Are International Environmental Policies Effective? The Case of the Rotterdam and the Stockholm Conventions*

Thaís Núñez-Rocha[1] and Inmaculada Martínez-Zarzoso[2]

Economic Modelling

https://doi.org/10.1016/j.econmod.2018.04.013

Abstract

This paper is the first to estimate the effectiveness of two international agreements (the Rotterdam Convention (RC) and the Stockholm Convention (SC)) in reducing the trade of hazardous substances. We estimate the effects of ratifying these agreements on the imports of affected products with emphasis on flows from OECD to non-OECD countries to capture pollution deviation. We use product level data to identify goods subject to these conventions and our identification strategy relies on the use of difference-in-difference techniques in a panel data framework. For trade flows from OECD to non-OECD countries, we find that when the exporter ratifies the RC, there is an observable and statistically significant reduction in the import of hazardous chemicals of about 7 percent. In the case of the SC, the results show significant reductions of around 16 percent in trade shipments of persistent organic pollutants. This level is more than double the effect found for the RC, which was expected due to a more restricted obligation imposed by the SC convention.

Keywords: Hazardous chemicals, persistent organic pollutants, environmental agreements, international trade, gravity model.

JEL codes: F13, F14, F18, Q53, Q56, Q58

Acknowledgments: We would like to thanks the Editor and two anonymous referees for the very helpful comments and suggestions received. I. Martínez Zarzoso would like to thank the Spanish Ministry of Economy and Competitiveness for the financial support received (ECO2017-83255-C3-3-P) and the University Jaume I (UJI-B2017-33). All errors are our own.

* A previous version of this paper has been circulated under the title "Are international environmental agreements effective? The case of trade in hazardous chemicals and persistent organic pollutants."

[1] Université d'Orléans.
[2] University of Göttingen and University Jaume I.

Are International Environmental Policies Effective? The Case of the Rotterdam and the Stockholm Conventions

1. Introduction

Developing countries have an incentive to sign International Environmental Agreements (IEAs) to prevent themselves from becoming pollution or waste havens. However, they may fail to effectively enforce the obligations of ratified IEAs. Consequently, unscrupulous individuals and firms could take advantage of these lax or non-existent regulations to send dangerous products to developing countries. To prevent this from happening, IEAs could act as a vehicle through which both importing and exporting countries can establish better institutional frameworks. Among the existing IEAs, there are two conventions that offer a good scenario to evaluate the effect of well-defined and explicit regulations: the Rotterdam Convention (RC, ratification started in 1999) and the Stockholm Convention (SC, ratification started in 2001). They focus specifically on regulating the production, use, export and import of hazardous chemicals (HCs) and persistent organic pollutants (POPs), which are among the abovementioned dangerous products and which have undesirable effects on human health.

The conventions' main aim is to decrease the production and trade of dangerous substances, especially shipments to developing countries. In order to understand the mechanisms through which they operate, it is necessary to revise the provisions and binding commitments included in each convention. The RC has two key provisions. The first is a legally binding Prior Informed Consent (PIC) procedure, according to which the exporting country must obtain consent from the importing country in order to send HCs. For example, for Aldrin —one of the products targeted by the RC— there have been 120 such requests since 1993 (only 40 after 2004), of which 113 have resulted in a 'no consent to import' response, only 4 have received 'consent to import' (the importers were the Congo, Nepal, Tanzania and Zimbabwe) and the remaining 3 obtained 'consent to import subject to specific conditions' (Korea, Singapore and Zambia). Interestingly, all requests since 2004 have been denied. The second key provision is the Information Exchange, which was developed to facilitate the exchange of information among parties involved with and affected by potentially hazardous chemicals. This provision stipulates that the secretariat of the convention must be notified of any change in national regulations that results in the banning of or restrictions on a chemical.

The SC is a treaty aimed at protecting human health by requiring parties to take measures to eliminate or reduce the release —whether intentional or unintentional— of POPs into the environment. Intentionally released POPs are listed in Annexes A and B (See text of the Convention), and unintentionally released POPs in Annex C (See text of the

Convention). Each party is required to eliminate the production, export, import and use of POPs listed in Annex A, and to restrict the production and use of those listed in Annexes B and C. The key challenge identified by the convention secretariats is the inadequate implementation of national-level obligations concerning adoption and compliance mechanisms.

In this paper, we assess the extent to which the ratification of these conventions affects exports of these dangerous substances to developing countries. To the best of our knowledge, this paper is the first to consistently evaluate the effects of the RC and SC on trade using difference-in-differences techniques in a panel data framework. We hypothesize that the ratification of these conventions should have had a direct effect on trade in HCs in the case of the RC and POPs in the case of the SC. Both conventions deal with substances that when released into the environment could be very harmful to human health, and are therefore undesirable unless appropriately used or treated to reduce or eliminate the damage they may cause. In particular, HCs (as classified by the American Occupational Safety and Health Administration) are both toxic and reactive and have great potential to cause harmful health effects when they are released. Relatively low-level exposure to these substances is linked to cancer, birth defects, genetic damage, miscarriages and even death. Regarding the products covered by the second convention, POPs, those have been shown to also have non-negligible negative effects on human health and the environment. Some of the identified health effects are cardiovascular disease, cancer, obesity and diabetes. POPs are also considered hormone disruptors, which can alter the normal functioning of the endocrine and reproductive systems in humans and wildlife.

To investigate whether the entry into force of these conventions has altered trade flows of the products in question, we estimate a gravity model of trade using highly disaggregated trade data (6-digit Harmonized System (HS) classification) on HCs and POPs in 88 countries over the period 1995-2012. More specifically, we seek to establish whether there has been a reduction in shipments from OECD to non-OECD countries[3] when trading partners have ratified any of the two conventions. The identification strategy relies on estimating the difference in import levels before and after the ratification of each convention by controlling for unobserved heterogeneity that is country-pair-product specific and time-invariant and also for multilateral resistance factors that are country-specific and time-variant. This strategy is borrowed from the international trade literature that seeks to identify the effect of regional

[3] We distinguish between OECD and non-OECD countries because according to the Basel Convention Ban Amendment "Parties agreed that Parties listed in Annex VII (members of OECD, EU, Liechtenstein) prohibit immediately all transboundary movements of hazardous wastes which are destined for final disposal operations from OECD to non-OECD States". Available at: http://www.basel.int/Implementation/LegalMatters/BanAmendment/tabid/1484/Default.aspx.

trade agreements on bilateral trade (Baier and Bergstrand, 2007). This strategy has been applied to disaggregated trade data, which allows us to exploit variation in imports over time at the country-pair-product level.

To the best of our knowledge, Kellenberg and Levinson (2014) conducted the only published study evaluating the effects of the most recent agreements on trade in waste. They investigate whether the Basel Convention and Ban have resulted in less waste being traded among ratifying countries. The paper finds that the Basel Convention and Ban seem to have no effect at all on the growth of international hazardous waste and almost no effect on shipments from developed to developing countries. As a consequence, the authors suggest linking IEAs to trade sanctions to strengthen their effectiveness. Our main departure from Kellenberg and Levinson (2014) is that whereas they aggregate all waste categories and estimate the model for total waste exports, we use the product-level data in our estimations and focus on two more recent conventions. Moreover, we present estimation results at different aggregation levels to infer whether there could be an aggregation effect.

The main results indicate that when the exporter ratifies the RC, lower amounts of HCs are shipped from OECD countries to non-OECD countries. In the case of the SC, smaller amounts of POPs are shipped from ratifying OECD countries to non-OECD countries, when the importer ratifies the treaty. These results are substantially different to those of Kellenberg and Levinson (2014), who do not find any effect of the Basel Convention and the corresponding Ban.[4] Our results point instead to the effectiveness of both conventions in reducing trade of the targeted substances. Moreover, when the gravity model is estimated using data at different aggregation levels, we find that the estimated effects are substantially different when descending at the product level.

Although, in accordance with the corresponding theoretical models, most of the early research evaluating the effects of IEAs found that they were generally ineffective (Barrett, 1994, 1997; Carraro and Siniscalco, 1993), recent theoretical developments show more mixed results (Carraro, 2014). Hence, we claim that the question of the effectiveness of the agreements is very relevant and is ultimately an empirical question. This paper's main methodological innovation is the use of highly disaggregated data that serves as a basis for the used identification strategy. Indeed, our findings show that IEAs, which intended to regulate and eventually stop trade of hazardous substances, are effective.

The rest of the paper is structured as follows. Section 2 describes the conventions, presents the related theories and the main hypotheses and summarizes the closely related empirical literature. Section 3 describes the data and

[4] Notice that since the conventions, the number of countries and the period under evaluation differ between Kellenberg and Levinson (2014) and our study, the results are not directly comparable.

variables and outlines the empirical strategy and model specification. Next, Section 4 presents the main results and Section 5 details the results of several robustness checks. Finally, Section 6 concludes.

2. Environmental Treaties on Waste, Hazardous Chemicals and Persistent Organic Pollutants: Theory and Evidence

2.1. The Conventions

The Basel Convention emerged as a result of the claim by developing countries, especially African countries, which found that waste was being improperly disposed of in their territories. This convention was adopted in 1989 and entered into force in May 1992. Its main objective was to control international shipments of hazardous waste and to foster the development of appropriate management techniques.

Initially, the instrument used was a mandatory PIC. The available evidence shows that the Basel Convention was not a strong enough commitment to reassure all involved parties. It drew further criticism from developing countries for the fact that the PIC provision of the Basel Convention legitimized a waste trade that had previously been illegal (Kellenberg, 2012). As a result, a few signatory countries added the Ban Amendment in 1994. Nevertheless, this Amendment, which was intended as a ban on all waste imported from OECD countries to non-OECD countries, is still not enforced today. This means that there may still be hazardous waste shipments to developing countries from industrialized ones, especially since the United States, one of the largest waste exporters, has not yet ratified the Basel Convention (Kellenberg, 2012). Moreover, its effectiveness is also unclear according to Kellenberg and Levinson (2014).

On the other hand, there is great awareness about the potential threat of products such as HCs and POPs. Some of these products are more production by-products than dangerous waste in its purest sense, but they have also been linked to health and environmental problems. The RC and SC emerged in response to specific problems posed by these products, which we will discuss in greater detail below.

The urgent need to control and restrict trade in these substances stems from the fact that exposure to some pollutants poses a major health risk around the world, though these risks are generally higher in developing countries, where poverty and a lack of investment in modern technology, combined with weak environmental regulations, cause greater pollution-related health problems (Briggs, 2003). More specifically, Johnson (1997) states that uncontrolled hazardous waste, and other unplanned releases of hazardous substances into the environment, are a concern due to

their impact on human health and the ecological damage they cause. Infants and young children are the most vulnerable to these effects (Gavidia et al., 2009).

Scientific studies have also linked POPs exposure to declining populations, diseases and abnormalities in a number of wildlife species. Wildlife can also act as sentinels for human health, indicating the potential effects on humans. Some evidence has led scientists to investigate POPs exposure in humans; it is known that people are mainly exposed to POPs through contaminated foods, although less common sources of exposure include drinking contaminated water and direct contact with these chemicals. In people and other mammals alike, POPs can be transferred through the placenta and breast milk[5] to developing offspring.[6]

The impressive growth in chemical production and trade, and the consequential potential risks posed by dangerous chemicals and pesticides, ultimately led to the adoption of the RC. It was the result of a joint initiative of the Food and Agriculture Organization (FAO) and the United Nations Environment Program (UNEP). In the 1980s, the two UN organizations had already started to develop and promote voluntary information-exchange programs on HCs and pesticides. Two of the first voluntary codes of conduct in support of food security and human health were the 'International Code of Conduct on the Distribution and Use of Pesticides', launched in 1985 at an FAO Conference, and the 'London Guidelines for the Exchange of Information on Chemicals in International Trade', set up by the UNEP in 1987. As a next step, the UNEP and the FAO jointly launched the voluntary PIC procedure in 1989, which provided governments with the necessary information to make informed decisions on their future imports. However, given that developing countries were particularly vulnerable and lacked the appropriate infrastructure to gather information on dangerous products and to monitor the import and use of these chemicals, a call for a legally binding instrument on the PIC procedure was made at the Rio Earth Summit in 1992. As a result, in 1998, the text of the Convention on the PIC Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was completed, ratification began in 1999 (see Table A1 in the Appendix for ratification dates by country) and entered into force in 2004, at which time it became legally binding for its parties.

According to the text of the RC, it has two main objectives. The first is to establish standards of conduct for all public and private entities engaged in or associated with the distribution and use of pesticides and to promote shared

[5] It should be noted, however, that despite this potential exposure, the known benefits of breastfeeding far outweigh the suspected risks.

[6] "Persistent Organic Pollutants: A Global Issue, A Global Response" (United States Environmental Protection Agency. Content created in 2002 and updated in December 2009.), https://www.epa.gov/international-cooperation/persistent-organic-pollutants-global-issue-global-response.

responsibility and cooperation among the parties, in order to protect human health and the environment from potential harm. The second objective is to facilitate the exchange of information about the characteristics of the HCs targeted by the convention, provide the necessary input for the national decision-making process on exports and imports of these chemicals, and to disseminate this information to all parties. Countries have a maximum period of nine months to prepare a response on the future import of a targeted product.

The targeted products, which include 28 hazardous pesticides and 11 other chemicals, are all products that are banned or severely restricted by a party. Annex III of the RC contains a list of products covered by the RC convention. A copy of that list can be found in Table A.2 in the Appendix.

The second convention we cover in this paper, the SC, was adopted in 2001 and entered into force in May 2004. It covers chemicals that are highly toxic, persistent, bio-accumulate and move long distances in the environment (POPs). The main aim of the convention is to restrict or eliminate the production and use of all intentionally produced POPs and to minimize unintentionally produced POPs (e.g. dioxins and furans). The list of products subject to the convention includes the pesticides used on various crops (aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene) and the industrial chemical polychlorinated biphenyls (PCBs), with the latter slated for elimination. Both types of chemicals have unforeseen effects on human health and the environment.

The parties are also obliged to ensure that the export and import of POPs listed in Annex A (see Table A.3 in the Appendix) or B of the convention, comply with the strict requirements laid out.[7] In particular, imports are only allowed for the purpose of environmentally sound disposal or for a specific use permitted for the party under the convention, whereas exports are only permitted when safer alternatives are not available in the market. Nevertheless, there is no specific procedure defined under the SC for the international trade of POPs.

Summarizing, the conventions provide explicit lists of products and focus on the reduction or elimination of production and trade in said products. We thus restrict the sample of products in our analysis to the trade of hazardous substances to only include these products. This allows us to analyze the two existent provisions in place for these conventions —the PIC used in the RC and the Ban (elimination) in the SC— and facilitates comparison

[5] Parties must take measures to restrict the production and use of the chemicals listed under Annex B for any applicable acceptable purposes and/or in light of any specific exemptions listed in the Annex. Annex B includes the pesticide DDT and the industrial chemical perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F).

with results from previous studies, particularly Kellenberg and Levinson (2014). The SC is expected to have had a greater impact than the RC due to the stronger provisions (Ban) in the former.

