The Effect of Multi-Lateral Environmental Agreements on Bilateral Trade Flows

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Abstract

In this paper we analyse the consequences of multi-lateral environmental agreements (MEAs) on international bilateral trade, following Baier and Bergstrand (2007). To mitigate potential bias caused by the endogeneity due to unobserved heterogeneity, we apply panel data estimation techniques to examine the specific effects of environmental agreements when simultaneously taking the effects of trade agreements into account. To identify the categorical impacts of both trade and environmental agreements, we divide all complete trade agreements into two categories: (i) free trade agreements, (ii) custom and economic unions; and environmental agreements into those dealing with (i) pollution, and (ii) natural resource management. Additionally, we look at the different impacts of small and large size MEAs on trade flows. From a policy point of view, concurrent negotiations of trade and environmental agreements may be preferable to offset the negative effects of the latter.

Keywords: multi-lateral environmental agreements, panel gravity estimation

JEL Classification: F18; F53; Q56

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1 Introduction

A central preoccupation of the international trade-environment debate is the impact of environmental regulations on trade. In the past few decades, many countries have placed great emphasis on meeting the dual goals of high human development and low ecological impact. Various environmental protections have been adopted in order to limit the emission of pollutants and to protect the environment. As a result of increasing abatement cost for polluting industries, the pollution haven effect states that a tightening of environmental regulation will have an effect on plant location decisions and trade flows (Taylor, 2004). It is also known that lax environmental regulation in developing countries may increase their comparative advantage in polluting industries, at the expense of developed countries.

Extensive research effort has been examining the pollution haven effect, both theoretically and empirically. Pethig (1976), Siebert (1977), McGuire (1982), Markusen (1999), Ulph et al. (1999), and Millimet and List (2004) show environmental regulations reduce international trade. Walter (1982), Pearson (1985, 1987), Leonard and Duerksen (1980), and Taylor (2004) showed stringent environmental regulations could also decrease foreign direct investment. To better evaluate the impact of environmental regulations, Ederington and Minier (2003) use environmental compliance costs as a proxy for the stringency of U.S. environmental regulations and enforcement from 1978 to 1992, and find empirical support for modeling environmental policy endogenously. They also provide an argument that, international cooperation over environmental policies, by deterring countries from relaxing their environmental standards, can actually lead to increased global welfare. In a later study, Levinson and Taylor (2008) develop a theoretical model and test it empirically to examine the effect of environmental regulations on trade flows between the U.S., Canada, and Mexico, for 130 manufacturing industries from 1977 to 1986 with an instrument variable weighted by state characteristics.

Despite such a large and still growing literature on the puzzling relationship between trade growth and global environmental policies, few studies have been sought to examine the effects of international environmental agreements (IEAs) due to limited data availability. None has been investigating the specific role of multi-lateral environmental agreements (MEAs), which serve as one of the most adopted measures to introduce and coordinate stringent environmental policies across countries. An MEA is a legally binding agreement among several countries which implements a new environmental regulation agreed upon by member countries. While environmental treaties date back to the end of the 19th century, the vast majority of MEAs have been adopted since the 1972 United Nations Conference on the Human Environment (UNCHE)[1] that took place in Stockholm, Sweden. Adopted by all 113 countries present at the conference, the Stockholm Declaration was the first universal document of importance on environmental matters. It placed environmental issues squarely on the international scene and lead to a dramatic increase in the number of MEAs after 1972. After that, with the ratification of the Montreal Protocol (1989) and a series of other conventions, the number of MEA signatories has also risen tremendously.

In the overall framework of setting up environmental protection laws and conventions, MEAs have been playing a critical role in recent decades. When a country makes a decision whether to engage in a multilateral trade or environmental agreement, it will compare costs and benefits that depend not only on bilateral economic development, but also on bilateral political issues. Hence signing an MEA could eliminate the disadvantage in international competition caused by unilaterally imposed more stringent environmental regulations. Such arguments are broadly supported by later studies. For instance, Rose and Spiegel (2009) use a bilateral cross-section of data on international crossholdings of assets and environmental treaties to find that multilateral environmental engagement facilitates international economic exchange. Therefore, participation in such non-economic partnerships tends to enhance international economic relations. In addition to their finding, Bergstrand, Egger, and Larch (2010) show that countries are more likely to sign a trade agreement if they are geographically closer to each other and of similar economic size, while Besedeš, Johnson, and Tian (2016) find the same to be true for environmental agreements. Egger, Jeßberger, and Larch (2011) investigate the determinants of MEAs and suggest that international economic coalitions about trade and cross-border direct investment stimulate

[1]Often referred to as the Stockholm Conference. UNCHE was a watershed event that helped launch the last 30 years of increasingly intensive treaty-making in the area of international environmental law as well as much activity within national governments.

