the ITPD-E did not find any correspondent in the WDI dataset. However the vast majority of these countries were small islands, we assumed they were non-high-income countries.

3.2.5 Merge and process the data

Merge of 4 datasets

The WBDTA-H database was our baseline database since it contained the highest number of common PTAs among the other databases. In the first place, we reported the values of the enforceability from the WBDTA-V database into the WBDTA-H database for every agreement. From the 325 PTAs of WBDTA-H database, 285 were available in the WBDTA-V database. We explain hereafter how we treated the missing values. Then, we collected for each PTA of the WBDTA-H database, the corresponding value of the number of EPs in TREND. For this merge, 307 PTAs were matching between both databases. Next, we aggregated the ITPD-E trade flows at the country-pair level before we merged them with this modified WBDTA-H database. Finally, we added the income level information from the WDI and obtained our final database.

Multiple agreements for one trade flow

In this final step of the merge, some exchange flows in the ITPDE database matched with several agreements in the WBDTA database. In this case, we decided, as did Brandi et al. (2020), to keep the number of EPs from the matching agreement with the largest number of EPs. Concerning the depth level, we thought it made sense to choose the highest level of depth regardless of the number of EPs. Although this means we take information from different agreements for a single trade flow in ITPD-E, this makes sense since our "depth" variable should tell the general level of depth of the agreement which is not directly linked to the number of EPs. It should thus be logical to take the value for depth from the agreement with the highest level of depth between two countries in a given year, since this agreement has in principle the strongest effect of depth on trade between these two countries.

Regarding the enforceability of EPs, the choice was slightly less straightforward. While at first glance, following the same logic as for the depth level, one might want to keep the highest level of enforceability, we decided to take the enforceability level from the same agreement as the one with the highest number of EPs. This makes sense since $ENFORCE_{eit}$ relates the

level of enforceability for EPs, this would thus not be consistent to report the maximum level of enforceability if it comes from another agreement than the one with the highest number of EPS.

Missing values

In our final merged dataset, 2.65% of the observations which are under a PTA, $PTA_{eit} = 1$, have a missing value for the number of EPs (EPs_{eit}). To this is added 8.87% of missing values for the $ENFORCE_{eit}$ variable among the observations under a PTA. Concerning the EPs_{eit} missing values, we decided to drop them. Indeed, their percentage among the observations under PTA is relatively small, and above all, they are missing because there was not a perfect matching between the PTAs covered by TREND and by ITPD-E. We might thus assume that the reason for this non-availability is random. Therefore, removing them from our database should not have any significant impact on our estimators, especially if they represent a small share of the data.

However, for the $ENFORCE_{eit}$ missing values, we decided to replace the missing values with the mean of the enforce variable. We did not want to lose too many observations, and thus information on other variables. Also, for the case of $ENFORCE_{eit}$, since the variable comes from the same source (World Bank) as the rest of the information on PTAs, it is less clear whether the nature of the missing value is random. Simply removing those observations might have led to a larger bias than replacing them with the mean.

3.3 Descriptive statistics

In this section, we will briefly portray our dataset in order for the reader to have a clearer view of the organization and range of our data.

Our final database contains 1,342,276 observations of trade flow between 260 different exporters and 260 importers over the period 1986-2019. Among these observations, 528,855 (39.4%) have a value of trade flow equal to 0 and 148,138 (11.04%) are under a PTA. Table 9 in the appendix further dives into the descriptive statistics of the 325 PTAs collected from the WBDTA-H database. Table 10 describes numerical variables from our final merged database.

4 Empirical findings

This section first presents the empirical results found by estimating equation 2 with OLS. For the sake of convenience, we reported equation 2 hereafter. The regression is first estimated on the full sample introduced in the previous section and is then estimated on four sub-samples based on the income level of exporters and importers. Subsequently, several robustness checks have been conducted, and the section ends up with a discussion on these results and their limitations as well as some potential paths for further research.

$$\begin{aligned} EXPORTS_{eit} = &\beta_0 + \beta_1 * EPS_{eit} + \beta_2 * PTA_{eit} + \beta_3 * DEPTH_{eit} \\ &+ \beta_4 ENFORCE_{eit} + \alpha_{ei} + \alpha_{et} + \alpha_{it} + \epsilon_{eit} \end{aligned} \tag{2}$$

4.1 Main results

4.1.1 Full sample

The results of equation 2 are displayed in Table 1. Interestingly enough, the four variables are highly significant, each at the 1% level except $Enforce$ which is still significant at the 5% level. These are good news, it means all the variables included in our model have a significant impact on the natural log of the export value. Furthermore, one can note a relatively high R^2, meaning our regression explains a consequent part of the change in $Exports$.