2.2. Theory and Main Hypotheses

A number of authors have investigated the effectiveness of IEAs in reducing pollution or improving environmental quality. Others have focused on the conditions that might facilitate full participation in IEAs (Cai et al., 2013; Takashima, 2016). The early theoretical models conclude that most IEAs tend to be ineffective due to the so-called free-rider problem.[8] Indeed, the findings tend to show that global agreements can only work if the abatement targets are far below the optimum level (Barrett, 1994; Carraro and Siniscalco, 1993). The free-rider problem could be overcome by establishing a central authority with coercive power, but in the case of international environmental issues, this solution seems unlikely. Nevertheless, more recent literature (summarized in Carraro, 2014) suggests that these predictions might be too pessimistic. For instance, if countries involved in the agreements are risk averse and the environmental damage attached to non-compliance is uncertain, countries may be willing to comply and to cooperate. This could be the case with hazardous waste, since most countries are aware of the detrimental effects on the environment and on human health. In these cases, it could be enough to have the right institutions to encourage cooperation and compliance (Carraro and Siniscalco, 1998; and Ecchia and Mariotti, 1998). Some countries may show more interest than others in controlling or stopping these activities and non-state actors may also play an important role. As such, the ratification of agreements could be influenced by different incentives. Indeed, as early as 1994, developing countries (G-77) and environmental NGOs called for a decision to ban the trade of waste, which then materialized in the Basel Ban Amendment.[9]

The effectiveness of the IEAs also depends on the existence of optimal environmental policies at the country level. According to Rauscher (1997), the international trade of hazardous waste might be biased towards the importing country if environmental externalities are not internalized. In such cases, the countries that produce waste or dangerous products may have incentives to export these products to countries with lower environmental standards (Fikru, 2012). Moreover, the importation of 'bad' products by developing countries could also be explained by the prevalence of low-cost disposal and organized crime (Clapp, 1997); the latter is negatively correlated with the stringency of environmental regulations (Kellenberg, 2013 and Copeland and Taylor, 2004).

[8] In this context, a free-rider problem occurs when some countries can benefit from lower global emissions without investing in clean technologies, or implementing environmental regulations, because other countries do it for them.

[9] At the Second Conference of Parties held in Geneva.

Grossman and Krueger (1991) decomposed the environmental impact of trade liberalization into the scale, technique and composition effects. These three effects work in tandem and in different directions: Whereas the scale effect has a negative impact on the environment (i. e. Boutabba, 2014) and the technique effect predicts that changes in the production methods induce by trade liberalization have a positive impact (i.e. Farajzadeh and Bakhshoodeh, 2017), the composition effect has an ambiguous effect (i.e. Gumilang et al., 2011). The impact of the composition effect on the environment depends on whether the source of a country's comparative advantage lies in a country's endowment of capital or labor and/or the stringency of environmental regulations (Copeland and Taylor, 2004)[10]. In the spirit of Copeland and Taylor (2004), the composition effect can also be linked to the choice of policy instruments and the flexibility of environmental policies and its effects on international competitiveness. In general, developing countries are less industrialized and their main comparative advantage usually comes from price advantages due mainly to low labor standards rather than to low environmental standards, and this can lead to a displacement of industries (Cole et al., 2017 and Kheder and Zugravu, 2012) or to waste displacement (Nunez-Rocha, 2016, Kellenberg and Levinson, 2014 and Kellenberg, 2013).

The relevance of differences in environmental regulations between countries as a source of comparative advantage is examined by Copeland and Taylor (2004).In this regard, the paper distinguishes between two hypotheses linking environmental regulations to comparative advantage. The first is the pollution haven effect (PHE), which has strong theoretical support, and states that more stringent regulations will have an effect on plant location decisions and hence on trade flows. The second is the pollution haven hypothesis (PHH) that states that countries engaged in liberalized trade with more stringent environmental regulations shall specialize in clean industries, whereas countries with lax environmental regulations would specialize and export dirty products. The theoretical support of this second hypothesis is very weak, since trade theory suggests that many other factors, different from pollution regulations, also affect trade flows. The available empirical evidence indicates the existence of a PHE, but it is not supportive of the PHH. Indeed, other factors are more important than the differences in environmental regulations in determining trade patterns (Copeland and Taylor, 2004). This is true for trade in general, but when assessing the effect of the trade of waste or dangerous substances, the scenario is quite different since this trade encompasses some local and regional pollution problems. The PHE applied to waste (the waste haven effect, as termed by Kellenberg (2012)) implies that greater differences in environmental standards between countries will foster trade in waste from

[10] In Cherniwchan et al. (2017) a 'firm-level focus' is given to the trade and environment relationship. The paper reviews the research on this relationship and adds a novel decomposition of the effects of trade liberalization on the environment, which partly emerges from the application of a new-new trade theory approach.

countries with stringent environmental laws to countries with lax environmental laws. The PHE applied to dangerous substances, such as HCs or POPs, would imply that countries which have ratified one of the two conventions and are thus subject to more stringent regulations, will reduce exports of the substances affected by the given convention at least to ratifying countries, whereas exports to non-ratifying countries might increase in comparison to ratifying countries.

The fact that institutions often fail to create the necessary environmental regulations in developing countries means that additional mechanisms must be implemented to control and deter trade in dangerous goods. One way of overcoming the inadequate institutions or lack of regulatory framework in developing countries could be based on a developed country policy approach. Yokoo and Kinnaman (2013) found that a tax on the consumption of new durable goods in developed countries, combined with a waste tax set below the domestic external cost of disposal, could be sufficient to achieve global efficiency. To that end, IEAs could be used as additional policy instruments to prevent the imports of dangerous substances by developing countries.

Applying these insights to dangerous products, we expect more stringent regulations concerning the production and use of hazardous products to generate an incentive to send those dangerous substances to countries with lax environmental regulations. In the case of the two conventions examined in this paper, the RC and the SC, we hypothesize that the ratification of these conventions should have had a negative direct effect on trade in the products covered by the conventions: HCs in the RC and POPs in the SC. More specifically, we expect the amount of dangerous substances sent from OECD countries to non-OECD countries to decrease after the exporters and/or importers ratify a convention, as proposed by the PHE. Hence, the effect will occur in North-South trade rather than North-North trade, given that the environmental standards and disposal facilities tend to be similar in developed countries and the conventions mainly affect trade between countries with very different environmental regulations (Kellenberg, 2015).

2.3. Empirical Evidence

This subsection summarizes the main results found in the related literature on the empirical evaluation of the influence of IEAs. We begin with general findings and then narrow the focus to papers that evaluate the effectiveness of treaties and conventions on hazardous products and waste.

A fairly comprehensive general overview of environmental agreements effects can be found in Mitchell (2003, 2006). He found that only a subset of the numerous existing agreements, more than 1000 IEAs in 2013, has been empirically evaluated. There are several reasons for the lack of scientific research in this area. First, there is a lack of

available data on the relevant environmental quality indicators until recent years and it is somewhat difficult to identify the expected effects of specific agreements. Second, some agreements target multiple environmental problems and it is not obvious which environmental indicator should be the focus of the evaluation. Finally, the endogeneity of participation in the agreement hinders the precise identification of the effect.

Mitchell (2003) points to somewhat mixed results regarding the identifiable effectiveness of IEAs. Some studies show clear evidence of a positive effect on the targeted environmental quality indicator; for example, Parson (2003), Wettestad (2001) and Greene (1998) evaluated ozone agreements and found a reduction in the consumption of chlorofluorocarbons (CFCs) in industrialized countries, perhaps also due to the existence of close substitutes for these products or due to declining rates of manufacturing in these countries.

In other cases, the evaluations show no effect. International whaling agreements, for example, were widely believed to have contributed to the current stable stock levels until Schneider and Pearce (2004) showed that market forces - and not the ratification of these agreements- were behind the declining catch. Skjaerseth (2001) and Haas (1990) found the Mediterranean Pollution Plan to have had little effect on marine pollution. Finally, some conflicting outcomes are put forward in Munton et al. (1999), who emphasize that the results of many studies are highly susceptible to the chosen methodology.

Another major international agreement is the Kyoto Protocol, for which a few authors have found mixed evidence of its effectiveness. Aichele and Felbermayr (2012) analyzed the impact of ratifying the Kyoto Protocol on countries' CO_2 emissions between 1997 and 2007. In order to overcome the problem of self-selection into the protocol, the authors use a country's membership in the International Criminal Court (ICC) and its spatial lag to instrument the Kyoto variable and restrict the data to a sample of 40 countries. Their findings indicate that countries with Kyoto commitments emit, on average, about 8 percent less CO_2 than countries without. Using an alternative identification strategy to address the self-selection issue, namely a matching difference-in-differences estimator, Grunewald and Martinez-Zarzoso (2016) consistently found a 7-10 percent reduction in CO_2 emissions attributable to the adoption of the Kyoto Protocol. Mazzanti and Musolesi (2009) also found that the Kyoto Protocol has a negative effect on CO_2 emissions for the northern EU country group. This is in contrast to Almer and Winkler (2017) who tested for the existence of a reduction in emissions in 15 Annex B countries with binding emission targets and found that CO_2 emissions are not below what they would have been without the protocol. They claim that the opposing trends in CO_2 emissions between countries with and without binding emission targets lead to a violation of the common trend assumption made in previous studies and that failure to address this could invalidate the results. However,

Grunewald and Martinez-Zarzoso (2016) could not reject the parallel trend assumption when restricting the sample to high-income countries (see Figure 2, page 11). The possible divergence in the results may instead be due to the way in which the counterfactual sample is constructed in Almer and Winkler (2017).

Given the diversity of the agreements in terms of content, scope and targeted environmental outcomes, we now focus on papers that evaluate the effectiveness of agreements involving the trade of waste, HCs and POPs. Trade in waste and dangerous substances is a relatively new area of research. Baggs (2009) was one of the first authors to study this topic. He analyzed the determinants of trade in hazardous waste using a gravity model with country characteristics for the period from 1994 to 1997. He interpreted the negative coefficient of per capita income (only significant at the 10 percent level) for importer countries as an indication of the existence of a waste haven effect. Behind this interpretation is the idea that GDP per capita could be a proxy for the stringency of environmental regulations. Hence, assuming that citizens demand higher environmental quality when they become richer, lower amounts of waste should be exported to countries with higher GDP per capita. Since there were no IEAs limiting trade in waste in the study period, the author cannot analyze their effects on bilateral trade. Additionally, no environmental regulation differences are explicitly included in the analysis, and proxying those with GDP per capita might be problematic, given that differences in income per capita may also reflect wage differences across countries.

Assuming that differences in environmental regulation matter, Kellenberg (2012) uses aggregated imports of 62 HS-6 categories of waste for a cross-section of 92 countries in 2004. He found that the 10 largest exporters are OECD countries, while China, Turkey and South Korea are the largest importers. He also estimated a gravity model that includes a Basel ratification dummy, which is statistically significant and negative in two specifications. However, the author was not able to control for the endogeneity of the Basel-ratification in a cross-sectional setting, and for this reason, the results cannot be interpreted as causal.

Subsequently, Kellenberg and Levinson (2014) estimated the effect of the Basel Convention and the subsequent Ban Amendment on waste trade (aggregate trade for 60 HS6 categories of waste products) using data for 117 countries over the period from 1988 to 2008. The main results, after controlling for multilateral resistance to trade and endogeneity by using panel data techniques and time invariant controls, show no clear evidence supporting the effectiveness of the Basel Convention and the Ban Amendment. In particular, no decrease in bilateral waste trade was observed for country pairs that have ratified the Basel Convention. Only when using a restricted sample, was some evidence found.

In our empirical application, we will follow a similar estimation strategy to Kellenberg and Levinson (2014) to analyze the effectiveness of the SC and RC in reducing trade in their respective targeted products. The main difference with our strategy is that we estimate the gravity model using trade at the 6-digit disaggregation level — without aggregating— to control for any unobserved heterogeneity that is country-pair-product specific and time invariant and that could represent factors such as product-specific differences in comparative advantages or in production techniques between a pair of countries.

3. Empirical Strategy

3.1. Data and Variables

The first step in evaluating the effectiveness of the conventions is to correctly identify the products involved. The targeted products are identified using the Harmonized Commodity Description and Coding System, generally referred to as the Harmonized System (HS) of tariff nomenclature. Since there were a number of changes in the HS product codes during the period under study (1995-2012), we use different versions of the HS classification — namely the 1992, 1996, 2002, 2007, 2012 versions— and track the same products over time. To select the products affected by the two conventions, we take the list of products published on their respective websites.[11] The text of the RC, written before 1998, refers to the HS codes in the 1996-HS system (6 digits); those codes are then converted into 1992-HS using BACI[12].

In the case of the SC, the products covered are published in the Chemical Abstracts Service Registry Number (CASRN), with the corresponding product codes. These CASRN codes were converted into the 2012-HS codes (6 digits), and then re-converted into 1992-HS codes.[13]

Import flows in tones, as well as other gravity variables (distance, common border, common language and colonial links), are extracted from the BACI dataset compiled by CEPII for 88 exporters and 88 importers between 1995 and

[11] http://www.pic.int/ and http://chm.pops.int/, respectively.

[12] BACI is the world trade database developed by CEPII (Center for International Prospective Studies, referred to by its French acronym CEPII), which provides a high level of product disaggregation. http://www.cepii.fr/cepii/. BACI trade data is constructed using a procedure that reconciles the declarations of the exporter and the importer. The BACI trade data are sourced from the United Nations Statistical Division (COMTRADE database).

[13] The European Commission website has a tax and customs union section that contains a customs inventory of chemical substances, ECICS. It also contains a guide to the classification of chemicals in the combined nomenclature (HS codes at the 6- digit level of disaggregation) and the corresponding Chemical Abstracts Service Registry Number (CASRN) classification used by the Stockholm Convention. More information about the procedure is available from the authors. For the conversion from CAS codes to HS6 codes, please refer to: http://ec.europa.eu/taxation_customs and for the conversion from 2012-HS6 codes to 1992-HS6, the information is available at: http://unstats.un.org/unsd/trade/conversions/HS.

2012. GDP and population data are from the World Development Indicators, while the RTA and common currency dummies are from De Sousa (2012).[14]

The OECD dummy takes the value of one starting from the year in which a new member joins the organization in our sample. The dummy variables representing ratification of the SC and RC have been constructed using the information available on their respective websites, as shown in Table A1 in the Appendix. The year of ratification has been used in the empirical analysis irrespective of the specific month in which the ratification was completed. Table 1 presents summary statistics of the main variables.

The dependent variable has been constructed using the volume imported of the specific products (at the 6-digit disaggregation level) using the 1992-HS6 codes provided in Table A2 for the products targeted by the RC, and the definitions listed in Table A3 for the products targeted by the SC. The use of disaggregated data allows us to control for product-specific time-invariant effects (Cherniwchan et al, 2017). It is worth mentioning that there are many countries that do not trade certain products for the entire period under study and hence those countries are excluded from our primary analysis. Our data is a strongly balanced panel of 88 countries comprising an exhaustive sample of hazardous products and persistent organic pollutants covered by the two conventions, for which trade is available every year from 1995 to 2012. Therefore, we focus on explaining the changes in the quantity traded in the selected products, that is, the intensive margin of trade.