MEA memberships. Another recent work by Egger, Jeßberger, and Larch (2013) proposes an empirical model of the number and characteristics of specific MEAs regarding environmental issues, which involves their economic, political and environmental determinants. For this purpose, they classify MEAs into five different clusters of environmental issues: bio-diversity, atmosphere, land, chemicals and hazardous wastes, and seas. Their results point to an overwhelming importance of economic size and multilateral trade liberalization as drivers of MEA ratification across clusters.

Several recent studies estimating the effects of MEAs on bilateral trade flows take endogeneity into account. Aichele and Felbermayr (2013) investigate the Kyoto Protocol's effects on international trade flows using matched pairs estimation dealing with self-selection in Kyoto Commitments. They estimate a difference-in-differences specification including standard gravity variables as well as free trade agreements and participation in the Kyoto Protocol. Their results show that Kyoto Commitments have had a negative effect of exports. Aichele and Felbermayr (2015) derive a gravity equation for the carbon content of trade and suggests that Kyoto commitment on average leads to increased imports in committed countries. However, most of their work focuses on environment regulation stringency in a single MEA. (Aichele and Felbermayr, 2010, 2012, 2013).

The objective of this paper is twofold. Firstly, we aim to examine how multilateral environmental agreements affect international trade. Secondly, we examine the joint effect that multilateral environmental agreements and international trade agreements have on trade, by building on the panel gravity estimation approach of Baier and Bergstrand (2007) and mainly inquiring whether more MEAs encourage or discourage the growth of trading volume between each country pair that shares the agreement. We also attempt to test the categorical impact of MEAs on trade flows when taking free trade agreements into account simultaneously, which to our knowledge has not been explored before. This paper is distinguished from other papers in this literature in several aspects. First, the basis of our MEA data is obtained from the International Environmental Agreements (IEA) Database Project by Ronald B. Mitchell and the IEA Database Project, 2002-2014. This truly systematic, comprehensive and up to date list (i.e., the population) of MEAs include not only the agreements that counter pollution but also those that aim to preserve the ecology and species. Our work is the first investigation on trade flows with comprehensive MEAs data rather than national environmental regulation or single multinational environmental agreement. Second, by applying the panel cross sectional time series data, we take into account the endogeneity of FTAs as well as MEAs. Furthermore, we separate the different types of FTAs to capture the effects of trade liberalization rather than using a single dummy. We also separate MEAs into the two types, pollution and resource management agreements, and also take into account the number of MEAs a pair of countries has. This provides us a more accurate estimation for the effects of MEAs on international trade flows.

The empirical results in this paper suggest several important conclusions. First, while EIAs have a significant positive effect on trade growth, we find little evidence of the oft-supposed negative effect of MEAs which either have no significant effect or have a positive statistically significant effect. Second, we find that the simultaneous presence of trade and environmental agreements increases bilateral trade, an economically and statistically significant result. Third, to have a detailed investigation of the differential effects of each type of environmental agreement, we separate them into two categories: resource type and pollution type. We find that both types either have no effect or have a small positive impact on bilateral trade flows. Finally, to see if the size of MEAs will have any influence, we count the number of signatories of each agreement as well. We find that small-size MEAs have more significantly positive impact than large-size MEAs.

The remainder of this paper is organized as follows. Section 2 presents a detailed description of our empirical methodology to assess the impact of environmental agreements, following the panel gravity estimation approach from Baier and Bergstrand (2007). Section 3 discusses our three data sources and related work. Section 4 explains the empirical findings of a general MEA influence and also categorical impacts on trade flows, from which we confirm the mutual supportiveness between MEAs and trade growth. Section 5 provides additional robustness checks by separating MEAs according to their number of signatories, followed by concluding remarks in Section 6.

2 Methodology

In this section we begin by reviewing the Baier and Bergstrand (2007) approach to estimate the effect of trade agreements on international trade, which we then replicate and extend to examine the effect of environmental agreements.

2.1 Estimating the MEA impact: Baier-Bergstrand (2007) Panel Methodology

Ever since its introduction by Tinbergen et al. (1962), the gravity equation has dominated the international trade literature in studying the determinants of bilateral trade flows. With its theoretical foundation developed in Anderson (1979), the gravity model relates the trade value between countries to their size and the economic distance between them. As pointed out by Anderson and van Wincoop (2003) the volume of trade between any two countries depends not only on their level of bilateral trade resistance but also on how difficult it is for each of them to trade with the rest of the world-what they term multilateral resistance. Higher levels of multilateral resistance should be associated, ceteris paribus, with lower bilateral trade volumes.