As expected, being member of a PTA increases the trade flow between two partners consequently. Note that since our dependent variable is expressed in log, the coefficient of our independent variables should be interpreted as a variation in percentage of the export value. In the case of PTA for example, one can see that being part of a PTA pretty much doubles in average the level of export between two partners as this increases it by about 100% ($e^{0.6973} - 1 = 1.0083$). This is roughly in line with what was found by (Baier and Bergstrand (2007), but largely above what was reported by Brandi et al. (2020) or Berger et al. (2020).

Next, one can see a surprisingly positive effect of the number of EPs included in a PTA on the level of trade. Although statistically significant and positive, this coefficient might at first glance seem not so economically significant, with a partial effect on export value of only about 0.4%. One should however keep in mind that this is the partial effect of one additional EPs in a PTA on the level of export. Looking at the average number of EPs for trades under an active PTA, 28.36, the positive effect on trade with this amount amount of EPs goes up to slightly more than 10%, which is definitely not insignificant economically speaking.

Concerning the deepness level of the PTA, we obtained an unexpected significant negative effect. In order to interpret this coefficient correctly, let's remind how this depth variable has been formed. Our index of deepness is based on the number of provisions mentioned in a PTA among a pool of 52 different provisions. Taken literally, the coefficient thus means that each mentioned provision decreases the trade level on average by 3.7%. At the average level

of deepness for the exchange flows under a PTA in our sample, 16.6, this means a 61.37% decrease. This would induce that participating in a PTA increases largely the trade among the signatory countries, although, the larger the policy areas covered by the agreement, the lower the trade enhancing effect.

Table 1: Baseline results

	(1)
	Full sample
PTA	0.6973***
	(0.0802)
EPs	0.0038***
	(0.0008)
Depth	-0.0363***
	(0.0027)
Enforce	0.0534**
	(0.0267)
Constant	8.4319***
	(0.0049)
Country-pair FE	Yes
Exporter-year and Importer-year FE	Yes
Observations	1,341,917
Share of exports under PTA	0.11
Mean EPs if Exports under PTA	28.36
Mean Depth if Exports under PTA	16.60
R^2	0.8105

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2.

Finally, considering the level of enforceability of the EPs, we found a significant positive effect. In this case, the interpretation is not so straightforward since, as explained in section 3.2.3, the index of enforceability is based on an average of the enforceability level of each EP contained in a PTA and has thus not a clear quantitative meaning. However, one can still state that the

more binding the environmental provisions in a PTA are, the greater the effect on trade flow will be.

4.1.2 Country income sub-sample

Table 2 displays results from equation 2 estimated using sub-samples based on the income level of exporters and importers. Northern countries, or developed countries, are defined as high-income countries while southern countries, or developing countries, are defined as non-high-income countries. For instance, Column (2) represents results based on the sample with trade flows from high-income countries towards non-high-income countries.

The first striking finding is the non-significance of some coefficients compared to the estimation on the full sample where all coefficients were significant. Especially for exchanges between developed economies (column 1) where neither PTA nor EPs are significant anymore, suggesting that trade flows between rich countries are neither significantly influenced by the presence of a PTA nor by the number of EPs they contain, whereas the average number of EPs in such trade flows under a PTA are much higher than in other sub-samples. One can however note the persistent significant negative effects of the depth.

Most interesting are the results implying developing economies. Contrary to what was expected, one can see that the number of EPs influence positively the level of exchange both from rich countries towards developing ones (column 2) and between developing countries (column 4). Furthermore, the effect of the addition of one environmental provision in a PTA stands around 0.65%, which is not far from being twice as big as the effect in the full sample (0.38%). However, this effect is non-significant both statistically and economically for exchange from developing countries towards developed ones (column 3). In addition, one can see that the deepness of an agreement has also a negative effect on trade in the three sub-samples including developing countries.

Table 2: Results by income groups

	(1)	(2)	(3)	(4)
	North-North	North-South	South-North	South-South
PTA	0.1198	0.6299**	0.5216**	0.5432***
	(0.2642)	(0.2497)	(0.2629)	(0.1189)
EPs	0.0009	0.0066***	0.0001	0.0064***
	(0.0016)	(0.0017)	(0.0018)	(0.0018)
Depth	-0.0257***	-0.0388***	-0.0145**	-0.0219***
	(0.0090)	(0.0066)	(0.0070)	(0.0054)
Enforce	0.1293***	0.0621	-0.1689**	0.2520***
	(0.0405)	(0.0074)	(0.0079)	(0.0523)
Constant	14.7521***	10.7607***	10.0826***	6.2301***
	(0.0268)	(0.0074)	(0.0079)	(0.0098)
Country-pair FE	Yes	Yes	Yes	Yes
Exporter-year and Importer-year FE	Yes	Yes	Yes	Yes
Observations	89,917	258,568	260,979	730,607
Share of exports under PTA	0.25	0.09	0.08	0.11
Mean EPs if Exports under PTA	65.59	40.07	40.08	11.90
Mean Depth if Exports under PTA	32.92	22.93	22.93	8.74
R^2	0.8930	0.8447	0.8348	0.7569

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2 and the difference in country income described in section 3.2.4.