Table 1. Summary Statistics

Variable	Obs.*	Mean	Std. Dev.	Min	Max
Rotterdam Convention					
Ln(imports)	209,951	2.718	2.843	-6.911	12.497
Importer ratifies	209,951	0.469	0.499	0	1
Exporter ratifies	209,951	0.51	0.500	0	1
Both ratify	209,951	0.369	0.482	0	1
Ln(gdp) importer	209,951	12.017	1.890	7.242	16.598
Ln(gdp) exporter	209,951	13.304	1.615	7.242	16.598
Ln(distance)	209,951	8.188	1.095	4.742	9.886
Contiguity	209,951	0.100	0.300	0	1

[14] We acknowledge the fact that we do not consider re-imports (re-exports) of the products analyzed. Nevertheless, according to UNCOMTRADE data these flows account for a very low share of total trade in the corresponding product categories. Considering the volume of trade in the products subject to the RC and the SC, the corresponding shares of global re-exports amount to 4 and 7 percent, respectively.

Common language	209,951	0.179	0.384	0	1
Colony ties	209,951	0.027	0.161	0	1
RTA	209,951	0.394	0.489	0	1
WTO	209,951	1.809	0.416	0	2
Common currency	209,951	0.054	0.225	0	1
Stockholm Convention					
Ln(imports)	91,673	1.793	3.073	-6.908	13.084
Importer ratifies	91,673	0.426	0.495	0	1
Exporter ratifies	91,673	0.426	0.495	0	1
Both Ratify	91,673	0.337	0.473	0	1
Ln(gdp) importer	91,673	12.429	1.754	7.242	16.598
Ln(gdp) exporter	91,673	13.640	1.426	7.464	16.598
Ln(distance)	91,673	8.237	1.088	4.742	9.881
Contiguity	91,673	0.097	0.296	0	1
Common language	91,673	0.151	0.358	0	1
Colony ties	91,673	0.018	0.132	0	1
RTA	91,673	0.400	0.490	0	1
WTO	91,673	1.813	0.412	0	2
Common currency	91,673	0.063	0.242	0	1

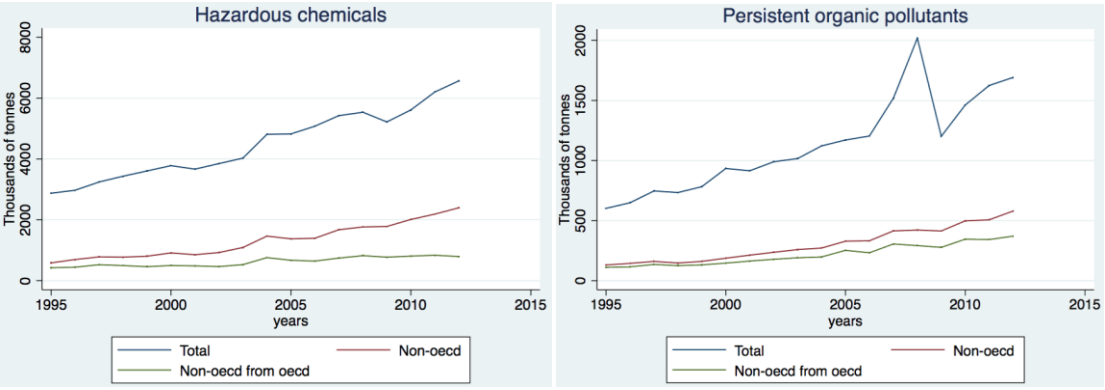
Note: *The number of observations differs between the two conventions due to the different disaggregation levels used.

3.2. Stylized Facts

To illustrate the evolution of trade flows over time, we plotted total annual imports of HCs and POPs in Figure 1[15]. In this figure, imports of both HCs and POPs show a positive trend over time and it can be observed that a large part of non-OECD countries' imports come from OECD countries. It also indicates a more pronounced increase in the total amount imported after 2004 in comparison to changes over time in imports before this date. However, when looking at the flow from OECD countries to non-OECD countries, the volume of imports levels out after 2004 on the left-hand side of the figure (HCs) and increases only slightly on the right-hand side (POPs).

Figure 1. Imports over time of HCs and POPs

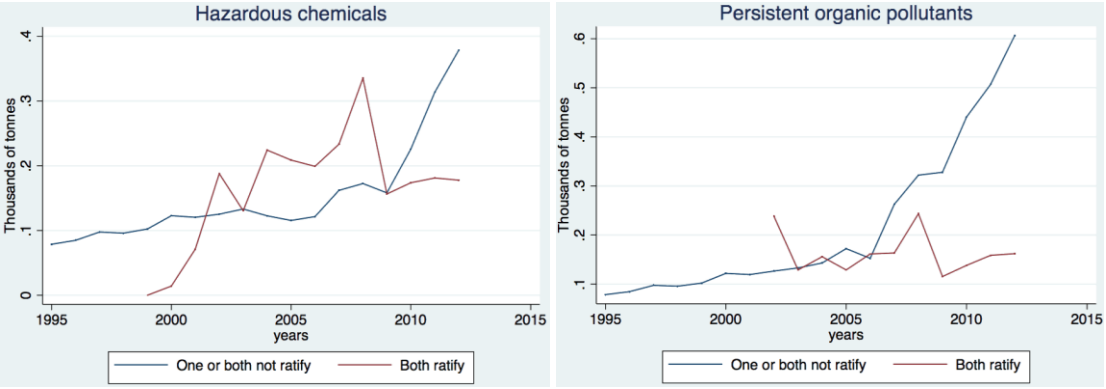
[15] Graphs used in this paper are illustrations based on a global sample of trade data brought over to a specific mean according to the graph. In addition, this panel –in contrast to the sample of our estimations—may not be balanced.



Source: BACI.

Since the main question at hand is if OECD countries have indeed reduced the amount of these products exported to non-OECD countries as a consequence of ratifying and subsequently adopting the conventions, we now present the trends in imports for the different groups of countries before and after ratification, and compare the figures for ratifying and non-ratifying countries in Figure 2. The Figure shows that when one or both trading partners do not ratify the corresponding convention, the average volume of bilateral imports increases by a factor of 3 and 6 for RC and ST, respectively. This already provides an idea of the success of these conventions in reducing trade to non-OECD countries.

Figure 2. Imports from OECD to Non-OECD countries

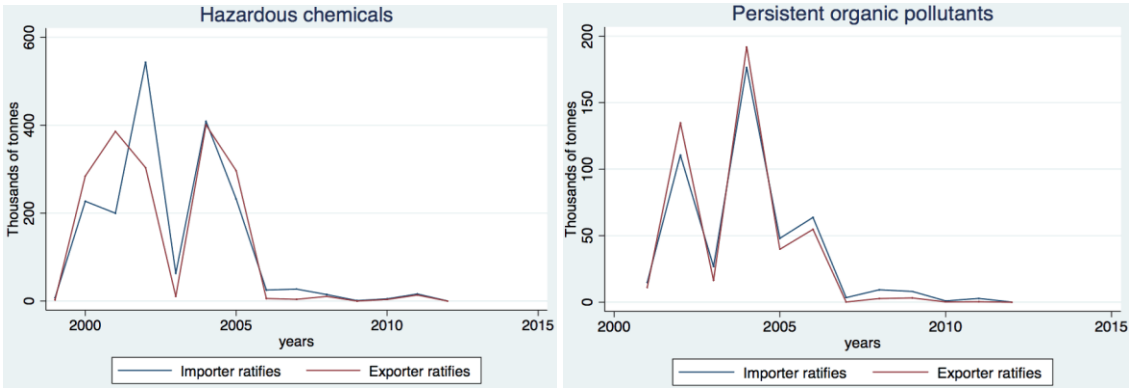


Source: BACI.

Nevertheless, we acknowledge that there are two potential explanations for the reduction of trade flows between ratifying countries. First, the conventions could have a real effect on reducing trade of HCs and POPs among participants relative to HCs and POPs shipped among nonparticipants. Second, the effect could be explained by a change in the composition of participants over time. It could be that countries with large volumes of trade in HCs and POPs have chosen to ratify earlier in time than countries with lower volumes. Figure 3 shows the average annual shipments by year of ratification illustrating that the largest volumes are observed in the earlier years of the sample

and hence part of the decrease in imports shown in Figure 2 is explained by this composition effect. Moreover, if those joining the Convention later are those trading less than the average, annual shipments among participants might decline even with the same pattern of trade across countries.

Figure 3. Average Annual Total Shipments by Year of Treaty Ratification



Source: BACI.

Finally, since the main question at hand is whether developed countries have indeed reduced the amount of these products exported to developing countries as a consequence of ratifying and subsequently adopting the conventions, we now present, in Figure 4, the trends in imports for the different groups of countries before and after ratification, and compare the figures for ratifying and non-ratifying countries.

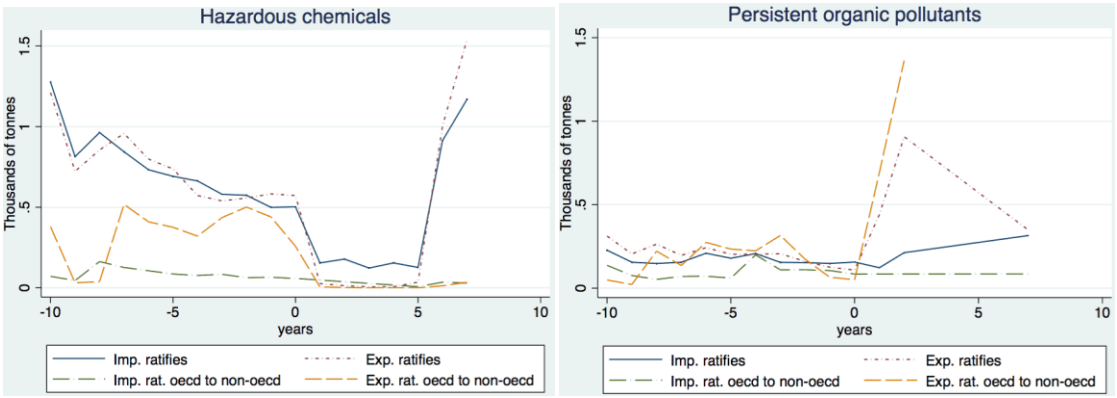
Figure 4 shows the average annual shipments of HCs and POPs separately for when only the importer ratifies and for when only the exporter ratifies, as well as for when either of the two ratifies and the flow goes from OECD to non-OECD countries. The figure shows aggregation of all products and depicts the average bilateral imports by year for the given group of countries. We define year zero as the point in time when the convention was ratified by the exporter or the importer.

In the case of HCs, when it is only the importer or only the exporter that ratifies, a big drop is shown the year after the convention is ratified (and consequently enters into force), followed five years later by an increase. This suggests that countries, respecting the legal framework, may have started to comply with the PIC procedure and after some years trade in HCs when back to normal levels. For cases in which the flow goes from North to South and the importer ratifies the RC, the amount of HCs imported shows a steady decrease in the years before ratification before stabilizing. Conversely, when using the date when the exporter ratifies with the same flow (North-South), a sharp decrease in the amount traded is observed at year 1, with quantities of HCs remaining low after that date.

Concerning POPs (right-hand side of Figure 4), the results indicate a sharp increase at years 1 and 2 after the exporter ratifies, followed by a sharp decrease. However, when the flow is North-South, there are no observations after year 1 indicating that there are zero imports from OECD to non-OECD countries. This could be explained by the fact that the convention imposes a clear ban or import prohibition rather than simply controlling the flows. This is already a sign of the effectiveness of the convention.

When using the date the importer ratifies, a slight decrease in imports of POPs is observed at year 1, followed by a steady increase, whereas a steady decrease is observed that had already started four years before ratification for the same flow for OECD to non-OECD trade only, with trade remaining at low levels thereafter.

Figure 4. Imports of HCs and POPs Before and After Ratification of the RC and SC



Source: BACI.

The analysis of the total annual shipments of HCs and POPs made 10 years before and after countries ratified the conventions reveals an interesting picture for both conventions (Figure 4). Since Figures only show trends in the data, we aim to employ a modeling strategy to investigate if the conventions are effective at reducing the intensive margin of imports of the products that they target.

3.3. Model Specification

The gravity model of trade is considered the workhorse in estimating the effect of policy-based bilateral agreements on bilateral trade flows (Feenstra, 2016). In particular, it has been widely used since the 1960s to estimate the effects of free trade agreements (FTAs), economic integration agreements (EIAs) and monetary unions (MUs). More recently, it has also been used to estimate the effects of IEAs on trade (Kellenberg and Levinson, 2014) and in most cases the methodology has been borrowed from the literature on trade agreements. We base our main state-of-the-art specification of the gravity model on Baier and Bergstrand (2007), but due to the shorter time span for which IEAs have been in force, we will only be able to capture short-term IEA effects. As explained by Baier and Bergstrand

(2007), IEAs can take more than 10 years for their full impact on bilateral trade to materialize; since the IEAs under analysis have been in force only since 2004 and because the dataset only covers up to 2012, we will not be able to estimate the long-run effects at this point in time.[16]

An important issue in the estimation of the effects of IEAs on trade is the fact that self-selection of country pairs into IEAs may create an endogeneity bias in the estimates. For instance, trade partners that ratify the conventions might be those for which trade in HCs or POPs is not growing. As suggested by Baier and Bergstrand (2007), panel data techniques can be used to avoid endogeneity bias by incorporating bilateral effects in a log-level specification. A second issue that is well known in the trade literature is the need to include the so-called multilateral resistance terms (MRT, Anderson and Van Wincoop, 2004) in the model, which represents the relative-price differences across countries with respect to all their trading partners. Since these factors vary over time in a panel data framework, they could be proxied using time-varying exporter and importer fixed effects, which will not only capture price effects, but also all the unobservable heterogeneity that varies over time for each origin and for each destination. In what follows, we specify a theoretically founded (or structural) gravity model of trade that will be estimated in the next section.

According to the underlying theory that has been reformulated and extended by Anderson and Van Wincoop (2003), our model assumes a constant elasticity of substitution and product differentiation by place of origin. In addition, prices differ among locations due to symmetric bilateral trade costs. The reduced form of the model is specified as:

$$M_{ijt} = \frac{Y_{it} Y_{jt}}{Y_t^W} \left(\frac{t_{ijt}}{P_{it} P_{jt}} \right)^{1-\sigma} \qquad (1)$$

where M_{ijt} are the bilateral imports from country i to country j in year t, and Y_{it}, Y_{jt} and Y^W are the GDP of the exporting country, the importing country and the world in year t, respectively. t_{ijt} denotes trade costs between the exporter and the importer in year t, and P_{it} and P_{jt} are the so-called MRT. σ is the elasticity of substitution between all goods.

The empirical specification in log-linear form is given by:

$$\ln M_{ijt} = ln\, Y_{it} + ln\, Y_{jt} - ln\, Y_t^W + (1-\sigma) ln\, t_{ijt} - (1-\sigma) ln\, P_{it} - (1-\sigma) ln\, P_{jt} \quad (2)$$

[16] In any case, the agreements we analyze here imply a reduction or elimination of trade in the targeted products and hence, the short-run effects are more relevant in this setting than the case of IEAs, in which the agreements favor trade increases and could lead to trade creation in new products that takes time to materialize.

The estimation of equation (2) is not straightforward due to the presence of trade costs and MRT.