Recent theoretical literature on heterogeneous firms and trade emphasizes firm selection into international markets and reallocations of resources across firms. Melitz (2003) adapts a dynamic industry model from Hopenhayn (1992) to monopolistic competition with heterogeneous firms in a general equilibrium setting. In so doing, the paper provides an extension of the trade model in Krugman (1980) that incorporates firm level productivity differences. Firms with different productivity levels coexist in an industry because each firm faces initial uncertainty concerning its productivity before making an irreversible investment to enter the industry. Entry into the export market is also costly, but the firm's decision to export occurs after it gains knowledge of its productivity. Earlier studies use the instrumental variables approach and cross-sectional data to deal with endogenous self-selection of country pairs into EIAs.

Several econometric approaches have been applied to deal with the endogeneity problem including using panel data with fixed effects, matching econometrics, and difference-in-difference estimators. Baier and Bergstrand (2007) apply a fixed effects approach to eliminate the potential endogeneity bias of EIAs. Following Anderson and van Wincoop (2003) and Baier and Bergstrand (2007) one can generate the following panel gravity equation to estimate the effect of trade agreements:

$$
\begin{aligned}
\ln X_{ijt} = \beta_0 + \beta_1 (\ln RGDP_{it}) + \beta_2 (\ln RGDP_{jt}) + \beta_3 (\ln DIST_{ij}) \\
+ \beta_4 (ADJ_{ij}) + \beta_5 (LANG_{ij}) + \beta_6 (EIA_{ijt}) - \ln P_{it}^{1-\sigma} \\
- \ln P_{jt}^{1-\sigma} + \epsilon_{ijt}
\end{aligned}
\tag{1}
$$

where X_{ijt} is the bilateral trade flow from country i to j in year t, $RGDP_{it}$ ($RGDP_{jt}$) denotes real gross domestic product (GDP) in country i (j) in year t, $DIST_{ij}$ is the bilateral distance between the exporter i and importer j, a longer distance indicates higher fixed trade costs from transportation; ADJ_{ij} is a dummy variable which equals 1 if the two trading countries share a common land border (and 0 otherwise); $LANG_{ij}$ is a dummy variable which equals 1 if a common language is shared between the two countries; and EIA_{ijt} is a dummy variable, taking the value of 1 if an economic integration agreement (EIA) exists to between the two countries in year t. Multilateral resistance price terms for the exporter i and importer j are explicitly accounted for in $\ln P_{it}$ and $\ln P_{jt}$. Ignoring the time-varying multilateral price variables might lead to an omitted variable bias, hence Baier and Bergstrand (2007) suggest using the specification below to scale the LHS variable by the product of real GDPs.

$$
\begin{aligned}
\ln \frac{X_{ijt}}{Y_{it} Y_{jt}} = \beta_0 + \beta_1 (lnDIST_{ij}) + \beta_2 (ADJ_{ij}) + \beta_3 (COMLANG_{ij}) \\
+ \beta_4 (EIA_{ijt}) - \ln P_{it}^{1-\sigma} - \ln P_{jt}^{1-\sigma} + \epsilon_{ijt}
\end{aligned}
\tag{2}
$$

where Y_{it} (Y_{jt}) denotes GDP in country i (j) in year t. Following Baier and Bergstrand (2007), there might be unobserved time-invariant bilateral variables, as the source of potential endogeneity bias, simultaneously affecting the EIA_{ij} existence as well as the size of trade flows between the two countries in an agreement. These variables are best controlled for using bilateral fixed effects that allow for arbitrary correlations of unobserved heterogeneity with EIA_{ij}. Previous literature, such as Egger (2000), has provided econometric evidence for the support of a fixed-effects gravity model by using Hausman Test to test fixed versus random effects approach. Hence by taking country-pair (ij) and country-and-time (it, jt) fixed effects into account, this estimation approach generates an unbiased estimate of the EIA impact.