4.2 Robustness checks

Some additional tests have been conducted in order to see whether our results depend on the specification of the model we used or if they are robust to other specifications.

Phased-in effects

Until now, we have only accounted for the date of entry into force of the PTAs that have been used to create our variable PTA. However, most PTAs are implemented gradually, and it is therefore likely that their entire economic effect cannot be fully captured in the single year of their implementation. Thus, in order to account for this delayed effect, we included two lagged variables of PTA in our model. The results of these regressions are presented in Table 11 in the annex. We reported our standard results in column (1) for convenience. Column (2) reports the results using one lagged variable of PTA, and column (3) adds a second lag. Whereas column (3) leads to insignificant values of the effect of PTA and its first lag, column 2 shows that including one lag results in significant effects. The overall effect of participating in a PTA on exports in column (1) is the sum of the coefficients of PTA_{eit} and its lag, that is an increase of about 81%, which is somewhat smaller than the increase when not using any lags of about 100%. In this specification, one can however note that $Enforce$ is not significant anymore while still positive. Results about this variable in our main model should thus be interpreted cautiously. Otherwise, our results are overall rather similar and are thus still valid even with the inclusion of this lagged variable.

Table 11 also contains a fourth column accounting for a future level of PTA, or a so-called "Lead" variable. This allows to check for a potential reverse causality problem. As one can see, the coefficient of this lead variable is significant, meaning there might be some reversed causality in our model. In other words, it is plausible that not only the participation in a PTA influences trade between two countries, but the level of trade between two countries may also influence the decision to participate in a PTA. Although this would mean there is still an endogeneity issue, despite our effort to account for this endogeneity using fixed effects, as noted in section 3.1.1 about the gravity model, this simultaneity issue should not be the most important part of the endogeneity problem. A potential solution will be presented regarding this problem in section 4.3.

Check for multicollinearity

As shown in the assumptions of the model, section 3.1.3, variables of our model are somewhat highly correlated although not perfectly collinear. Whereas high collinearity does not cause the assumptions of OLS to fail, multicollinearity could however still be problematic. Indeed, high multicollinearity would cause our estimators to be much less precise. Therefore, we reported in Table 4 the variance inflation factors (VIFs) of our explanatory variables, which show their level of multicollinearity. Fortunately, all our VIFs are largely under the threshold of 10 which signals a potential problem of multicollinearity. We can thus assume there is no multicollinear-

ity problem in our sample.

Standard gravity equation

Another way to check for the dependence of our results on our main model is to use a more standard gravity equation, without fixed effects, but including classical control variables often employed while assessing trade between countries, such as the GDP of both trade partners or the distance between both countries. Such an equation has been estimated, its results are displayed in Table 12. The most striking difference with our baseline model is the change of sign of the coefficient for the number of environmental provisions and the level of depth of the PTA. These results hence do not provide robustness arguments for our model, however, as explained in section 3.1.1, we believe our baseline model is more precise. Especially, it accounts for at least some part of the endogeneity that could be present in the model used in Table 12. Plus, The R-squareds are much lower in these specifications. For these reasons, we believe the baseline equation 2 provides more reliable results.

Testing for the usefulness of the fixed effects

In order to see to which extent our baseline model depends on its fixed effects and potentially to assess their usefulness, we estimated equation 2 on our full sample, omitting parts or all fixed effects. Table 13 depicts these results. Column (1) shows the results using neither country-pair FE nor exporter- or importer-year FE, column (2) includes country-pair FE, and column (3) shows our baseline results with both types of FE. One can see in column (1) a tiny R^2, meaning that the independent variables explain very little of the variation in the export level. This is rather obvious since lots of the variables explaining trade between two countries, such as the GDP or the common language, which were normally accounting for in the model through the FE, are not present in this version of the equation.

Then, we can see that accounting for country-pair FE, going from column (1) to (2), both EPs and Depth's coefficient change signs, which is a major change for the conclusions one can draw. Finally, adding the exporter-year and importer-year fixed effects, that is accounting for the country-specific evolution over time, one can see the effect of PTA being largely reduced, probably because some of the effects of the evolution of GDP, for example, was not taken into account without exporter- and importer-year FE, and the coefficient of Enforce gains in significance. Overall it is clear that FEs have a significant impact on the results and should not be omitted.