In the gravity literature, the trade cost function $t_{ijt,}$ is assumed to be a linear function of a number of trade barriers, namely, the time-invariant determinants of trade flows, including distance, common border, common colonial past and common language dummies and the time-varying policy variables (membership in international agreements such as RTAs, IEAs, WTO, etc.). It takes the form:

$$T_{ijt=}d_{ij}^{\alpha_3}\exp\left(\alpha_4 Contig_{ij}+\alpha_5 Comlang_{ij}+\alpha_6 Comcol_{ij}+\alpha_7 RTA_{ijt}+\alpha_8 WTO_{ij}+\alpha_9 Comcur_{ijt}+\alpha_{10} IEA_{ijt}\right) \quad (3)$$

Substitution of the trade cost function (3) into equation (2) and adding the product dimension as well as group, product, time dummy variables, interaction terms and an idiosyncratic error term gives the following specification:

$$Ln(M_{ijkt}) = \alpha_0+\alpha_1 \ln Y_{it}+\alpha_2 \ln Y_{jt}+\alpha_3 \ln Dist_{ij}+\alpha_4 Contig_{ij}+\alpha_5 Comlang_{ij}+\alpha_6 Comcol_{ij}+\alpha_7 RTA_{ijt}+$$
$$\alpha 8WTOijt+\alpha 9Comcurijt+\alpha 10IEAijt+g\tau tgGroupijt+g\delta g(IEAijt*Groupijt)+diyIiy+djyIjy+\gamma t+\theta k+uijkt \quad (4)$$

where M_{ijkt} is the quantity imported (in tons) of the products (*k*) subject to each convention shipped from country *i* to country j in year *t*; ln $Dist_{ij}$ denotes the geographical distance between country *i* and country *j* in logs; $Comlang_{ij}$ and $Comcol_{ij}$ take the value of one when countries *i* and *j* share an official language or have ever had a colonial relationship, respectively, and zero otherwise; $Contig_{ij}$ takes the value of one when the trading countries share a border, zero otherwise; RTA_{ijt} takes the value of one when the trading countries are members of a regional trade agreement, zero otherwise; WTO_{ijt} takes the value of one if country *i* or country *j* are WTO members and two if both are members; and $Comcur_{ijt}$ takes the value of one when countries *i* and *j* belong to the same currency union. IEA_{ijt} takes the value of one when the trading countries i and j have ratified the corresponding convention (RC for the Rotterdam Convention and SC for the Stockholm Convention)[17], γ_t denotes a set of year dummies that proxy for business cycle and other time-variant common factors (globalization) that affect all trade flows in the same manner.

[17] In the estimations without price effects that are presented in the next section, three membership dummies are included: the 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if the importer (or exporter) ratifies (independently of what the exporter does) and zero otherwise. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

$\Sigma g\ Group_{ij}$ are g=3 dummy variables that represent trade from OECD to non-OECD countries, from non-OECD to OECD countries and from OECD to OECD countries, respectively, in order to partially control for group-specific bilateral unobservable heterogeneity. $\sum_{g}(\mathrm{IEA_{ijt}} * \mathrm{Group}_{ijt})$ is the term that represent the interaction of the ratification or the IEAs (importer, exporter or both) with the group dummy OECD to non-OECD countries. These are our target variables. Since the model is estimated using product-level trade data, we add a *k* subscript that denotes a given product at the 6-digit HS disaggregation level and also add dummy variables that are product specific to control for any unobserved product characteristics that are constant across bilateral flows and over time. In line with recent gravity literature, the MRT ($ln\ P_{it}$, $ln\ P_{ij}$) are modeled as time-varying country-specific dummies. Hence, in equation (4), we also introduce two sets of dummies: $\mathrm{d_{iy}}$ and $\mathrm{d_{jy}}$ for exporters and importers. We construct country-and-time dummies that vary every five years (*y*) instead of yearly (*t*) in an attempt to account for factors that vary slowly over time and are country specific such as domestic environmental regulations, political stability and industrial policies (Gylfason et al. (2015)).

Finally, in an additional specification, rather than adding the usual time-invariant gravity variables to control for differences in trade costs (distance, etc.), we use country-pair-product fixed effects γ_{ijk} to control for bilateral unobserved characteristics. The equation is given by:

$$\ln(\mathrm{M_{ijkt}}) = \gamma_{\mathrm{ijk}} + \beta_1 \mathrm{FTA_{ijt}} + \beta_2 \mathrm{WTO_{ijt}} + \beta_3 \mathrm{Comcur_{ijt}} + \beta_4 \mathrm{IEA_{ijt}} + \sum_{g} \delta_g (\mathrm{IEA_{ijt}} * \mathrm{Group_{ijt}}) + \sum \mathrm{d_{iy}}\, \mathrm{I_{iy}} + \sum \mathrm{d_{jy}}\, \mathrm{I_{jy}} + \mathrm{u_{ijkt}} \quad (5)$$

Our estimation strategy follows Baier and Bergstrand (2007), Gylfason et al. (2015) and Head and Mayer (2014) by using country-pair-product fixed effects to control for endogeneity of the agreement effects (introduced in equation (5)), as well as exporter-and-time and importer-and-time dummy variables to control for MRT (already introduced in equation (4) and kept in (5)). In this way, the gravity models that we estimate in this paper control for the possibility of endogeneity present in the ratification variables, which could arise if countries self-select themselves into both the ratification process and the time of ratification, depending on their volume of trade for the pollutant in question. In summary, in the most comprehensive specification shown by equation (5), we exploit the panel nature of the data and include three sets of fixed effects (dummy variables) that account for time-varying unobserved factors for the exporter and the importer separately, and across the country-pair-product dimension (country-pair-product or 'dyadic'-product fixed effects). For comparison, we present the traditional gravity model estimations with economic

and bilateral variables and product fixed effects (instead of dyadic-product fixed effects) and with common time effects instead of MRT. Standard errors are clustered at the country-pair-product level in the regressions using disaggregated data and at the country-pair in regressions using aggregated data.

4. Main Results

In this section, the estimation results are presented separately for each convention. Table 2 presents the results obtained for the RC and Table 3 the results for the SC.

Table 2 presents the results obtained by estimating equation (4) above with the inclusion of dummy variables for three groups of trading partners (OECD to non-OECD, OECD to OECD and non-OECD to OECD), as well as exporter and importer dummy variables for our target variable (RC ratification) and its interaction with the group of OECD and non-OECD trading partners (North-South dummy). This latter term is added to analyze whether there was a decrease in the amount of trade between OECD and non-OECD members that ratified, following ratification. This could occur if the ratification process exerts a greater impact on the countries that have to adapt to more markedly different environmental regulations on standards of use for these HCs.

More specifically, for comparative purposes, columns (1) and (2) present estimates of the traditional gravity model (specification (4) of the gravity model but without country-and-time dummies (MRT)). In column (1), group dummies are included, whereas in column (2) the interaction between the North-South dummy and ratification status are added. Columns (3) and (4) incorporate MRT with and without interaction terms, respectively. Column (5) presents estimates of equation (5), which includes 'dyadic-' or bilateral-product time-invariant fixed effects and group dummies and finally, column (6) adds additional interaction terms (between the North-South dummy and ratification status, as in columns (2) and (4)).

Table 2. Main Results for the Rotterdam Convention

Dep. Variable: ln bilateral imports	Gravity controls & t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
OECD to non-OECD	-1.104***	-1.115***	3.674***	3.682***		
	(0.0436)	(0.0487)	(0.506)	(0.508)		
OECD to OECD	-1.648***	-1.642***	7.030***	6.962***		
	(0.0560)	(0.0561)	(0.595)	(0.597)		
Non-OECD to OECD	-1.272***	-1.265***	2.755***	2.728***		

	(0.0599)	(0.0599)	(0.318)	(0.318)		
Importer ratifies RC	0.106**	0.0109				
	(0.0432)	(0.0511)				
Exporter ratifies RC	0.0655*	0.148***				
	(0.0396)	(0.0470)				
Both ratify RC	-0.142***	-0.134**	-0.0548	-0.0447	-0.0542**	-0.0310
	(0.0474)	(0.0599)	(0.0363)	(0.0424)	(0.0218)	(0.0268)
Imp. ratifies RC *OECD to non-OECD		0.295***		0.0426		-0.00195
		(0.0738)		(0.0681)		(0.0477)
Exp. ratifies RC * OECD to non-OECD		-0.184***		-0.111**		-0.0730**
		(0.0550)		(0.0522)		(0.0359)
Both ratify RC * OECD to non-OECD		-0.0740		-0.0440		-0.0513
		(0.0895)		(0.0825)		(0.0584)
Observations	209,951	209,951	209,951	209,951	209,951	209,951
R-squared	0.255	0.255	0.349	0.349	0.067	0.067
Time dummies	YES	YES	YES	YES	YES	YES
Product dummies	YES	YES	YES	YES	-	-
Country-and-time dummies	-	-	YES	YES	YES	YES
Dyadic-product fixed effects	-	-	-	-	YES	YES
Ratification-country group interaction terms	-	YES	-	YES	-	YES
Number of ijk					25,900	25,900

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. In column (1)-(4) other gravity controls, namely distance, common border, common language and colonial ties, are also included, but the coefficients are not shown to save space. Full results can be found in Table A.4 in the Appendix. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year. i denotes importer, j denotes exporter and k denotes product.

The results of the model including interactions show that lower volumes are shipped when the exporter ratifies the RC (row (8), columns (2), (4) and (6)). That is, the interaction between the ratification dummy and the group dummy OECD to non-OECD countries is negative and statistically significant. The magnitude of the effect is a cumulative decrease in imports of HCs of about 7 percent[18] (column (6)), though given the relatively short time span since ratification, this should be considered a short-run effect. These results highlight the importance of the exporter ratifying the convention when a PIC is the instrument used to deter or regulate trade. The intuition behind this result is that since the ratifying country has to ask for consent of the importing country in order to export, this discourages trade of these substances. The additional gravity controls have the expected signs and indicate that countries with higher GDPs, as well as those with a shared border, official language or colonial history, trade more.[19]

[18] This figure is obtained as [exp(-0.073)-1]*100.

[19] Full results tables can be found in Table A4 in the Appendix.

The results shown in columns 1 and 2, which include group dummies but not bilateral-product (*ijk*) fixed effects, are biased due to the fact that we only partially control for endogeneity issues and do not control for MRT. Similarly, the results shown in columns (3) and (4) include the MRT but still do not incorporate the bilateral-product fixed effects. For these reasons, we focus on the interpretation of the results in columns (5) and (6). Whereas in column (5) the dummy 'both ratify' is negative and statistically significant, in column (6) it is indeed the interaction dummy that captures this effect, meaning that trade from OECD countries to non-OECD countries is significantly lower when the exporter ratifies. Interestingly, the estimated effects are similar to those found in columns (2) and (4), but lower in magnitude, confirming our suspicion of a possible endogeneity bias, which in this case magnifies the effect.

Table 3 shows the results for the SC regression obtained for the gravity model estimated using the imported products that are affected by this convention. The structure of the table is similar to Table 2. Columns (1) and (2) are for specification (4) of the gravity model but without country-and-time dummies (MRT), (3) and (4) include MRT and columns (5) and (6) also incorporate bilateral-product time-invariant fixed effects as in equation (4). As in Table 2, interactions between the North-South dummy and ratification dummies are also added in columns (2), (4) and (6).

Table 3. Main results for the Stockholm Convention

Dep. Variable: Ln Bilateral Imports	Gravity controls & t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
OECD to non-OECD	-1.188***	-1.221***	4.913***	5.051***		
	(0.0784)	(0.0838)	(0.832)	(0.837)		
OECD to OECD	-1.427***	-1.428***	9.344***	9.469***		
	(0.0961)	(0.0961)	(0.989)	(0.992)		
Non-OECD to OECD	-0.405***	-0.407***	4.545***	4.553***		
	(0.109)	(0.109)	(0.552)	(0.551)		
Importer ratifies STO	-0.147*	-0.163*				
	(0.0801)	(0.0931)				
Exporter ratifies STO	0.237***	0.254***				
	(0.0765)	(0.0916)				
Both ratify SC	-0.0208	-0.0413	0.00223	-0.0436	0.0143	0.0209
	(0.0871)	(0.109)	(0.0650)	(0.0732)	(0.0381)	(0.0439)
Imp. ratifies SC* OECD to non-OECD		0.0613		-0.253**		-0.157**
		(0.113)		(0.103)		(0.0798)
Exp. ratifies SC* OECD to non-OECD		-0.0509		0.0286		-0.0820
		(0.103)		(0.0877)		(0.0601)

Both ratify SC * OECD to non-OECD		0.0721		0.267**		0.0887
		(0.149)		(0.133)		(0.0988)
Observations	91,673	91,673	91,673	91,673	91,673	91,673
R-squared	0.219	0.219	0.318	0.318	0.069	0.069
Time dummies	YES	YES	YES	YES	YES	YES
Product dummies	YES	YES	YES	YES	-	-
Country-and-time dummies	-	-	YES	YES	YES	YES
Dyadic-product fixed effects	-	-	-	-	YES	YES
Ratification-country group interaction terms	-	YES	-	YES	-	YES
Number of ijk					11,675	11,675

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. In column (1)-(4) other gravity controls, namely distance, common border, common language and colonial ties, are also included, but the coefficients are not shown to save space. Full results can be found in Table A.5 in the Appendix. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year. i denotes importer, j denotes exporter and k denotes product.

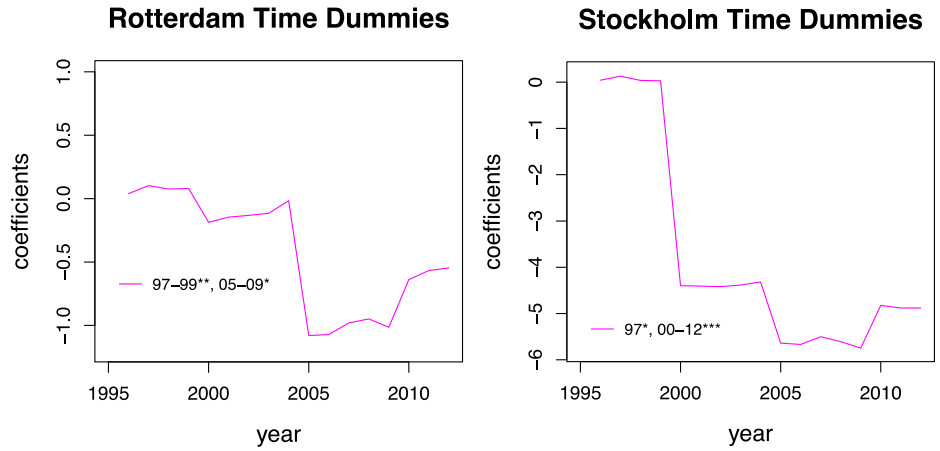
The main results differ from those found for the RC. This is not surprising given the different aims of the conventions and the products affected. In particular, contrary to what we found in Table 2, significant effects are found in Table 3 (row (7), columns (4) and (6)) when the importer ratifies the SC and the flow is from OECD to non-OECD countries. It shows a sharp decrease in POPs shipped from OECD to non-OECD countries after the non-OECD importer has ratified the convention. Comparing the results in columns (4) and (6) —with and without bilateral-product fixed effects— it can be observed that the magnitude of the effect decreased from 0.253 to 0.157, indicating the importance of controlling for endogeneity in the model to avoid biased results. Similar to Table 2, the rest of the gravity controls have the expected signs and a reasonable magnitude.[20] It is also not surprising that the SC has a greater effect, especially since this study focuses on the products that are to be eliminated and that are therefore subject to stronger provisions. This result indicates that a stricter measure –the Ban of trade– specified for the SC products with a few exceptions implies a larger effect. Additionally, the Ban can be used by developing countries as an efficient tool to protect their territory from the import of dangerous products.