Another extension in Baier and Bergstrand (2007) to account for the unobserved heterogeneity is the first-differenced panel gravity equation. Wooldridge (2010) has pointed out that the individual-specific (i.e., firm, city, and country) trend is an additional source of heterogeneity. Therefore the strict exogeneity assumption on the explanatory variable for the random trend (or random growth) model becomes:

$$E\left[u_{it}|x_{i1},...,x_{iT},c_i,g_i\right]=0 \tag{3}$$

where u_{it} are the idiosyncratic errors, c_i denotes the country heterogeneity, and g_i is the country-specific average growth rate over a period, holding the explanatory variables fixed. Since taking first difference to eliminate c_i would lose one time period, the policy effect could be estimated consistently in the random trend model only if T is no less than 3 periods. We are expecting that taking first difference would increase our estimation efficiency because of the unobserved heterogeneity in country pairs. Additionally, Cheng and Wall (1999) have argued that five-year differences are more appropriate than annual differences, due to the likelihood that trade flows cannot adjust within one year to EIA formations and that time is needed to capture full effects, which is supported by the result in Baier and Bergstrand (2007) that it can take 10 to 15 years for an EIA to have its full effect.

2.2 Estimating the general MEA impact

To empirically estimate the precise MEA impact on trade following Baier and Bergstrand (2007), we begin with a set of five-year fixed-effect panel gravity equations:

$$\ln TRADE_{ijt} = \beta_0 + \beta_1 (EIA_{ijt}) + \delta_{it} + \psi_{jt} + \upsilon_{ijt} \tag{4}$$

$$\ln TRADE_{ijt} = \beta_0 + \beta_1 (MEA_{ijt}) + \delta_{it} + \psi_{jt} + \upsilon_{ijt} \tag{5}$$

$$\begin{aligned} lnTRADE_{ijt} = &\beta_0 + \beta_1 (EIA_{ijt}) + \beta_2 (MEA_{ijt}) \\ &+ \delta_{it} + \psi_{jt} + \upsilon_{ijt} \end{aligned} \tag{6}$$

$$\begin{aligned} lnTRADE_{ijt} = &\beta_0 + \beta_1 (EIA_{ijt}) + \beta_2 (MEA_{ijt}) \\ &+ \beta_2 (EIA \times MEA_{ijt}) + \delta_{it} + \psi_{jt} + \upsilon_{ijt} \end{aligned} \tag{7}$$

where $TRADE_{ijt}$ refers to non-zero real trade flow every 5 years. Note that using scaled or unscaled GDP value does not change the estimated results of average treatment effects because of the inclusion of country-pair and country-year fixed effects. We use bilateral (ij) fixed effects to account for variation in DIST, ADJ, and LANG along with country-and-time (it, jt) effects to account for variation in real GDPs and the multilateral price terms. Both the exporter-time δ_{it} and importer-time ψ_{jt} fixed effects are to capture changes in time-varying exporter and importer GDPs and multilateral price terms over the same five-year period. Otherwise, ignoring such effects would cause potential omitted variable bias (Foster, Poeschl, and Stehrer, 2011). Previous studies have shown that terms-of-trade changes tend to have lagged effects on trade volumes. To account for the lagged terms-of-trade effects, we follow Baier and Bergstrand (2007) and add both 5-year and 10-year lagged terms into our estimation.

As discussed in Baier and Bergstrand (2007), the FD approach yields some potential advantages over FE, especially when the unobserved heterogeneity are highly serially correlated. Under such circumstances, the inefficiency of FE is exacerbated as T increases. Additionally, as Wooldridge (2010) notes, if the data follow unit-root processes (e.g., aggregate trade flow and real GDP in importer and exporter countries) and T is large, the spurious regression problem can arise in a panel using FE. Therefore, with a large-T panel (T=8 after five-year differencing in our sample), the FD approach would be increasing estimation efficiency over the FE method. To avoid potential over-rejection problems, we use clustered standard errors at the country-pair level in each set of FD estimation.

Following the FD approach in Baier and Bergstrand (2007), we take a first step to difference: (i) the natural logarithm of $TRADE_{ijt}$; (ii) EIA_{ijt}; and (iii) MEA_{ijt}. Then we regress these differenced variables on all country-and-time dummies and predict the residuals. Finally, we regress the residuals from $d \ln TRADE$ on the residuals from $dEIA$ and $dMEA$, to capture the unbiased estimates of the average treatment effects (ATE). The estimation equation is given by:

$$\begin{aligned} d \ln TRADE_{ij,t-(t-1)} = \beta_0 + \beta_1 \left(dEIA_{ij,t-(t-1)}\right) + \beta_2 \left(dMEA_{ij,t-(t-1)}\right) \\ + \beta_{i,t-(t-1)} \left(Dum_{i,t-(t-1)}\right) + \beta_{j,t-(t-1)} \left(Dum_{j,t-(t-1)}\right) + \upsilon_{ij,t-(t-1)} \end{aligned} \tag{8}$$

where $\upsilon_{ij,t-(t-1)}$ refers to white noise. Using such FD estimation allows us to account for changes in the unobservable theoretical multilateral resistance terms $d \ln P_{it}$ and $d \ln P_{jt}$ to eliminate the potential estimation bias.