Testing for the different depth definitions

As explained in section 3.2.3, 4 variations of the definition of a PTA deepness were possible. We chose $Depth\_all$ for the depth variable in our model suggesting it was the most comprehensive one. However, since this choice is somewhat arbitrary, we also estimated our regression on our full sample using the 4 variations of depth as well as on the sub-sample including only

trade flows from developing countries towards developed ones. These results are depicted respectively in Table 14 and Table 15. One can see that, overall, the results are mostly similar using $Depth\_all$ or one of the three other variables, except some slight variations in the significance level of some variables. The choice of $Depth\_all$ for our depth variable is thus robust. A notable variation is still the change of sign for the variable EPs in Table 15. However, it stays insignificant for the 4 definitions of depth used and therefore does not change the interpretation of our results.

4.3 Discussion

4.3.1 Interpretation of the results

The results we obtained in the two previous sections mostly go contrary to what we expected. Apart from the effect of signing a PTA on trade, which is, as the literature was widely suggesting, positive, all our explanatory variables have the opposite sign to the one we expected. We will go throughout all of them and suggest potential explanations for these unexpected signs.

Effect of Depth

First, considering the effect of the deepness of PTAs on trade, we obtained a large negative effect on trade. This goes against what we expect and against what some previous studies have found (Baccini et al. (2017); Brandi et al. (2020); Berger et al. (2020); Dür et al. (2014)). However, these studies all based their depth measure on the DESTA dataset presented by Dür et al. (2014). We state in this study that the measure of depth we adopted, which we explained in section 3.2.3 is arguably more precise than the one in DESTA. Indeed, the depth index from the WBDTA-H database is based on the compliance of the included PTAs with provisions from 52 policy areas as well as their enforceability, whereas the DESTA dataset only covers 10 policy areas (Hofmann et al. (2017)). This would be the main explanation for our finding of a negative effect of depth. This finding supports the idea that the more there are beyond-trade provisions included in a PTA, the smaller the beneficial effect of PTAs on trade is.

Effect of EPs

Next, we have seen that our results suggest a positive effect of the number of environmental provisions in a PTA on trade between signing partners. As a reminder, there is a priori two conflicting effects of EPs on trade. On the one hand, some EPs are committing signing countries to binding environmental-friendly pledges inducing a diminution of trade in non-ecological goods (trade-restrictive EPs). On the other hand, some EPs are fostering the exchange of environmental-friendly goods (trade-liberalizing EPs). There is a third argument going beyond the nature of the EPs, stating that well-designed environmental regulations will in the end lead to greater economic performances including a higher level of trade. This is the Porter hypothesis.

Our results are thus somewhat more in line with the Porter hypothesis. However, it is complicated, if we only take into account our results, to assess whether the positive effect of EPs on trade is only due to a confirmed Porter hypothesis. It might as well be that this positive effect comes from the fact that the effect of trade-liberalizing EPs prevails over the effect of trade-restrictive EPs. What is clear is that we found no evidence that environmental provisions restrict trade among signing countries of a PTA.

This goes against what found Berger et al. (2020) which is, to the best of our knowledge, with Brandi et al. (2020), the most advanced studies on the matter of EPs trade effects. Berger et al. (2020) found a slightly significant negative effect of EPs on trade whereas Brandi et al. (2020) found no significant effects on overall trade. We think these differences with our results mainly come from the data we used since our methodologies are rather similar. Indeed, in order to have access to the WBDTA-H database measure of depth, we had to restrict our analysis to the PTA included in this database, i.e. approximately half the PTAs contained in the TREND database used for the number of EPs in PTAs. Berger et al. (2020) and Brandi et al. (2020) conversely based their entire pool of PTAs on this TREND database. Since they used the depth index from the DESTA dataset, which is the dataset on which the TREND database is constructed, they did not lose information on PTA.

We thus see two potential reasons for this results divergence. The first is that we might have lost some precision on our estimators using a smaller set of PTAs. More precisely, the WBDTA database only records the PTAs that have been notified to the WTO. Our analysis might thus suffer from selection bias if the PTAs notified to the WTO have some specific characteristics that the other PTAs do not share and that are related to the variables in our model. On the other hand, it might be that the depth variable we used, which captures more precisely the PTAs depth, accounts for some variations that Berger et al. (2020) and Brandi et al. (2020) could not account for using a less precise depth index. This new variation, if correlated with the number of EPs, could have previously been falsely captured by the EPs coefficient, causing it to be biased downwards.

Effect of EPs for developing countries

Looking at the effect of EPs on trade while considering non-high-income countries, we found no proof that including EPs in PTAs reduces trade for developing countries. Particularly, while looking at the exchange from developing countries towards developed ones (column (3) in Table 2), although the coefficient of EPs is not significant anymore, it does not indicate any negative effects of EPs on trade. Following our results, hence we find no evidence indicating that developed countries pursue protectionist interests while leveling the playing field in environmental matters with developed countries. Furthermore, we found that EPs in PTAs for trade from rich countries towards non-rich countries as well as EPs in PTAs for trade among developing countries significantly increase trade.