Figure 5 shows the time effects represented by the coefficients estimated for the time dummies common to all trading partners. A decrease in the coefficients is observed for both conventions. It should be noticed that for the RC there is a substantial drop in the coefficients after the convention entered into force, whereas only a small drop is shown when ratification began. However, for SC there is a substantial drop in the time effect at the time of the first signature and then another smaller decrease when the convention entered into force. Nevertheless, we recognize that the time fixed effects also account for the business cycle and hence for the effect of the global recession of 2008 on

[20] Full results, including the coefficients for all variables included in the model can be found in Table A5 in the Appendix.

trade. For instance, in the last years of the sample, an increase of the time effects' coefficients is observed for both conventions. This is as expected, since those are post-crisis years.

Figure 5. Time Effects Associated to the Conventions



Note: The years for which the time dummies are statistically significant and the corresponding level are indicated inside each graph. ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively.

To assess whether there is an aggregation effect when the estimations are carried out with data that is more aggregated, we performed similar estimations summing all flows at the 4-digit level for the RC, at the 2-digit level for the SC[21] and finally with completely aggregated data. It is important to highlight that when aggregating the data we account for subgroup and sectoral effects in the estimations. This is different from what we do when using disaggregated data, in which case we are able to control for product specific time-invariant factors at the bilateral level. In this way we wash away cross-product effects.

The main results for the target variables are shown in Table 4 and full results are in the Appendix (Tables A6 and A7 for 2- and 4-digit aggregation, respectively, and A8 and A9 for full aggregation). When aggregating the data, we sum the quantities of all HCs imported in the case of the RC and all POPs for the SC; not distinguishing between products we might incur in a bias due to under or over-representation of a specific product (or industry) in the sample, which could lead to biased results in any direction. We illustrate this bias with our results, which show that the use of disaggregated data allows us to better isolate and identify the magnitude of the effect. In particular, the results from aggregating all products (column (2) of Table 4) indicate that when the exporter ratifies the RC and trade flows go

[21] For the Stockholm Convention, it is not straightforward to estimate at the 4-digit disaggregation level. Performing the estimation at the 2-digit level keeps the product disaggregation but to some extent mitigates the zero problem.

from OECD to non-OECD countries, imports of HCs are around 15.7 percent[22] lower (compared with 7 percent obtained using HS-6 product-level data).

Concerning the SC, there is no significant effect at the fully aggregated level, as shown in column (4) of Table 4, indicating that the average effect is not statistically different from zero. However, the effect using the 2-digit disaggregation level is slightly higher than that found at the 6-digit level and also statistically significant (0.195 versus 0.157). This highlights the importance of using disaggregated trade data when estimating the effects of the conventions in order to be able to properly isolate the effects and account for possible unobserved factors that affect specific products differently. In the case of the RC, aggregation magnifies the effect perhaps due to the fact that product-specific factors that affect trade are not controlled for in the corresponding estimation. For the SC, aggregation, which implies an important reduction in the number of observations, prevent us from obtaining an effect that is statistically significant.

There are two possible explanations for these different results for RC and SC. The first is that the intermediate aggregation level is different (4 digits for RC and 2 digits for SC, that is, sub-group within sectors and sectors, respectively). Second, in the fully aggregated specification, there could be effects that go in the same direction in the case of RC and hence this could explain the magnified effect. At the same time, there could be opposite forces in place that could cancel out the effect in the aggregated specification and for this reason the SC aggregated specification shows no significant effect.

Table 4. Summary Table of Main Results at Different Aggregation Levels

Dep. Variable: ln Imports	**Rotterdam Convention**		**Stockholm Convention**	
	(1)	(2)	(3)	(4)
Disaggregation level:	**Both Ratify**	**Exp. Rat x OECD-Non-OECD**	**Both Ratify**	**Imp. Rat x OECD-Non-OECD**
6-digit	-0.0542**	-0.0730**	0.0143	-0.157**
2/4-digit	-0.134***	-0.102*	-0.0033	-0.195**
Aggregated	-0.119***	-0.171***	-0.0294	-0.172

Note: The coefficients shown are from columns (5) and (6) of Tables 2 and 3 for the first row, Tables A6 and A7 for the second row and Tables A8 and A9 for the last column. The "importer (or exporter) ratifies" variable is encoded as a dummy variable equal to one if the importer (or exporter) ratifies (independently of what the exporter does) and zero otherwise. The "both ratify" dummy takes the value of one when the two trade partners are ratifying countries in a given year.

With respect to Kellenberg and Levinson (2014), there are three main differences in our analysis. First, our dataset contains fewer countries (88 versus 117) and highly disaggregated data, meaning that we have very detailed

[22] This figure is calculated as [exp(-0.171)-1]*100=15.7%.

information concerning the type of product and that we can control for unobserved factors that are time invariant and product specific. In contrast, Kellenberg and Levinson (2014) aggregate all imports and apply the gravity model to the aggregated shipments. We claim that the use of data at the product level allows us to identify the effectiveness of the conventions without incurring an aggregation bias. We are also able to identify an 'aggregation effect', as described above, which indicates that the results substantially differ depending on the degree of aggregation used in the estimations.

Second, the time period is also likely to matter in explaining the different results obtained. Whereas Kellenberg and Levinson (2014) used trade data over the period from 1988 to 2008, our period of analysis runs from 1995 to 2012. The starting year is 1995 because positive trade flows are found for more countries beginning in the mid-1990s, and because our highly disaggregated data meant that we faced a trade-off between extending the time period back to past years or including more countries. In the end, we opted to include more countries.

Finally, the treaties differ clearly in their scope and implementation strategy. We believe that the provisions defined in each convention play an important role. We suspect that imposing a ban (as in the SC for Annex A products) or a PIC system (as in the RC), or both at different times (as in the Basel Convention or for products subject to both the RC and the SC) are likely to matter, since bans may be more effective in reducing the trade of hazardous products. When comparing the results in Kellenberg and Levinson (2014) with those we found for aggregated data and the SC, we found neither a fundamental difference nor a statistically significant effect on imports.

Our main model seeks to infer whether ratification influences imports by taking into account the ratification date of each country (countries ratify at different points in time): ratifying countries are included in the treatment group and the control group includes those that do not ratify at that moment nor at any other time (countries that have not ratified the RC are Algeria, Bangladesh, Egypt, Iceland, Malta, Tunisia, Turkey and the US, while those that have not ratified the SC are Israel, Italy, Malaysia, Malta and the US). Nevertheless, the conventions were not implemented until 2004, while the period of study runs from 1995 until 2012. See Table A1 for a list of countries, their ratification status and the date of ratification. In the next section, we analyze the timing of the impacts from ratifying the conventions to infer when the effects in terms of lower imports can be noted.

5. Robustness

As a first robustness test, we estimated the model including interactions between the years and the ratification dummies. Results are shown in Tables 5 and 6 for the RC and SC, respectively. Next, we estimated regressions separating the sample into three groups of developing countries; see results in Table 7. In these three tables (5-7), we

focus on the preferred model specification that uses the three sets of fixed effects (dyadic-product, origin-and-time and destination-and-time FE) and only the coefficients of the target variables are shown.

The results obtained with time-varying treatment effects, before and after ratification of the RC, are shown in Table 5.

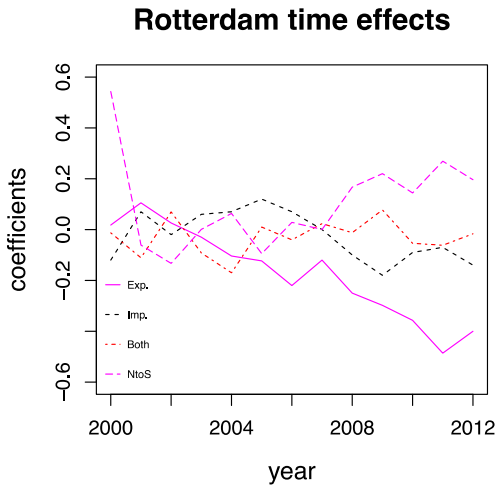
Table 5. Time-varying ratification effects. The Rotterdam Convention

Dep. Variable: ln Imports	MRT & ijk FE			
	Both Rat.	Imp. Rat. NS	Exp. Rat. NS	Both Rat. NS
	(1)	(2)	(3)	(4)
Year				
2000	-0.0131	-0.121	0.0176	0.543
	(0.193)	(0.116)	(0.0896)	(0.385)
2001	-0.111	0.0741	0.105*	-0.0611
	(0.113)	(0.107)	(0.0620)	(0.258)
2002	0.0693	-0.0225	0.0262	-0.133
	(0.0554)	(0.0640)	(0.0498)	(0.122)
2003	-0.0962*	0.0606	-0.0272	0.000720
	(0.0499)	(0.0600)	(0.0520)	(0.110)
2004	-0.170***	0.0673	-0.104**	0.0633
	(0.0396)	(0.0764)	(0.0473)	(0.103)
2005	0.0101	0.124	-0.123	-0.0946
	(0.0521)	(0.0923)	(0.0797)	(0.117)
2006	-0.0403	0.0717	-0.218***	0.0284
	(0.0527)	(0.0947)	(0.0824)	(0.122)
2007	0.0234	-0.00190	-0.121	0.000283
	(0.0543)	(0.0986)	(0.0859)	(0.130)
2008	-0.0123	-0.0966	-0.245***	0.167
	(0.0571)	(0.0973)	(0.0933)	(0.135)
2009	0.00772	-0.179*	-0.298***	0.220
	(0.0579)	(0.0987)	(0.0974)	(0.140)
2010	-0.0540	-0.0911	-0.357***	0.144
	(0.0698)	(0.115)	(0.116)	(0.158)
2011	-0.0616	-0.0736	-0.486***	0.269
	(0.0820)	(0.126)	(0.138)	(0.183)
2012	-0.0164	-0.137	-0.400***	0.196
	(0.0853)	(0.132)	(0.145)	(0.194)

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. Only the coefficients for the ratification dummies and interactions with the group dummy are shown. 'Both Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when both countries ratify the convention, zero otherwise. 'Imp. Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when only the importer country ratifies the convention, zero otherwise. 'Exp. Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when only the exporter country ratifies the convention, zero otherwise. 'Both Rat. NS' denotes interactions between time dummies and a dummy variable that takes the value of one when both countries ratify the convention zero otherwise. NS stands for North South meaning imports into non-OECD countries from OECD countries. i denotes importer, j denotes exporter and k denotes product. Results are displayed from 2000 onwards because ratifications began in 1999.

The results indicate that the coefficients are mostly non-significant before 2004, and we observe only a single coefficient that is positive and significant at the 10 percent level in 2001 for the interaction between exporter ratifies and the North-South dummy (column (3), second row in Table 5). However, there are negative and significant effects in 2003 and 2004 when both countries ratify the convention (column (1), rows (4) and (5) in Table 5) and for most years from 2004 onwards, when the exporter ratifies and exports are from OECD to non-OECD countries. It is shown that the magnitude of the effects increased over time, with the highest coefficient in 2011 (-0.486), showing a lower level of imports in HCs for this trade flow (see also Figure 6 for a graphical representation of the time effects). Our interpretation of the positive effect in 2001 is that firms anticipated that both their country and other countries would ratify, and tried to trade as much of the targeted substances as possible before ratification.

Figure 6. Evolution over Time of the Coefficients in Table 5, Column 3



Note: 'Both rat' denotes interactions between time dummies and a dummy variable that takes the value of 1 when both countries ratify the convention zero otherwise. 'Imp.' denotes interactions between time dummies and a dummy variable that takes the value of 1 when only the importer country ratifies the convention zero otherwise and the flow is OECD to non-OECD. 'Exp.' denotes interactions between time dummies and a dummy variable that takes the value of 1 when only the exporter country ratifies the convention zero otherwise and the flow is OECD to non-OECD. 'NtoS' stand for North and South meaning imports of Non-OECD countries from OECD countries.

Table 6 shows that in the case of the SC, imports were higher in 2002 when both countries ratify the convention (column (1)); whereas for the years after ratification, we only find significant and negative coefficients for the year 2011 when the importer ratifies and exports go from OECD to non-OECD countries and for the year 2012 for the same trade flow but when the exporter has ratified the convention. For this convention, there are also some negative and significant results for the year 2002 (column (4)). These could be interpreted as anticipation effects.

Table 6. Time-varying ratification effects. The Stockholm Convention

Dep. Variable: ln Imports	MRT & ijk FE			
	Both Rat.	Imp. Rat. NS	Exp. Rat. NS	Both Rat. NS
Year	(1)	(2)	(3)	(4)
2002	0.188*	0.0117	0.119	-0.158*
	(0.108)	(0.198)	(0.364)	(0.0811)
2003	-0.0381	-0.105	0.112	-0.104
	(0.0810)	(0.175)	(0.262)	(0.0744)
2004	-0.0718	-0.166	0.0474	-0.0648
	(0.0654)	(0.114)	(0.174)	(0.0905)
2005	0.0239	0.0381	0.0588	-0.107
	(0.0746)	(0.132)	(0.200)	(0.151)
2006	0.0765	-0.0512	-0.0535	0.140
	(0.0757)	(0.140)	(0.199)	(0.143)
2007	0.0838	-0.0710	-0.228	0.222
	(0.0803)	(0.135)	(0.226)	(0.178)
2008	0.0201	-0.229	0.0875	0.110
	(0.0832)	(0.142)	(0.259)	(0.213)
2009	0.190**	-0.0955	-0.0367	-0.00025
	(0.0893)	(0.145)	(0.329)	(0.288)
2010	0.0274	-0.212	0.194	-0.109
	(0.191)	(0.177)	(0.358)	(0.311)
2011	0.0976	-0.459**	-0.429	0.642
	(0.198)	(0.188)	(0.493)	(0.461)
2012	0.205	-0.143	-1.202**	0.987*
	(0.202)	(0.191)	(0.591)	(0.561)

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. Only the coefficients for the ratification dummies and interactions with the group dummy are shown. 'Both Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when both countries ratify the convention, zero otherwise. 'Imp. Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when the importer country ratifies the convention, zero otherwise. 'Exp. Rat.' denotes interactions between time dummies and a dummy variable that takes the value of one when the exporter country ratifies the convention, zero otherwise 'Both Rat. NS' stands for North South meaning imports into non-OECD countries from OECD countries. i denotes importer, j denotes exporter and k denotes products. Results are displayed from 2002, because ratifications started in 2001.

Additionally, Table 7 shows estimations for specific groups of countries. We observe that in the case of the RC, there are negative and significant effects for African and American developing countries, but no effect for Asian developing countries. Regarding the SC, there is no significant effect observed with respect to individual groups of developing countries, rather the effect is for the group as a whole. One explanation could be that characteristics of developing countries other than their geographical location may affect the average results.