2.3 Estimating the categorical impact of MEAs

After testing the general effect of all environmental agreements, we then separate all MEAs into two types (pollution and resource) to examine whether there's a significant difference between each sub-category of MEAs. The "Pollution" category aims to capture all agreements related to all forms of pollution, whether affecting air, land, oceans, or freshwater systems at regional or global scales, while the "Resource" category includes most non-pollution related subjects: Species, Nature, Habitat and oceans, and Freshwater resources. In our work we do not take into account the last MEA category, "Other" type, due to the limited number of MEAs in that category[2]. Moreover, we also divide all trade agreements in our sample into two categories: free trade agreements and custom unions or deeper agreements. Following Baier, Bergstrand, and Feng (2014), these complete preferential trade agreements refer to EIA type equal to or greater

[2] "Other" refers to the rest of non-pollution related agreements, including "Energy" and "Weapons and Environment." These agreements seek to capture agreements that address energy production, including nuclear energy, as well as weapons that affect the environment such as the nuclear bomb as well as bacteriological, chemical, and toxin weapons.

than Type 3 [3].

The estimating equations for each MEA type on member countries' bilateral trade flows are:

$$
\begin{aligned}
\ln TRADE_{ijt} = \beta_0 &+ \beta_1 (FTA_{ijt}) + \beta_2 (CUC_{ijt}) + \beta_3 (POL_{ijt}) + \beta_4 (RES_{ijt}) \\
&+ \delta_{it} + \psi_{jt} + \upsilon_{ijt}
\end{aligned} \tag{9}
$$

where POL_{ijt} is a binary variable which is unity if country i and j belong to one or more MEAs in pollution type and zero otherwise, RES_{ijt} is a binary variable which is unity if country i and j share the natural resource type of MEA and zero otherwise, and FTA_{ijt} is again a binary variable indicating whether country i and j belong to the same free trade agreement in year t. Following Baier, Bergstrand, and Feng (2014) we combine custom union, common market, and economic union into one dummy CUC_{ijt}, denoting the status of "deeper EIA." Additionally, we generate four interaction terms for each sub-category as below:

$$
\begin{aligned}
\ln TRADE_{ijt} = \beta_0 &+ \beta_1 (FTA_{ijt}) + \beta_2 (CUC_{ijt}) + \beta_3 (POL_{ijt}) + \beta_4 (RES_{ijt}) \\
&+ \beta_5 (FTPOL_{ijt}) + \beta_6 (FTRES_{ijt}) + \beta_7 (CUPOL_{ijt}) \\
&+ \beta_8 (CURES_{ijt}) + \delta_{it} + \psi_{jt} + \upsilon_{ijt}
\end{aligned} \tag{10}
$$

where $FTPOL_{ijt}$ is a binary variable which is unity if country i and j share both a FTA and a MEA in pollution type and zero otherwise, $FTRES_{ijt}$ is a binary variable which is unity if country i and j have a FTA and a natural-resource type of MEA and zero otherwise. Similarly, $CUPOL_{ijt}$ ($CURES_{ijt}$) is indicating whether country i and j belong to the same "deep" EIA and pollution (resource)-type MEA in year t. We also use FD approach to check the effects of changes in each agreement type and their interaction terms on trade flows:

[3] In EIA dataset, Type 1 refers to one-way preferential trade agreements and Type-2 refers to two-way preferential trade agreements.

$$
\begin{aligned}
d\ln TRADE_{ij,t-(t-1)} = {} & \beta_0 + \beta_1 \left(dFTA_{ij,t-(t-1)}\right) + \beta_2 \left(dCUC_{ij,t-(t-1)}\right) \\
& + \beta_3 \left(dPOL_{ij,t-(t-1)}\right) + \beta_4 \left(dRES_{ij,t-(t-1)}\right) \\
& + \beta_{i,t-(t-1)} \left(Dum_{i,t-(t-1)}\right) + \beta_{j,t-(t-1)} \left(Dum_{j,t-(t-1)}\right) + \upsilon_{ij,t-(t-1)}
\end{aligned} \tag{11}
$$

$$
\begin{aligned}
d\ln TRADE_{ij,t-(t-1)} = {} & \beta_0 + \beta_1 \left(dFTA_{ij,t-(t-1)}\right) + \beta_2 \left(dCUC_{ij,t-(t-1)}\right) \\
& + \beta_3 \left(dPOL_{ij,t-(t-1)}\right) + \beta_4 \left(dRES_{ij,t-(t-1)}\right) \\
& + \beta_5 \left(dFTPOL_{ij,t-(t-1)}\right) + \beta_6 \left(dFTRES_{ij,t-(t-1)}\right) \\
& + \beta_7 \left(dCUPOL_{ij,t-(t-1)}\right) + \beta_8 \left(dCURES_{ij,t-(t-1)}\right) \\
& + \beta_{i,t-(t-1)} \left(Dum_{i,t-(t-1)}\right) + \beta_{j,t-(t-1)} \left(Dum_{j,t-(t-1)}\right) + \upsilon_{ij,t-(t-1)}
\end{aligned} \tag{12}
$$