Effect of enforceability

Considering the enforceability of the environmental provisions, our results are somewhat in accordance with what we were expecting. Indeed, we expected the EPs to have a negative effect on trade, and the level of enforcement of these EPs to lead to an even stronger negative effect on trade, suggesting the level of enforceability would reinforce the effect of the EPs. However, we found a positive effect of EPs on trade. Thus, the enforceability does indeed reinforce the effect of EPs on trade, but positively. This $Enforce$ variable should nevertheless be interpreted cautiously since its significance was not robust to the introduction of a lagged variable in our model.

4.3.2 Limitations and future research

The interpretations here above should be read keeping in mind that our model suffers from some limitations.

First, the results of the RESET test in Table 5 indicate a potential misspecification of our model. We think this misspecification mainly comes from the problem of reversed causality identified in the previous section. Indeed, although signing a PTA arguably leads to more trade among signing countries, it is quite possible that the level of trade between several countries before a PTA is signed influences the decision to sign such a PTA. Even if Baier and Bergstrand (2007) argue this issue is negligible, one should keep in mind it might leave some endogeneity issues in our model which cannot be taken into account with the fixed effect method we used. Future research on this topic could try to tackle this problem using IVs techniques as Frankel et al. (1997) proposed, while maintaining fixed effects.

Another problem of our equation is the vagueness of our depth variable, in the sense that, some policy areas will tend to have an overall positive effect on trade like the environmental one that we considered in this study, whereas other areas will, on average, lead to negative effects on trade. We thus reach a conclusion on the impact of depth in general which might be somewhat weak in sense. An interesting question for future research could be to split the depth measure into a few large bodies of policies in order to see the effect of each main area of policy on trade.

One should also note that our enforceability variable lacked in some ways of consistency. Indeed, the variable is based on the average of the EPs enforceability available in the WBDTA database for each PTA which makes it in some way really precise. However, the variable EPs in our model is not based on the environmental provisions from the WBDTA-V database, but on the one from the TREND database. Then, although we assume the average level of enforceability captured by our variable $Enforce$ should be rather similar to the average level of enforceability of the EPs in TREND, we have no proof of that. Plus since TREND covers a much wider variety of EPs, it might well be that this assumption does not hold.

Finally, what might be the largest issue in our research is the smaller number of PTAs included in the WBDTA-H database compared to what is usually used in the literature with the DESTA database. Especially if there is a selection bias due to the characteristics of PTAs specifically notified to the WTO. A widening of the WBDTA databases to account for every PTAs available in the DESTA and TREND databases would allow future research to take advantage to the fullest of what both TREND as well as the WBDTA databases have to offer.

An interesting path for future research could be to shed light on the reasons for the positive effects of environmental provisions on trade. Whether this positive effect comes from an outperforming effect of trade-liberalizing EPs over trade-restricting one or whether, more broadly, the Porter hypothesis turns out to be verified, could lead to very different policy decisions. Indeed, in the former case, policy makers might have larger interests only to include trade-liberalizing provisions in PTAs, whereas in the latter case, any type of provisions could in the long run lead to greater economic outcomes.

5 Conclusion

The number of preferential trade agreements signed has increased drastically over the past thirty years becoming the primary driving force of trade liberalization in our globalized world. The scientific literature has followed the trend with ever more studies exploring various aspects of the effects and determinants of PTAs. However, the literature addressing the effect on trade of environmental provisions included in such agreements has not received yet such wide attention. Furthermore, there is an ever-growing fear from developing countries that richer countries may use EPs as a sort of green protectionism. This study aimed at reducing this gap, using a novel mix of data.

We brought three main findings to the table. First, we obtained some results that might support the Porter hypothesis, stating that environmental regulations can yield greater economic outcomes through stimulated innovation and enhanced competition. At the very least we found some evidence that including EPs in PTAs can lead to larger levels of trade among signing countries.

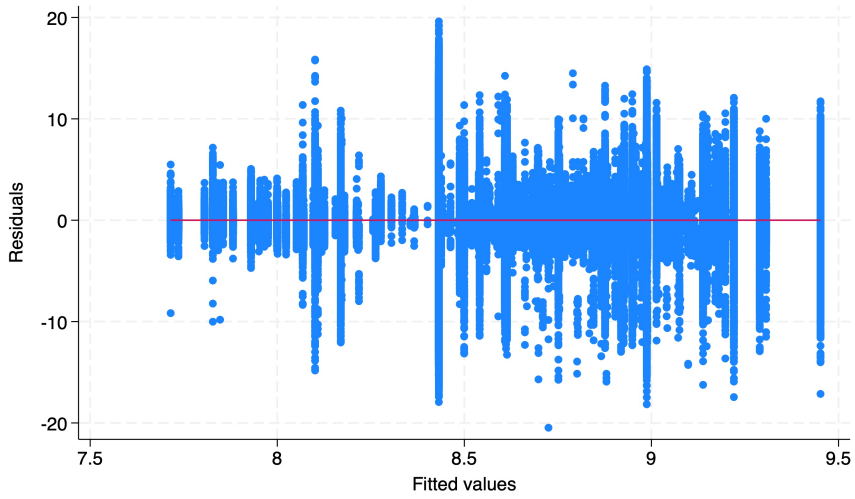
Second, we find no proof that there might be some protectionist interests from developed countries behind the inclusion of EPs in PTAs. Indeed, we did not get any significant effect of EPs on exports from non-rich countries towards rich ones. If anything, we found that the inclusion of environmental provisions lead to larger trade among developing economies as well as from developed economies towards developing ones.