As a final robustness test, we estimate the gravity model using the Helpman et al. (2008) method, which also considers the existence of zero trade flows. Methodologically, this is done by first estimating a Probit model for each year to infer if the ratification of the agreements influences the probability of deciding whether or not to import a

given product (HCs and POPs for the RC and SC, respectively) and then, in a second step, incorporating some elements of the first estimation (the inverse Mills ratio and the yearly predictions of the Probit) into the gravity model as specified in equation (5). The results indicate that the effect of ratifying the RC is slightly higher for imports into non-OECD countries from OECD countries when the extensive margin of imports is considered (coefficient equals 0.09), whereas the effect of the SC is only significant in the first step, but not statistically significant in the second, although the coefficient still maintains the direction of the change.[23] More research is needed to be able to properly identify separate effects for the extensive and intensive margins of trade.

In addition to these robustness tests, we have performed falsification tests. The first one is a placebo test simulating the date of ratification at different dates before the real ratification. More specifically, we estimate a placebo test using the same data for each convention and moving the date of ratification from five to one year before the real date. It should be noted that when we move the date of ratification to the past, we restrict the time period by excluding the years after 2003 in order to avoid the noise that adoption of the conventions (in year 2004) could generate.[24] We focus on the preferred model specification that uses the three sets of fixed-effects. The results obtained with time-varying treatment effects before the ratification show some possible anticipation strategy of the countries. For the Rotterdam convention, our results indicate that the coefficients are mostly non-significant or positive, in t-5 and t-4. There is, however, a negative and significant effect at t-3 already indicating a decrease in the imports of some hazardous chemicals, but it is only significant at the ten percent level. Our interpretation for the positive effect is that firms anticipated ratification of the respective country and also of other countries, and tried to trade as much as possible of those substances before ratification, whereas the negative coefficient at t-3 could be an anticipation effect. For the SC, there are some negative and significant results for t-3 and t-1 of ratification. We also attribute these to an anticipation effect.

Secondly, we have estimated a single model for all products that are targeted by both conventions. We found that the effects of the ratification of the conventions for the OECD to non-OECD group is bigger in size for the RT (around 0,8%) and slightly smaller for the SC (around 15%) than in our main results. The results support our main findings about the causal effect of convention ratification[25].

[23] Results were displayed in previous forms of this paper and they are available upon request from the authors.
[24] Results were displayed in previous versions of this paper and they are available upon request from the authors.
[25] Results are available upon request from the authors. In previous versions, we have also performed a pure difference-in-differences estimation to assess the effect on entering into force of RC and ST conventions in 2004, the effects were significant and much bigger in size, showing a decrease in imports when only the importer ratified which was magnified when also the exporter ratified.

Table 7: Estimations by region of developing countries

Developing countries by regions						
Rotterdam Convention	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable: ln Imports	MRT & ijk FE					
Regions	**Africa**		**Asia**		**America**	
Both ratify RC	-0.0392	-0.0189	-0.0392	-0.0389	-0.0392	0.0119
	(0.0280)	(0.0300)	(0.0280)	(0.0302)	(0.0280)	(0.0313)
Imp. ratifies RC x OECD to non-OECD		**-0.192****		0.0796		0.00473
		(0.0915)		(0.102)		(0.0887)
Exp. ratifies RC x OECD to non-OECD		**-0.131****		-0.0914		-0.0642
		(0.0637)		(0.0613)		(0.0588)
Both ratify RC x OECD to non-OECD		-0.000189		-0.0468		**-0.194****
		(0.104)		(0.113)		(0.0984)
Observations	111,849	111,849	111,849	111,849	111,849	111,849
R-squared	0.088	0.088	0.088	0.088	0.088	0.088
Number of ijk	14,370	14,370	14,37	14,37	14,370	14,370
Stockholm Convention	(1)	(2)	(3)	(4)	(5)	(6)
Both ratify SC	-0.0456	-0.0428	-0.0456	-0.0332	-0.0456	-0.0475
	(0.0544)	(0.0583)	(0.0544)	(0.0592)	(0.0544)	(0.0587)
Imp. ratifies SC x OECD to non-OECD		-0.0292		-0.0679		0.234
		(0.135)		(0.154)		(0.180)
Exp. ratifies SC x OECD to non-OECD		-0.206		-0.128		0.0639
		(0.180)		(0.104)		(0.0991)
Both ratify SC x OECD to non-OECD		0.161		4.50e-06		-0.193
		(0.220)		(0.174)		(0.197)
Observations	42,011	42,011	42,011	42,011	42,011	42,011
R-squared	0.087	0.087	0.087	0.088	0.087	0.088
Time dummies	YES	YES	YES	YES	YES	YES
Product dummies	YES	YES	YES	YES	NO	NO
Country-and-time dummies	YES	YES	YES	YES	YES	YES
Dyadic-product fixed effects	YES	YES	YES	YES	YES	YES
Ratification-country group interaction terms	NO	YES	NO	YES	NO	YES
Number of ijk	6,113	6,113	6,113	6,113	6,113	6,113

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only exporter) ratifies, and zero otherwise. The

'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year. i denotes importer, j denotes exporter and k denotes product.

6. Conclusions

The main findings of this paper indicate that the Rotterdam Convention (RC) and the Stockholm Convention (SC) have been effective in reducing trade in HCs and POPs, respectively. This result is in contrast to the outcomes reported in the previous literature concerning other IEAs.

More specifically, we find that when the exporter ratifies the RC and the flow is from OECD to non-OECD countries, a significant reduction of imports in HCs is observed after ratification. The magnitude of the effect is a cumulative decrease in imports of about 7 percent, which is not particularly high but may increase further the longer the convention remains in force. This effect is found after controlling for different sources of unobservable heterogeneity and is robust to changes in the specification.

In the case of the SC, the results show significant reductions in trade in POPs for importers that ratify the convention and for POPs shipped from OECD to non-OECD countries, with trade decreasing after the non-OECD-importer has ratified the convention. We observe a reduction of around 16 percent, more than double the effect found for the RC, which was expected due to the different obligations imposed by the respective conventions. However, while the import-reducing effect of the RC is robust to the inclusion of zero trade flows and to changes in the aggregate level of import flows, that of the SC fades away when using aggregated imports. Since there are products that are subject to both conventions and others that are affected only by one of them, ideally each product-case should be investigated separately. We leave for further research a detailed analysis with product-specific ratification effects for each convention, which also takes into account the registry of final decisions on individual PICs for specific trading countries.

From a globalization and trade perspective, the main policy implication of this research is that IEAs can be effective instruments to reduce and eventually stop pollution diversion when environmental regulation increases in a country and not in the trading partner. For instance, the more stringent an agreement is the bigger the effect. This goes in line with stringent environmental regulations in both countries and enforcement institutions.

References

Aichele, R. and Felbermayr, G. (2012). Kyoto and the carbon footprint of nations. Journal of Environmental Economics and Management, 63(3), 336–354.

Almer, C. and Winkler, R. (2017). Analysing the effectiveness of international environmental policies: The case of the Kyoto Protocol. Journal of Environmental Economics and Management 82, 125-151.

Anderson, J. E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, *93*(1), 170–192.

Baggs, J. (2009). International trade in hazardous waste. Review of International Economics, 17(1), 1-16.

Baier, S. L., and Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade?. Journal of international Economics, 71(1), 72-95.

Barrett, S. (1994). Self-enforcing international environmental agreements. Oxford Economic Papers, 878-894.

Bernard, S. (2015). North–south trade in reusable goods: Green design meets illegal shipments of waste. Journal of Environmental Economics and Management, 69, 22-35.

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: Evidence from the Indian economy. Economic Modelling, 40, 33-41.

Briggs, D. (2003). Environmental pollution and the global burden of disease. British Medical Bulletin, 68(1), 1-24.

Cai, Y., Riezman, R. and Whalley, J. (2013). International trade and the negotiability of global climate change agreements, Economic Modelling 33, 421-427.

Carraro, C. (2014). *International environmental cooperation*, in Atkinson, G., Dietz, S., Neumayer, E. and Agarwala, M. Eds. Handbook of Sustainable Development, Edward Elgar, 418-431.

Carraro, C., and Siniscalco, D. (1993). Strategies for the international protection of the environment. Journal of Public Economics, 52(3), 309-328.

Carraro, C., and Siniscalco, D. (1998). International institutions and environmental policy: International environmental agreements: Incentives and political economy, European Economic Review 42(3-5), 561-572.

Cherniwchan, J., Copeland, B. R., & Taylor, M. S. (2017). Trade and the environment: New methods, measurements, and results. Annual Review of Economics 9, 59-85,

Clapp, J. (1997). The illicit trade in hazardous wastes and CFCs: International responses to environmental "bads". Trends in Organized Crime, 3(2), 14-18.

Cole, M. A., Elliott, R. J., & Zhang, L. (2017). Foreign direct investment and the environment. Annual Review of Environment and Resources, *42*, 465-487.

Copeland, B. R., & Taylor, M. S. (2004). Trade, growth, and the environment. *Journal of Economic literature*, *42*(1), 7-71.

De Sousa, J. (2012). The currency union effect on trade is decreasing over time. Economics Letters, 117(3), 917-920.

Ecchia, G. and Mariotti, M. (1998). Coalition formation in international environmental agreements and the role of institutions. European Economic Review 42 (3-5), 573-582.

Farajzadeh, Z., Zhu, X., & Bakhshoodeh, M. (2017). Trade reform in Iran for accession to the World Trade Organization: Analysis of welfare and environmental impacts. Economic Modelling, 63, 75-85.

Feenstra, R. C. (2016). Advanced international trade: theory and evidence. Princeton University Press.

Fikru, M. G. (2012). Trans-boundary movement of hazardous waste: evidence from a new micro data in the European Union. Review of European Studies, 4(1), 3.

Gavidia, T. G., de Garbino, J. P. and Sly, P. D. (2009). Children's environmental health: an under-recognised area in paediatric health care. BMC pediatrics, 9(1), 1.

Gumilang, H., Mukhopadhyay, K., & Thomassin, P. J. (2011). Economic and environmental impacts of trade liberalization: The case of Indonesia. *Economic Modelling*, *28*(3), 1030-1041.

Greene, O. (1998). The system for implementation review in the ozone regime. In Victor, D.G., Raustiala, K. and Skolnikoff, E.B. Eds. *The Implementation and Effectiveness of International Environmental Commitments: Theory and Practice*, Part I, Chapter 3, 89-136.

Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement* (No. w3914). National Bureau of Economic Research.

Grunewald, N. and Martínez-Zarzoso, I. (2016). Did the Kyoto Protocol fail? An evaluation of the effect of the Kyoto Protocol on CO2 emissions, Environment and Development Economics, 21 (1), 1-22.

Gylfason, T., Martínez-Zarzoso, I. and Wijkman, P. M. (2015). Free trade agreements, institutions and the exports of Eastern Partnership Countries. Journal of Common Market Studies 53 (6), 1214-1229.

Haas, P. M. (1990). Saving the Mediterranean: The politics of international environmental cooperation. Columbia University Press.

Head, K., and T. Mayer (2014). Gravity equations: Workhorse, toolkit, and cookbook, in Gopinath, G., E.

Helpman, E., Melitz, M., & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. The Quarterly Journal of Economics, 1*23*(2), 441-487.

Helpman, E. and K. Rogoff (eds.): *Handbook of International Economics*, Vol. 4, 131-195, Amsterdam, Elsevier-North Holland.

Johnson, B. L. (1997). Hazardous waste: human health effects. Toxicology and Industrial Health, 13(2-3), 121-143.

Kellenberg, D. (2012). Trading wastes. Journal of Environmental Economics and Management, 64(1), 68-87.

Kellenberg, D. (2013). Do weak environmental regulations determine the location of US exports of SLAB and lead waste. In D'Amato, A., Mazzanti, M. And Montini, A. Eds, Waste Management in Spatial Environments, 137-151.

Kellenberg, D., and Levinson, A. (2014). Waste of effort? International environmental agreements. Journal of the Association of Environmental and Resource Economics 1 (1-2), 135-169.

Kellenberg, D. (2015). The economics of the international trade of waste. Annu. Rev. Resour. Econ., 7(1), 109-125.

Kheder, S. B., & Zugravu, N. (2012). Environmental regulation and French firms location abroad: An economic geography model in an international comparative study. Ecological Economics, 77, 48-61.

Mazzanti, M. and A. Musolesi. (2009). Carbon kuznets curves: Long-run structural dynamics and policy events. *SSRN eLibrary*, November.

Miles, E. L. (2002). *Environmental regime effectiveness: confronting theory with evidence*. Mit Press.

Mitchell, R. B. (2003). International environmental agreements: a survey of their features, formation, and effects. Annual Review of Environment and Resources, 28(1), 429-461.

Mitchell, R. B. (2006). Part two: The effectiveness of international environmental regimes—Problem structure, institutional design, and the relative effectiveness of international environmental agreements. Global Environmental Politics, 6(3), 72–89.

Munton, D., Soroos, M., Nikitina, E. and Levy, M. A. (1999). Acid rain in Europe and North America. *The effectiveness of international environmental regimes. Causal connections and behavioral mechanisms*, 155-247.

Nuñez-Rocha, T. (2016). Waste haven effect: Unwrapping the impact of environmental regulation, Documents de travail du Centre d'Economie de la Sorbonne 16047, Université Panthéon-Sorbonne (Paris 1), Centre d'Economie de la Sorbonne.

Parson, E. A. (2003). *Protecting the ozone layer: science and strategy*. Oxford University Press.

Rauscher, M. (1997). International trade, factor movements, and the environment. Oxford University Press.

Schneider, V. and Pearce, D. (2004). What saved the whales? An economic analysis of 20th century whaling. Biodiversity and Conservation, 13(3), 543-562.

Skjaerseth, J. B. (2001). The effectiveness of the Mediterranean action plan. *See Ref*, *42*, 311-30.

Takashima, N. (2017). International environmental agreements with ancillary benefits: Repeated games analysis, Economic Modelling 61, 312-320.

Wettestad, J. (2001). Designing effective environmental regimes: the conditional keys. *Global Governance*, *7*, 317

Yokoo, H. F., and Kinnaman, T. C. (2013). Global reuse and optimal waste policy. *Environment and Development Economics*, *18*(05), 595-614.