2.4 Estimating the size impact of MEAs

Besedeš, Johnson, and Tian (2016) in their work address a series of economic factors that lead to MEAs being formed. They find that a country pair is more likely to sign an MEA or have more of them if they are economically larger and of similar economic size, closer in distance, have a preferential trade agreement, and trade more. Additionally, they find results are strongest for MEAs between a small number of countries, indicating that MEAs are formed to manage common pool resources. On the basis of their finding, we divide our MEAs into different-size groups and try to look into the size difference. To have a comparison between the baseline results based on all the MEAs, we additionally examine the sub-groups of: (i) MEAs with fewer than the sample median number of signatories (26); and (ii) MEAs with greater than the 3rd quartile number of signatories (68). In our combined dataset, number of MEA signatories among all trading countries are from 3 to 197.

Small and large environmental agreements have different economic determinants, as the former would be more closely brought up by member countries' cooperation in the use of common pool resources (Besedeš, Johnson, and Tian, 2016). As a result it is possible that they may have different effects on international trade as well. Previous studies such as Barrett (1994) and Murdoch, Sandler, and Vijverberg (2003) also provide theoretical supporting evidence: self-enforcing environmental agreements could sustain a large number of signatories only when the difference in net benefits between the non-cooperative and fully cooperative outcomes is very small. Specifically, the smaller the actual commitment, the larger the set of participants. Hence, our preassumption is that environmental agreements with fewer signatories are signed by countries which desire to deal with common pool resource issues, while larger ones are most likely what one may call "statement" or "preference" agreements in which countries express a desire to deal with an issue but make no strict commitments.

3 Data Description

Our trade flow data are an aggregation of trade flows from the UN Comtrade database, using the 5-digit SITC revision 1 data as the starting point as it provides the longest possible time series. In this paper, we use five-year window data from 1965 to 2005 for all potential trade partners with zero trade flows excluded. Previous studies such as Eichengreen and Irwin (1995) and Felbermayr and Kohler (2006) address the issue of zero trade flows. Baier and Bergstrand (2007) in their work test the effect of zero trade flows by substituting ones for zeros, and find the estimated coefficients of FTAs are materially the same. The reason that we use every five-year data instead of annually data is that the policies, such as FTAs and IEAs do not change that frequently (see Anderson and Yotov, 2011). It will provide us a clearer result of how the environmental policies and trade agreements affect international trade. All trade flow data are scaled by GDP deflators to generate real trade flows.

Our economic integration agreements data including 198 countries are obtained from Baier and Bergstrand (2007) who compiled the Database on Economic Integration Agreements. They classified integration agreements following Lawrence (2000) and Frankel, Stein, and Wei (1997).[4] We use the most recently updated version (September 2015) of the database which coverd 23,201 country-pairs over 56 years and generate dummy variables for all types of free trade agreements

[4]The original data resource is at www3.nd.edu/~jbergstr.

according to their indexes. Baier and Bergstrand (2007) chose to include only full (no partial) FTAs and customs unions in their assessment of trade agreement impact. Baier, Bergstrand, and Feng (2014) define a multichotomous index of the level of EIA between a large number of country pairs for a large number of years. Their finding of a positive EIA impact on trade margins further confirms the earlier conclusion in Baier and Bergstrand (2007) that FTAs significantly increase bilateral trade flows between trading members. Baier, Bergstrand, and Feng (2014) further find that "deeper EIA" types have significantly positive stimulating effects on both the intensive and extensive margins, and such beneficial effects even become larger when lagged effects are considered.

Our environmental agreements data are obtained from the Ronald B. Mitchell (2002-2015) IEA Database project. The IEA Database includes a comprehensive list of over 1,190 multilateral environmental agreements (MEAs), over 1,150 bilateral environmental agreements (BEAs), and 250 other environmental agreements since 1857. As membership data for almost all MEAs are included and updated, our research relies mostly on MEAs to grasp a better understanding of the role of IEAs on trade growth. For each agreement, basic information provides signature date, agreement titles, members, agreement type by topic covered, lineage,[5] and sequences.[6] To control the change in intensity of international environmental cooperation within the sample period 1965-2000, we use the count of all agreements between each trading pair by year. As some agreements are updated and amended over time, we adjust all our counts of the IEA members by their lineages to avoid any potential duplication.