Third, using the index of depth presented by Hofmann et al. (2017) which is arguably more precise than the ones having been used previously, we reached the conclusion that deeper trade agreements might lead to lower trade flows among signing countries. This results is however rather superficial and does not take a look at which policy areas in non-trade provisions lead to reduced trade and which one lead to higher trade. Future research could assess with more detail the effect on trade of the different types of non-trade provisions in PTAs.

It is still important to note that this study also presents some econometric limitations and its results should hence be interpreted knowingly.

Appendix

Figure 2: Scatter plot of the residuals from our main regression



Source : Own computation based on the data presented in section 3.2

Table 3: Correlation matrix

	PTA	EPs	depth_all	enforce
PTA	1.0000			
EPs	0.5645	1.0000		
depth_all	0.7212	0.8179	1.0000	
enforce	0.7520	0.6119	0.7391	1.0000

Source : Stata output from own computation based on the data described in section 3.2.

Table 4: Variance inflation factors

Variable	VIF	1/VIF
PTA	4.68	0.2138
EPs	3.04	0.3286
Depth	2.83	0.3528
Enforce	2.69	0.3717

Notes : results based on a simple regression of the log value of trade on PTA EPs Depth, and Enforce

Source : Stata output from own computation based on the data described in section 3.2.

Table 5: RESET test

Fitted value form	Coefficient	P-value
$Fitted\,values^2$	11.00555	0.029
$Fitted\,values^2$	0.5645	0.030

Source : Stata output from own computation based on the data described in section 3.2.

Table 6: Different definitions of depth

Variable name	Definition
Depth_all	All provisions, whether legally enforceable or not
Depth_le	All provisions only if legally enforceable
Depth_core_all	Only strictly economically significant provisions (WTO-plus + 4 WTO-extra provisions), whether legally enforceable or not
Depth_core_le	Only strictly economically significant provisions and only the one legally enforceable

Source : Mattoo et al. (2022).

Table 7: Regression of squared residuals on our independent variables (Breusch-Pagan Test)

Variables	(1)
PTA	0.2114582
	(0.0855034)
EPs	-0.0108935
	(0.0018103)
Depth	-0.1886157
	(0.0048993)
Enforce	-0.0343871
	(0.0431639)
Standard errors in parentheses	
p<0.01 ***, p<0.05 **, p<0.1 *	

Source : Stata output from own computation based on the data described in section 3.2.

Table 8: Index of enforceability

Value	Meaning
0	No provision
1	Non-binding provision
2	Binding provision with no dispute settlement (DS)
3	Binding provision with only state-to-state DS
4	Binding provision with only private-state DS
5	Binding provision with both state-to-state and private-state DS

Source: This table is based on the Deep Trade Agreements database 2.0 (vertical depth) (chapter 18) of the WB.

Table 9: Summary statistics PTAs

Variable	Observation	Mean	Std. Dev.	Min	Max
EPs	307	25.86645	28.32985	0	134
Depth_all	325	17.84308	9.64317	0	48
Depth_le	325	11.03385	6.199519	0	37
Depth_core_all	325	12.03692	4.752373	0	18
Depth_core_le	325	9.686154	4.308328	0	18
Enforce	285	2.50607	0.9556872	0	5
Year_entry	325	2003.757	10.86531	1958	2023

Notes: This table represents descriptive statistics for the 325 initial PTAs obtained from the Horizontal WBDTA database we wrote about in section3.2.3.

Source : Stata output from own computation based on the data described in section 3.2.

Table 10: Summary statistics trade flow observations

Variable	Observation	Mean	Std. Dev.	Min	Max
Trade	1,342,276	279.1653	3974.989	0	575075.1
Log_trade	1,342,276	8.461167	7.562737	0	27.07777
EPs	1,342,276	3.129493	15.73957	0	134
Depth_all	1,342,276	1.831548	7.209866	0	48
Depth_le	1,342,276	1.1227	4.624439	0	37
Depth_core_all	1,342,276	0.9337931	3.45038	0	18
Depth_core_le	1,342,276	0.8023842	2.98003	0	18
Enforce	1,342,276	0.1687365	0.6371034	0	5

Notes: This table represents descriptive statistics for the 1,342,276 trade flow observations in our final dataset described in section 3.2.