Appendix

Table A1. Status of ratification of the conventions

Country	Rotterdam Convention	Stockholm Convention	Country	Rotterdam Convention	Stockholm Convention
Algeria	NR	2006	Madagascar	2004	2005
Argentina	2004	2005	Malawi	2009	2009
Australia	2004	2004	Malaysia	2002	NR
Austria	2002	2002	Malta	NR	NR
Bangladesh	NR	2007	Mauritius	2005	2004
Belgium	2002	2006	Mexico	2005	2003
Bolivia	2003	2003	Morocco	2011	2004
Brazil	2004	2004	Mozambique	2010	2005
Bulgaria	2000	2004	Netherlands	2000	2002
Canada	2002	2001	New Zealand	2003	2004
Chile	2005	2005	Nicaragua	2008	2005
China	2005	2004	Nigeria	2001	2004
Colombia	2008	2008	Norway	2001	2002
Costa Rica	2006	2007	Pakistan	2005	2008
Croatia	2007	2007	Panama	2000	2003
Czech Republic	2000	2002	Paraguay	2005	2004
Denmark	2004	2003	Peru	2005	2005
Dominican Republic	2006	2007	Philippines	2006	2004
Ecuador	2004	2004	Poland	2005	2008
Egypt	NR	2003	Portugal	2005	2004
El Salvador	1999	2008	Romania	2003	2004
Estonia	2006	2013	Russian Federation	2011	2011
Ethiopia	2003	2003	Senegal	2001	2003
Finland	2004	2002	Singapore	2005	2005
France	2004	2004	Slovakia	2007	2002
Germany	2001	2002	Slovenia	1999	2004
Greece	2003	2006	South Africa	2002	2002
Guatemala	2010	2008	Spain	2004	2004
Honduras	2011	2005	Sri Lanka	2006	2005
Hungary	2000	2008	Sweden	2003	2002
Iceland	NR	2002	Switzerland	2002	2003
India	2005	2006	Thailand	2002	2005
Indonesia	2013	2009	Trinidad and Tobago	2009	2002
Ireland	2005	2010	Tunisia	NR	2004
Israel	2011	NR	Turkey	NR	2009
Italy	2002	NR	Uganda	2008	2004
Jamaica	2002	2007	Ukraine	2002	2007
Japan	2004	2002	United Kingdom	2004	2005
Jordan	2002	2004	United States of America	NR	NR
Kenya	2005	2004	Uruguay	2003	2004
Korea, Republic of	2003	2007	Venezuela (Bolivarian Republic of)	2005	2005
Latvia	2003	2004	Viet Nam	2007	2002
Lithuania	2004	2006	Zambia	2011	2006
Macedonia, Republic of	2010	2004	Zimbabwe	2012	2012

Note: NR = Not ratified. Source: Rotterdam Convention Website and Stockholm Convention Website: http://www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx. http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspxs.

Table A2. Harmonized System Codes Assigned to Annex III Chemicals. Rotterdam Convention. HS (rev. 2012)

Rotterdam Convention		
Annex III Chemicals and Pesticides	**HS Code Pure Substance**	**HS Code (*3) Mixtures, Preparations containing Substance**
2,4,5-T and its salts and esters	2918.91	3808.50 (*1)
Alachlor	See below (*4)	
Aldicarb	See below (*4)	
Aldrin	2903.82	3808.50 (*1)
Binapacryl	2916.16	3808.50 (*1)
Captafol	2930.50	3808.50 (*1)
Chlordane	2903.82	3808.50 (*1)
Chlordimeform	2925.21	3808.50 (*1)
Chlorobenzilate	2918.18	3808.50 (*1)
DDT	2903.92	3808.50 (*1)
Dieldrin	2910.40	3808.50 (*1)
DNOC and its salts (such as **ammonium salt, potassium salt and sodium salt)**	2908.92	3808.50 (*1)
DNOC and its salts (such as ammonium salt, potassium salt and sodium salt)	2908.92	3808.50 (*1)
Dinoseb and its salts	2908.91	3808.50 (*1)
Dinoseb acetate	2915.36	3808.50 (*1)
1,2-dibromoethane (EDB)	2903.31	3808.50 (*1) 3811.11, 3811.19
Endolsulfan	See below (*4)	
Ethylene dichloride	2903.15	3808.50 (*1)
Ethylene oxide	2910.10	3808.50 (*1) 3824.81
Fluoroacetamide	2924.12	3808.50 (*1)
HCH (mixed isomers)	2903.81	3808.50 (*1)
Heptachlor	2903.82	3808.50 (*1)
Hexachlorobenzene	2903.92	3808.50 (*1)

Lindane	2903.81	3808.50 (*1)
Mercury compounds including inorganic mercury compounds, alkyl mercury compounds and alkyloxyalkyl and aryl mercury compounds (CAS numbers)	2852.10	3808.50 (*1)
Monocrotophos	2924.12	3808.50 (*1)
Parathion	2920.11	3808.50 (*1)
Pentachlorophenol and its salts and esters	2908.11 – Pentachlorophenol 2908.19 – salts of Pentachlorophenol	3808.50 (*1)
Toxaphene	–	3808.50 (*1)
Dustable powder formulations containing a combination of : benomyl at or above 7 per cent, carbofuran at above 10 per cent, thiram at or above 15 per cent	–	3808.50 (*1)
Methamidophos (Soluble liquid **formulations of the substance that exceed 600 g active ingredient/l)**	2930.50	3808.50 (*1)
Phosphamidon (Soluble liquid **formulations of the substance that exceed 1000 g active ingredient/l)** mixture, (E)&(Z) isomers) (Z)-isomer (E)-isomer	2924.12	3808.50 (*1)
Methyl-parathion (emulsifiable **concentrates (EC) with 19.5%, 40%, 50%, 60% active ingredient and dusts containing 1.5%, 2% and 3% active ingredient)**	2920.11	3808.50 (*1)
Asbestos	2524.10 - Crocidolite 2524.90 –	

	Other (*2)	6811.40 – Containing asbestos. 6812.91 – Clothing, clothing accessories, footwear and headgear 6812.92 – Paper, millboard and felt 6812.93 – Compressed asbestos fibre jointingm in sheets or rolls 6812.99 - Other 6813.20 – Containing asbestos.
Crocidolite	2524.10	The same as Asbestos other than heading 68.12 (*2) 6812.80
Actinolite **Anthophyllite** **Amosite** **Tremolite**	2524.90 2524.90 2524.90 2524.90	The same as Asbestos (*2) 6812.91 – Clothing, clothing accessories, footwear and headgear 6812.92 – Paper, millboard and felt 6892.93 – Compressed asbestos fibre jointing in sheets or rolls 6892.99 - Other
Polybrominated biphenyls (PBB) (hexa-) (octa-) (deca-)	–	2710.91 3824.82
Polychlorinated biphenyls (PCB)	–	2710.91 3824.82
Polychlorinated terphenyls (PCT)	–	2710.91 3824.82
Tetraethyl lead	2931.10	e.g., 3811.11 – Anti-knock preparations based on lead compounds
Tetramethyl lead	2931.10	e.g., 3811.11 – Anti-knock preparations based

		on lead compounds
Tris (2,3-dibromopropyl) phosphate	2919.10	3824.83
Tributyl tin compounds	2931.20	3808.50 (*1)

Notes: (*1) Subheading 3808.50 covers only goods of heading 38.08, containing one or more of the following substances: aldrin (ISO); binapacryl (ISO); camphechlor (ISO) (toxaphene); captafol (ISO); chlordane (ISO); chlordimeform (ISO); chlorobenzilate (ISO); DDT (ISO) (clofenotane (INN), 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane); dieldrin (ISO, INN); 4,6-dinitro-o-cresol (DNOC (ISO)) or its salts; dinoseb (ISO), its salts or its esters; ethylene dibromide (ISO) (1,2-dibromoethane); ethylene dichloride (ISO) (1,2-dichloroethane); fluoroacetamide (ISO) (1,2-dibromoethane); ethylene dichloride (ISO) (1,2-dichloroethane); fluoroacetamide (ISO); heptachlor (ISO); hexachlorobenzene (ISO); 1,2,3,4,5,6-hexachlorocyclohexane (HSH (ISO), including lindane (ISO), INN; mercury compounds; methamidophos (ISO); monocrotophos (ISO); oxirane (ethylene oxide); parathion (ISO); parathion-methyl (ISO) (methyl-parathion); pentachlorophenol (ISO), its salts or its esters; phosphamidon (ISO); 2,4,5-T (ISO) (2,4,5-trichlorophenoxyacetic acid), its salts or its esters; tributyltin compounds. Subheading 3808.50 also covers dustable powder formulations containing a mixture of benomyl (ISO), carbofuran (ISO) and thiram (ISO).
(*2) Asbestos is a natural mineral substance produced by the decomposition of certain rocks.
(*3) The list of HS codes in the column for "HS Code Mixtures, Preparations containing Substance" is not exhaustive.
(*4) This substance has entered into Annex III in 2011. HS code for this substance is expected to be assigned by WCO in 2017

Source: Rotterdam Convention Website.
http://www.pic.int/TheConvention/Chemicals/AnnexIIIChemicals/tabid/1132/language/en-US/Default.aspx.

Table A3. CAS (Chemical Abstracts Service) and HS (Harmonized System) codes. Stockholm Convention. HS (rev. 2012)

Stockholm Convention			
Annex A		**ELIMINATION**	
Chemical	**HS code**	**Activity**	**Specific exemptions**
Aldrin*		Production	None
CAS No: 309-00-2	290382	Use	Local ectoparasiticide Insecticide
Alpha hexachlorocyclohexane*		Production	None
CAS No: 319-84-6	290381	Use	None
Beta hexachlorocyclohexane*		Production	None
CAS No: 319-85-7	290381	Use	None
Chlordane*		Production	As allowed for the Parties listed in the Register
CAS No: 57-74-9	290382	Use	Local ectoparasiticide Insecticide Termiticide Termiticide in buildings and dams Termiticide in roads Additive in plywood adhesives
Chlordecone*		Production	None
CAS No: 143-50-0	291470	Use	None
Dieldrin*		Production	None
CAS No: 60-57-1	291040	Use	In agricultural operations
Endrin*		Production	None
CAS No: 72-20-8	291090	Use	None
Heptachlor*		Production	None
CAS No: 76-44-8	290382	Use	Termiticide Termiticide in structures of houses Termiticide (subterranean) Wood treatment In use in underground cable boxes
Hexabromobiphenyl*		Production	None

CAS No: 36355-01-8	290399	Use	None
Hexabromodiphenyl ether*		Production	None
and			Use Articles in accordance with the
		Use	
heptabromodiphenyl ether*			provisions of Part IV of this Annex
Hexachlorobenzene		Production	As allowed for the Parties listed in the Register Intermediate
CAS No: 118-74-1	290392	Use	Solvent in pesticide Closed system site limited intermediate2
Lindane*		Production	None
CAS No: 58-89-9	290381	Use	Human health pharmaceutical for control of head lice and scabies as second line treatment
Mirex*		Production	As allowed for the Parties listed in the Register
CAS No: 2385-85-5	290389	Use	Termiticide
Pentachlorobenzene*		Production	None
CAS No: 608-93-5	290399	Use	None
		Production	None
Polychlorinated biphenyls (PCB)*		Use	Articles in use in accordance with the provisions of Part II of this Annex
Tetrabromodiphenyl ether* and		Production	None
pentabromodiphenyl ether*		Use	Articles in accordance with the provisions of Part V of this Annex
Toxaphene*		Production	None
CAS No: 8001-35-2	380850	Use	None

Notes: (i) Except as otherwise specified in this convention, quantities of a chemical occurring as unintentional trace contaminants in products and articles shall not be considered to be listed in this Annex.

(ii) This note shall not be considered as a production and use specific exemption for purposes of paragraph 2 of Article 3. Quantities of a chemical occurring as constituents of articles manufactured or already in use before or on the date of entry into force of the relevant obligation with respect to that chemical, shall not be considered as listed in this Annex, provided that a Party has notified the Secretariat that a particular type of article remains in use within that Party. The Secretariat shall make such notifications publicly available.

(iii) This note, which does not apply to a chemical that has an (*) following its name in the Chemical column in Part I of this Annex, shall not be considered as a production and use specific exemption for purposes of paragraph 2 of Article 3. Given that no significant quantities of the chemical are expected to reach humans and the environment during the production and use of a closed-system site- limited intermediate, a party, upon notification to the Secretariat, may allow the production and use of quantities of a chemical listed in this Annex as a closed-system site-limited intermediate that is chemically transformed in the manufacture of other chemicals that, taking into consideration the criteria in paragraph 1 of Annex D (see text of the Convention), do not exhibit the characteristics of persistent organic pollutants. This notification shall include information on total production and use of such chemicals, or a reasonable estimate of such information, and information regarding the nature of the closed-system site-limited process including the amount of any non-transformed and unintentional trace contamination of the persistent organic pollutant-starting material in the final product. This procedure applies except as otherwise specified in this Annex. The Secretariat shall make such notifications available to the conference of the parties and to the public. Such production or use shall not be considered a production or use specific exemption. Such production and use shall cease after a ten-year period, unless the party concerned submits a new notification to the Secretariat, in which case the period will be extended for an additional ten years unless the conference of the parties, after a review of the production and use decides otherwise. The notification procedure can be repeated.

(iv) All the specific exemptions in this Annex may be exercised by parties that have registered exemptions in respect of them in accordance with Article 4 with the exception of the use of polychlorinated biphenyls in articles in use in accordance with the provisions of Part II, which may be exercised by all parties.

Source: http://chm.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx.

Table A4. Full results Rotterdam Convention (six-digit codes disaggregation)

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.450***	0.449***				
	(0.0102)	(0.0102)				
Ln(GDP) exporter	0.615***	0.615***				
	(0.0114)	(0.0115)				
OECD to non-OECD	**-1.104*** **	**-1.115*** **	**3.674*** **	**3.682*** **		
	(0.0436)	(0.0487)	(0.506)	(0.508)		
OECD to OECD	**-1.648*** **	**-1.642*** **	**7.030*** **	**6.962*** **		
	(0.0560)	(0.0561)	(0.595)	(0.597)		
Non-OECD to OECD	**-1.272*** **	**-1.265*** **	**2.755*** **	**2.728*** **		
	(0.0599)	(0.0599)	(0.318)	(0.318)		
Ln(distance)	-0.478***	-0.480***	-0.825***	-0.822***		
	(0.0214)	(0.0214)	(0.0262)	(0.0261)		
Contiguity	0.537***	0.536***	0.472***	0.475***		
	(0.0639)	(0.0640)	(0.0635)	(0.0635)		
Common language	0.238***	0.236***	0.0803*	0.0804*		
	(0.0403)	(0.0403)	(0.0468)	(0.0468)		
Colony ties	0.149*	0.135	-0.0648	-0.0661		
	(0.0835)	(0.0832)	(0.0943)	(0.0942)		
RTA	0.290***	0.290***	0.171***	0.171***	0.134***	0.135***
	(0.0388)	(0.0389)	(0.0435)	(0.0435)	(0.0333)	(0.0334)
WTO	0.119***	0.114***	0.156***	0.153***	0.174***	0.174***
	(0.0334)	(0.0333)	(0.0455)	(0.0455)	(0.0429)	(0.0430)
Common currency	0.687***	0.685***	0.452***	0.435***	0.160**	0.138**
	(0.0742)	(0.0744)	(0.0813)	(0.0817)	(0.0633)	(0.0632)
Importer ratifies RC	**0.106** **	0.0109				
	(0.0432)	(0.0511)				
Exporter ratifies RC	**0.0655***	**0.148*** **				
	(0.0396)	(0.0470)				
Both ratify RC	**-0.142*** **	**-0.134** **	-0.0548	-0.0447	**-0.0542** **	-0.0310
	(0.0474)	(0.0599)	(0.0363)	(0.0424)	(0.0218)	(0.0268)
Imp. ratifies RC x OECD to non OECD		**0.295*** **		0.0426		-0.00195
		(0.0738)		(0.0681)		(0.0477)
Exp. ratifies RC x OECD to non-OECD		**-0.184*** **		**-0.111** **		**-0.0730** **
		(0.0550)		(0.0522)		(0.0359)
Both ratify RC x OECD to non-OECD		-0.0740		-0.0440		-0.0513
		(0.0895)		(0.0825)		(0.0584)
Observations	209,951	209,951	209,951	209,951	209,951	209,951
R-squared	0.255	0.255	0.349	0.349	0.067	0.067