[Insert Table 1 about here]

Table 1 summarizes our multilateral environmental agreements data collected from the IEA database. As we focus on the multi-lateral agreements only and use them to represent all IEAs in our estimation, MEA and IEA designations are used interchangeably. Among them, the variable "Value of Imports" represents the bilateral real trade flows between each country pair

[5] A lineage is any set of legally-related agreements that are linked by the fact that they modify, replace, extend or otherwise constitute agreements that have a legal relationship to each other.

[6] The sequence reflects the legal sequence of agreements capturing any amendments and protocols pertaining to an agreement.

in a specific year, summing over all sectors. We drop zero trade flows, following the rationale in Baier and Bergstrand (2007). "Full FTAs" is a binary variable when there exists at least one no-partial preferential trade agreement (EIA type equal or greater than 3) between a trading country pair. And "Both FTA and MEA" is the interaction term denoting the existence of both a FTA and MEA between two countries. As we also take into account the number of signatories for each environmental agreement. We also count the MEA size and divide them into the small size group (MEAs with less than 26 signatories) and large size group (MEAs with more than 68 signatories). Additionally, since our MEA dataset covers almost all environmental agreements in the sample period, we recode those missing observations as zero MEAs in the combined data.

[Insert Table 2 about here]

After taking a first step to analyze the overall impact of the presence of MEAs by generating a binary variable "MEA" to indicate whether a particular country pair has signed some environmental agreements during that year, we then separate MEAs according to the categories listed in the IEA database: (i) pollution type and (ii) resource type. Due to concerns that some early studies may have failed to properly detect the effect of environmental regulations, because of biases introduced into the estimation by aggregation, unobserved heterogeneity, and endogeneity of environmental standards, recent studies (e.g., Levinson and Taylor, 2008; Copeland and Taylor, 2009) have argued for the need to clarify the differing impact of environmental regulations across categories. Our data set allows us to alleviate the aggregation bias to some extent because of the precise disaggregated categories of IEAs. Under such circumstance we are able to control for unobserved heterogeneity caused by category-specific effects.

Table 2 provides a list of categorical dummies used in our FE specification and FD sensitivity analysis to test the impact of the existence of an MEA. As discussed in the previous section, The dummy variable of "Common Union" (CUC) is a binary variable when EIA type is equal to or greater than 3 in a specific year t and 0 otherwise. Specifically, it is a combined variable for three types of EIAs (customs unions, common markets and economic unions), because of the relative small number of observations in these three types. For the small- (number of signatories small than 26) and large-size (number of signatories greater than 68), we separate agreements by type into small and large.

4 Empirical Results

4.1 FE and FD Results without Specific Agreement Types

[Insert Table 3 about here]

Table 3 presents our main empirical results from Eqs. (4) to (7). Columns 1 to 4 give us a first set of estimates using EIA, MEA, and their interaction terms. Following the theoretically-motivated gravity equation in Baier and Bergstrand (2007) to take into account the "phased-in" effect of both trade and environmental agreements, we allow 5-year lagged terms in columns 5 to 8, and 10-year lags in columns 9 to 12. We find that with no lagged term added, the ATE of an EIA is an increase in its member countries' bilateral trade flow by 25.23% ($e^{0.225} - 1 \approx 0.2523$). Taking both agreements and their interaction terms into account leads to an even larger ATE at 26.49% ($e^{-0.391+0.626} - 1 \approx 0.2649$). Although the specific coefficient on concurrent MEA is statistically insignificant, the combined impact is larger in magnitude and indicates that multilateral environmental and trade agreements work as a stimulative factor of trade growth. The positive coefficient on interaction terms indicates that when countries have already signed bilateral trade agreements, there is a strong positive relationship between their environmental cooperation and trade growth. Such a finding is consistent with the empirical evidence found in Besedeš, Johnson, and Tian (2016). After lagged terms are added starting from Column 5, the cumulative impact of negotiating an EIA and MEA together is an increase of trade flows by 76.83% ($e^{0.363+0.207} - 1 \approx 0.7683$) within 5-10 year time frame. Additionally, the estimated coefficients on MEA and its lagged terms are statistically significant and indicating a positive impact on trade flows of 44.05% ($e^{0.365} - 1 \approx 0.4405$) after 10 years.