Source : Stata output from own computation based on the data described in section 3.2.

Table 11: Results from the full sample with lagged PTA

	(1)	(2)	(3)	(4)
	Full sample	Full sample	Full sample	Full sample
PTA_{eit+1}				-0.3741***
				(0.0441)
PTA_{eit}	0.6973***	0.2152***	0.1282	0.5211***
	(0.0802)	(0.0826)	(0.0847)	(0.0822)
PTA_{eit-1}		0.3782***	-0.0013	0.3898***
		(0.0467)	(0.0411)	(0.0471)
PTA_{eit-2}			0.3500***	
			(0.0468)	
EPs	0.0038***	0.0038***	0.0036***	0.0041***
	(0.0008)	(0.0007)	(0.0007)	(0.0008)
Depth	-0.0363***	-0.0299***	-0.0231***	-0.0295***
	(0.0027)	(0.0027)	(0.0027)	(0.0027)
Enforce	0.0534**	0.0372	0.0143	0.0447*
	(0.0267)	(0.0259)	(0.0251)	(0.0261)
Constant	8.4319***	8.6736***	8.8921***	8.6565***
	(0.0049)	(0.0052)	(0.0055)	(0.0056)
Country-pair FE	Yes	Yes	Yes	Yes
Exporter-year and Importer-year FE	Yes	Yes	Yes	Yes
Observations	1,341,917	1,285,637	1,233,136	1,233,136
R^2	0.8105	0.8129	0.8151	0.8130

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2.

Table 12: Results using a standard form of the gravity model

	(1)	(2)	(3)	(4)	(5)
	Full sample	North-north	North-south	South-north	South-south
PTA	2.8294***	2.7183***	3.9021***	3.2679***	4.0617***
	(0.1221)	(0.3279)	(0.2892)	(0.3136)	(0.1271)
EPs	-0.0215***	-0.0060***	-0.0203***	-0.0219***	-0.0322***
	(0.0022)	(0.0018)	(0.0021)	(0.0026)	(0.0046)
Depth	0.0576***	0.0241**	-0.0073	0.0180*	0.0177
	(0.0055)	(0.0098)	(0.0084)	(0.0096)	(0.0108)
Enforce	0.1854***	-0.0603***	-0.0090	-0.0928	0.0841
	(0.0498)	(0.0404)	(0.0999)	(0.1119)	(0.0753)
GDP_exp	1.36e-12***	5.29e-13***	7.41e-13***	2.20e-12***	3.29e-12***
	(4.22e-14)	(3.50e-14)	(2.84e-14)	(1.10e-13)	(1.01e-13)
GDP_imp	1.27e-12***	5.25e-13***	1.90e-12***	8.24e-13***	2.69e-12***
	(3.80e-14)	(3.53e-14)	(9.65e-14)	(3.45e-14)	(8.15e-14)
Distance	-0.0003***	0.0001***	-0.0002***	-0.0002***	-0.0003***
	(7.74e-06)	(0.0000)	(0.0000)	(0.0000)	(8.56e-06)
Contiguity	1.6416***	2.1338***	0.9720	2.0365***	2.2908***
	(0.1753)	(0.2653)	(0.7171)	(0.6262)	(0.1865)
Language	0.7723***	-0.5901***	-0.0248	0.0873	0.9075***
	(0.0709)	(0.2007)	(0.1318)	(0.1420)	(0.0794)
Colony_ever	3.1138***	2.3423***	2.8011***	3.6231***	1.9139***
	(0.1890)	(0.3969)	(0.2189)	(0.2471)	(0.3213)
Common_colonizer	-0.54801***	0.5312	0.8523***	-2.0966***	(0.2791)**
	(0.1191)	(0.4198)	(0.2282)	(0.3610)	(0.1205)
Landlocked_exp	-2.1785***	0.3767**	0.1155	-2.2949***	-1.9391***
	(0.0760)	(0.1784)	(0.1409)	(0.1453)	(0.0803)
Landlocked_imp	-1.8732***	-0.0945	-1.9091***	-0.1888	-1.6393***
	(0.0758)	(0.2100)	(0.1259)	(0.1752)	(0.0802)
Island_exp	-1.4474***	-1.6086***	-1.3400***	-1.9222***	-2.0943***
	(0.1035)	(0.2555)	(0.1660)	(0.2499)	(0.1195)
Island_imp	-1.4026***	-1.2183***	-1.6950***	-1.7067***	-2.0068***
	(0.1013)	(0.2452)	(0.2140)	(0.1732)	(0.1170)
Political_stability_exp	0.2613***	0.1599***	0.2432***	0.1608***	0.2070***
	(0.0045)	(0.0171)	(0.0099)	(0.0086)	(0.0048)
Political_stability_imp	0.2226***	0.0651***	0.1522***	0.2007***	0.1832***
	(0.0046)	(0.0165)	(0.0080)	(0.0110)	(0.0050)
Constant	10.649***	14.8248***	13.0370***	12.3974***	8.7924***
	(0.0803)	(0.2328)	(0.1505)	(0.1685)	(0.0918)
Country-pair FE	No	No	No	No	No
Exporter-year and Importer-year FE	No	No	No	No	No
Observations	609,782	32,413	108,988	110,457	357,924
R^2	0.3160	0.3522	0.2729	0.2729	0.2772

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2.
Notes : The new variables come from the ITPDE database.