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

Table A5. Full results Stockholm Convention (six-digit codes disaggregation)

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.603***	0.602***				
	(0.0181)	(0.0181)				
Ln(GDP) exporter	0.812***	0.812***				
	(0.0195)	(0.0196)				
OECD to non-OECD	**-1.188*** **	**-1.221*** **	**4.913*** **	**5.051*** **		
	(0.0784)	(0.0838)	(0.832)	(0.837)		
OECD to OECD	**-1.427*** **	**-1.428*** **	**9.344*** **	**9.469*** **		
	(0.0961)	(0.0961)	(0.989)	(0.992)		
Non-OECD to OECD	**-0.405*** **	**-0.407*** **	**4.545*** **	**4.553*** **		
	(0.109)	(0.109)	(0.552)	(0.551)		
Ln(distance)	-0.362***	-0.363***	-0.647***	-0.651***		
	(0.0368)	(0.0369)	(0.0437)	(0.0438)		
Contiguity	0.399***	0.399***	0.599***	0.598***		
	(0.0933)	(0.0933)	(0.0918)	(0.0918)		
Common language	0.166**	0.166**	0.0167	0.0155		
	(0.0686)	(0.0686)	(0.0814)	(0.0813)		
Colony ties	0.376***	0.372***	-0.0762	-0.0644		
	(0.141)	(0.141)	(0.173)	(0.173)		
RTA	0.0237	0.0187	-0.0542	-0.0517	0.00556	0.00658
	(0.0703)	(0.0705)	(0.0799)	(0.0799)	(0.0567)	(0.0567)
WTO	0.0701	0.0688	0.359***	0.361***	0.457***	0.458***
	(0.0595)	(0.0594)	(0.0852)	(0.0852)	(0.0754)	(0.0754)
Common currency	0.795***	0.799***	0.163	0.167	0.226**	0.215**
	(0.0969)	(0.0973)	(0.114)	(0.114)	(0.0960)	(0.0960)
Importer ratifies SC	**-0.147***	**-0.163***				
	(0.0801)	(0.0931)				
Exporter ratifies SC	0.237***	0.254***				
	(0.0765)	(0.0916)				
Both ratify SC	-0.0208	-0.0413	0.00223	-0.0436	0.0143	0.0209
	(0.0871)	(0.109)	(0.0650)	(0.0732)	(0.0381)	(0.0439)
Imp. ratifies SC x OECD to non-OECD		0.0613		**-0.253** **		**-0.157** **
		(0.113)		(0.103)		(0.0798)
Exp. ratifies SC x OECD to non-OECD		-0.0509		0.0286		-0.0820
		(0.103)		(0.0877)		(0.0601)
Both ratify SC x OECD to non-OECD		0.0721		**0.267** **		0.0887
		(0.149)		(0.133)		(0.0988)
Observations	91,673	91,673	91,673	91,673	91,673	91,673
R-squared	0.219	0.219	0.318	0.318	0.069	0.069

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

Table A6. Rotterdam Convention two digits codes aggregation

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.610***	0.609***				
	(0.0189)	(0.0189)				
Ln(GDP) exporter	0.921***	0.921***				
	(0.0200)	(0.0200)				
OECD to non-OECD	**-1.247*** **	**-1.209*** **	**5.159*** **	**5.223*** **		
	(0.0811)	(0.0880)	(0.869)	(0.874)		
OECD to OECD	**-1.935*** **	**-1.932*** **	**10.48*** **	**10.38*** **		
	(0.108)	(0.108)	(1.015)	(1.018)		
Non-OECD to OECD	**-1.699*** **	**-1.689*** **	**4.510*** **	**4.459*** **		
	(0.105)	(0.106)	(0.527)	(0.526)		
Ln(distance)	-0.732***	-0.734***	-1.234***	-1.230***		
	(0.0405)	(0.0405)	(0.0473)	(0.0472)		
Contiguity	0.769***	0.768***	0.510***	0.513***		
	(0.132)	(0.132)	(0.128)	(0.128)		
Common language	0.476***	0.474***	0.179**	0.179**		
	(0.0762)	(0.0762)	(0.0794)	(0.0795)		
Colony ties	0.328**	0.311**	0.0220	0.0181		
	(0.154)	(0.153)	(0.171)	(0.171)		
RTA	0.314***	0.319***	0.184**	0.185**	0.0816	0.0825
	(0.0745)	(0.0746)	(0.0784)	(0.0786)	(0.0524)	(0.0525)
WTO	0.146**	0.140**	0.230***	0.225***	0.245***	0.244***
	(0.0613)	(0.0612)	(0.0737)	(0.0738)	(0.0675)	(0.0676)
Common currency	0.869***	0.863***	0.573***	0.542***	0.180	0.132
	(0.158)	(0.158)	(0.146)	(0.146)	(0.111)	(0.111)
Importer ratifies RC	**0.199*** **	0.126				
	(0.0770)	(0.0874)				
Exporter ratifies RC	**0.233*** **	**0.384*** **				
	(0.0716)	(0.0839)				
Both ratify RC	**-0.238*** **	**-0.303*** **	**-0.143** **	**-0.129***	**-0.134*** **	**-0.0778***
	(0.0844)	(0.104)	(0.0611)	(0.0698)	(0.0364)	(0.0449)
Imp. ratifies RC x OECD to non-OECD		**0.256***		-0.00420		-0.0300
		(0.138)		(0.118)		(0.0759)
Exp. ratifies RC x OECD to non-OECD		**-0.346*** **		**-0.216** **		**-0.102***
		(0.0972)		(0.0856)		(0.0591)
Both ratify RC x OECD to non-OECD		0.0740		-0.0212		-0.117
		(0.166)		(0.142)		(0.0943)
Observations	72,176	72,176	72,176	72,176	72,176	72,176
R-squared	0.311	0.312	0.480	0.480	0.101	0.102

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise.. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

Table A7. Stockholm Convention fourth digits codes aggregation

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.591***	0.590***				
	(0.0203)	(0.0202)				
Ln(GDP) exporter	0.766***	0.766***				
	(0.0225)	(0.0226)				
OECD to non-OECD	**-1.099*** **	**-1.115*** **	**5.295*** **	**5.470*** **		
	(0.0887)	(0.0946)	(0.776)	(0.784)		
OECD to OECD	**-1.364*** **	**-1.363*** **	**9.727*** **	**9.858*** **		
	(0.108)	(0.108)	(1.032)	(1.038)		
Non-OECD to OECD	**-0.486*** **	**-0.488*** **	**4.521*** **	**4.523*** **		
	(0.122)	(0.122)	(0.683)	(0.683)		
Ln(distance)	-0.309***	-0.310***	-0.604***	-0.607***		
	(0.0412)	(0.0412)	(0.0507)	(0.0507)		
Contiguity	0.374***	0.374***	0.548***	0.548***		
	(0.111)	(0.111)	(0.111)	(0.111)		
Common language	0.123	0.122	-0.000910	-0.00224		
	(0.0801)	(0.0801)	(0.0967)	(0.0966)		
Colony ties	0.421***	0.416***	-0.0679	-0.0559		
	(0.143)	(0.143)	(0.180)	(0.180)		
RTA	0.0350	0.0309	-0.0401	-0.0370	-0.0160	-0.0147
	(0.0784)	(0.0787)	(0.0895)	(0.0896)	(0.0595)	(0.0596)
WTO	0.134**	0.131**	0.409***	0.413***	0.493***	0.497***
	(0.0670)	(0.0668)	(0.0876)	(0.0876)	(0.0787)	(0.0787)
Common currency	0.821***	0.823***	0.155	0.158	0.206**	0.192*
	(0.112)	(0.112)	(0.134)	(0.134)	(0.102)	(0.102)
Importer ratifies SC	-0.138	-0.156				
	(0.0903)	(0.105)				
Exporter ratifies SC	**0.265*** **	**0.302*** **				
	(0.0853)	(0.102)				
Both ratify SC	-0.0148	-0.0382	-0.00893	-0.0451	-0.00331	0.0223
	(0.0975)	(0.122)	(0.0713)	(0.0809)	(0.0398)	(0.0458)
Imp. ratifies SC x OECD to non-OECD		0.0731		**-0.280** **		**-0.195** **
		(0.129)		(0.115)		(0.0828)
Exp. ratifies SC x OECD to non-OECD		-0.103		0.0142		-0.0412
		(0.113)		(0.0963)		(0.0624)
Both ratify SC x OECD to non-OECD		0.0804		0.253*		0.0420
		(0.167)		(0.150)		(0.102)
Observations	80,720	80,720	80,720	80,720	80,720	80,720
R-squared	0.181	0.181	0.284	0.284	0.075	0.075

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise.. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

Table A8. Rotterdam Convention. Aggregated imports

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.586***	0.585***				
	(0.0204)	(0.0204)				
Ln(GDP) exporter	0.980***	0.980***				
	(0.0215)	(0.0215)				
OECD to non-OECD	**-1.230*** **	**-1.243*** **	**5.721*** **	**5.773*** **		
	(0.0879)	(0.0967)	(0.878)	(0.884)		
OECD to OECD	**-2.047*** **	**-2.045*** **	**11.04*** **	**10.93*** **		
	(0.117)	(0.117)	(1.015)	(1.019)		
Non-OECD to OECD	**-1.916*** **	**-1.906*** **	**4.412*** **	**4.374*** **		
	(0.113)	(0.114)	(0.511)	(0.512)		
Ln(distance)	-0.832***	-0.835***	-1.366***	-1.362***		
	(0.0421)	(0.0421)	(0.0473)	(0.0473)		
Contiguity	0.883***	0.880***	0.520***	0.522***		
	(0.134)	(0.134)	(0.131)	(0.131)		
Common language	0.616***	0.613***	0.216***	0.217***		
	(0.0815)	(0.0815)	(0.0782)	(0.0782)		
Colony ties	0.298*	0.276	0.106	0.0996		
	(0.176)	(0.175)	(0.190)	(0.191)		
RTA	0.413***	0.417***	0.300***	0.301***	0.102*	0.105*
	(0.0775)	(0.0777)	(0.0779)	(0.0782)	(0.0542)	(0.0542)
WTO	0.231***	0.225***	0.284***	0.281***	0.272***	0.273***
	(0.0662)	(0.0662)	(0.0824)	(0.0825)	(0.0768)	(0.0769)
Common currency	0.564***	0.563***	0.283**	0.243*	0.212*	0.142
	(0.167)	(0.166)	(0.133)	(0.134)	(0.110)	(0.110)
Importer ratifies RC	**0.177** **	0.0575				
	(0.0820)	(0.0930)				
Exporter ratifies RC	**0.205*** **	**0.323*** **				
	(0.0777)	(0.0896)				
Both ratify RC	-0.133	-0.144	**-0.137** **	-0.0869	**-0.119*** **	-0.0602
	(0.0890)	(0.109)	(0.0572)	(0.0653)	(0.0362)	(0.0451)
Imp. ratifies RC x OECD to non-OECD		**0.412*** **		0.0545		-0.102
		(0.148)		(0.116)		(0.0752)
Exp. ratifies RC x OECD to non-OECD		**-0.261** **		**-0.218*** **		**-0.171*** **
		(0.105)		(0.0823)		(0.0601)
Both ratify RC x OECD to non-OECD		-0.101		-0.150		-0.0646
		(0.176)		(0.136)		(0.0923)
Observations	53,268	53,268	53,268	53,268	53,268	53,268
R-squared	0.353	0.354	0.582	0.582	0.139	0.140

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. if only the importer (or only the exporter) ratifies and zero otherwise.. The 'ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.

Table A9. Stockholm Convention. Aggregated imports

Dep. Variable: ln Imports	Gravity controls& t, k FE		Gravity controls k FE&MRT		MRT & ijk FE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Ln(GDP) importer	0.801***	0.801***				
	(0.0284)	(0.0284)				
Ln(GDP) exporter	1.174***	1.174***				
	(0.0300)	(0.0300)				
OECD to non-OECD	**-0.995*** **	**-1.003*** **	**8.622*** **	**8.943*** **		
	(0.133)	(0.141)	(1.255)	(1.265)		
OECD to OECD	**-1.165*** **	**-1.166*** **	**15.53*** **	**15.72*** **		
	(0.159)	(0.159)	(1.733)	(1.743)		
Non-OECD to OECD	**-1.062*** **	**-1.063*** **	**6.458*** **	**6.451*** **		
	(0.183)	(0.182)	(1.194)	(1.199)		
Ln(distance)	-0.477***	-0.478***	-0.908***	-0.910***		
	(0.0562)	(0.0561)	(0.0611)	(0.0611)		
Contiguity	0.597***	0.597***	0.696***	0.699***		
	(0.155)	(0.155)	(0.141)	(0.140)		
Common language	0.393***	0.392***	0.253**	0.252**		
	(0.113)	(0.113)	(0.109)	(0.109)		
Colony ties	0.788***	0.785***	0.0663	0.0817		
	(0.213)	(0.213)	(0.271)	(0.270)		
RTA	0.215**	0.213**	0.0648	0.0706	-0.0573	-0.0537
	(0.106)	(0.106)	(0.107)	(0.107)	(0.0830)	(0.0832)
WTO	0.0602	0.0590	0.393***	0.398***	0.370***	0.377***
	(0.0983)	(0.0980)	(0.130)	(0.130)	(0.117)	(0.117)
Common currency	0.602***	0.603***	0.0750	0.0712	0.162	0.125
	(0.181)	(0.181)	(0.161)	(0.161)	(0.161)	(0.161)
Importer ratifies SC	**-0.260** **	**-0.268***				
	(0.126)	(0.144)				
Exporter ratifies SC	0.0893	0.126				
	(0.117)	(0.140)				
Both ratify SC	0.171	0.141	0.0108	-0.00547	-0.0294	0.0740
	(0.136)	(0.168)	(0.0852)	(0.0961)	(0.0573)	(0.0661)
Imp. ratifies SC x OECD to non-OECD		0.0404		**-0.407*** **		-0.172
		(0.184)		(0.150)		(0.108)
Exp. ratifies SC x OECD to non-OECD		-0.0935		-0.0708		-0.0912
		(0.159)		(0.119)		(0.0844)
Both ratify SC x OECD to non-OECD		0.0859		0.275		-0.159
		(0.234)		(0.188)		(0.134)
Observations	32,562	32,562	32,562	32,562	32,562	32,562
R-squared	0.349	0.349	0.537	0.537	0.111	0.112

Note: Robust standard errors are in brackets, ***, **, * denotes statistical significance at the 1, 5 and 10 percent level, respectively. The 'importer (or exporter) ratifies' variable is encoded as a dummy variable equal to one if only the importer (or only the exporter) ratifies and zero otherwise.. The 'both ratify' dummy takes the value of one when the two trade partners are ratifying countries in a given year.