Table 13: Results on the full sample using varying fixed effects

	(1)	(2)	(3)
	Full sample	Full sample	Full sample
PTA	4.1177***	5.1496***	0.6973***
	(0.1251)	(0.1107)	(0.0802)
EPs	-0.0128***	0.0024**	0.0038***
	(0.0020)	(0.0009)	(0.0008)
Depth	0.1728***	-0.0558***	-0.0363***
	(0.0059)	(0.0034)	(0.0027)
Enforce	-0.1043*	0.0353	0.0534**
	(0.0587)	(0.0360)	(0.0267)
Constant	7.7479***	7.9837***	8.4319***
	(0.0290)	(0.0065)	(0.0049)
Country-pair FE	No	Yes	Yes
Exporter-year and Importer-year FE	No	No	Yes
Observations	1,342,276	1,341,917	1,341,917
R^2	0.0812	0.6796	0.8105

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2.

Table 14: Results using different definitions of depth for the full sample

	(1)	(2)	(3)	(4)
	Full sample Depth_all	Full sample Depth_le	Full sample Depth_core_all	Full sample Depth_core_le
PTA	0.6973***	0.4620***	0.8032***	0.6057***
	(0.0802)	(0.0778)	(0.0884)	(0.0842)
EPs	0.0038***	0.0005	0.0025***	0.0016**
	(0.0008)	(0.0007)	(0.0007)	(0.0007)
Depth	-0.0363***	-0.0266***	-0.0857***	-0.0695***
	(0.0027)	(0.0035)	(0.0067)	(0.0072)
Enforce	0.0534**	0.0008	0.1219***	0.0708***
	(0.0267)	(0.0266)	(0.0273)	(0.0267)
Constant	8.4319***	8.4405***	8.4262***	8.4353***
	(0.0049)	(0.0047)	(0.0051)	(0.0049)
Country-pair FE	Yes	Yes	Yes	Yes
Exporter-year and Importer-year FE	Yes	Yes	Yes	Yes
Observations	1,341,917	1,341,917	1,341,917	1,341,917
R^2	0.8105	0.8105	0.8106	0.8105

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2 and the different depth specifications whose definitions are shown in table 6 in the appendix.

Table 15: Results using different definition of depth for the "non-rich towards rich countries" sample

	(1)	(2)	(3)	(4)
	South-North Depth_all	South-North Depth_le	South-North Depth_core_all	South-North Depth_core_le
PTA	0.5216**	0.4778**	0.5217*	0.4487*
	(0.2629)	(0.2386)	(0.3125)	(0.2578)
EPs	0.0001	-0.0004	-0.0006	-0.0006
	(0.0018)	(0.0015)	(0.0016)	(0.0015)
Depth	-0.0145**	-0.0234***	-0.0313	-0.0340*
	(0.0070)	(0.0083)	(0.0214)	(0.0188)
Enforce	-0.1689**	-0.1713**	-0.1351*	-0.1304*
	(0.0722)	(0.0731)	(0.0739)	(0.0735)
Constant	10.0826***	10.0835***	10.0820***	10.0835***
	(0.0080)	(0.0076)	(0.0085)	(0.0078)
Country-pair FE	Yes	Yes	Yes	Yes
Exporter-year and Importer-year FE	Yes	Yes	Yes	Yes
Observations	260,979	260,979	260,979	260,979
R^2	0.8348	0.8105	0.8106	0.8105

Robust and clustered at the country-pair level standard errors in parentheses
p<0.01 ***, p<0.05 **, p<0.1 *

Source : Stata output from own computation based on the data described in section 3.2 and the different depth specifications whose definitions are shown in table 6 in the appendix.

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Executive summary[4]

Amid the ever-growing number of preferential trade agreements (PTAs), more and more environmental provisions (EPs) are included. This raises the question of their ecological relevance in such agreements, as well as their would-be negative effect on trade. There also exists an increasing fear from the developing world that these EPs could be used as some form of green protectionism from richer countries. Using a novel mix of databases, this study aims at addressing these topics. Our results point towards a positive effect of EPs on trade without suggesting any evidence for potential green protectionism. This opens doors for future research to shed light on the effects of other non-trade provisions included in PTAs on trade flows.

[4]Word count = 11,564