[Insert Table 4 about here]

As our robustness check of the FE results in Table 3, Table 4 reports the estimation results from Eq. (8) using first-differenced data. Columns 1 to 4 present the results without lagged effects; For a country pair having both an EIA and MEA change, the concurrent ATE on trade flow is an increase of 13.31% ($e^{0.125} - 1 \approx 0.1331$). Allowing a 10-year lagged changes on both trade and environmental agreements, we find the cumulative ATE of MEAs are significantly negative at 26.43% ($e^{-0.307} - 1 \approx 0.2643$), but the combined impact of both trade and environmental agreements is at an increase of 26.33% ($e^{0.135+0.0987} - 1 \approx 0.2633$). Therefore we find comparable estimation results from our FE and FD approach in addressing the overall MEA impact: When all MEAs are tested as a group, we see a small and negative impact of environmental agreements on trade flows. However when we take into account the positive impact of trade agreements, the deterring MEA impact is dominated by the latter. Specifically, countries signing an EIA and MEA together seem to have an even larger increase on trade growth than their counterpart, from which we can infer that countries that tend to have more environmental agreements are more likely to be trading with each other.

4.2 FE and FD Results with Specific Agreement Types

[Insert Table 5 about here]

After taking the first step to estimate the general MEA effect, we then turn to look at the differing MEA effect in each sub-category. With the rationale explained in the previous section, we divide all MEAs into two types to see if there are any significant differences across the differing types of agreements. To have a more detailed investigation of EIA impact simultaneously, we follow Baier, Bergstrand, and Feng (2014) to separate trade agreements into two sub-groups. Table 5 presents the results from Eqs. (9) to (10). Columns 1 to 4 report the estimated coefficients on each type of agreement when no lagged terms are being considered. We can see that both types of trade agreements have a positive effect on trade flows, and deeper" trade agreements have an even larger impact in magnitude. With no lagged effect, the average treatment effect of having a free trade agreement is an increase in trade of 19.24% ($e^{0.176} - 1 \approx 0.1924$), while "deeper" agreements increase trade by 45.94%. There is no significant impact from MEAs. After allowing

5-year lagged changes, we find the resource-type of MEAs have a statistically significant positive impact on trade flows. The cumulative ATE of resource-type MEA is an increase of 18.41% ($e^{0.383-0.214} - 1 \approx 0.1841$) on bilateral trade flows. Additionally, when allowing both 5-year and 10-year lagged changes in the last 4 columns, we find the resource type of MEAs consistently show positive cumulative ATEs, with a further increase of 53.42% ($e^{0.428} - 1 \approx 0.5342$), and the pollution-type MEAs show a small and positive impact of 10.13% ($e^{0.0965} - 1 \approx 0.1013$) after 10 years. Our finding of the lagged IEA effect is consistent with the empirical evidence found in Rose and Spiegel (2009).

[Insert Table 6 about here]

Table 6 presents our estimation results from Eqs. (11) to (12) when we use our differenced data to investigate the categorical impact of both trade and environmental agreements. The estimated ATE of both EIA type is comparable to the results in Table 5 when using fixed effects approach: “deeper” trade agreements yield larger stimulative impact on trade, and allowing lagged changes we find the positive effects from both EIA type increase with time. We see no significant impact immediately from either type of MEAs in the short run. However when we relax the timing by adding 5-year and 10-year lagged terms in the last four columns, we find that the pollution-type MEAs have a positive impact on trade. Specifically, signing a pollution-type MEA would increase the member countries’ bilateral trade volume by 9.78% ($e^{0.0933} - 1 \approx 0.0978$) after 10 years.

5 Sensitivity Analysis

To check whether the number of signatories would influence our estimated impact of environmental agreements, we re-estimate all our fixed effects specifications by measuring the size of environmental agreements. We divide our MEAs into two sub-groups according to their number of signatories. MEAs of small size represent those agreements with less than 26 (the sample median) member countries, and MEAs of large size are the agreements with more than 68 (the 3rd quartile) member countries. With our results shown in Tables 7 to 10, we find the categorical

EIA and MEA effects are consistent with our FE estimation results in Table 3 and Table 5 when MEAs of all sizes are included.

5.1 FE Estimation of Small-size MEAs

[Insert Table 7 about here]

Table 7 presents the estimated coefficients when we focus on the sub-group of MEAs with less than 26 signatories. "$MEA26$" indicates a binary variable when there exists at least one MEA with less than 26 signatories between a trading country pair. We find a consistently positive impact from small size MEAs on trade flows within 5-10 year time frame. Additionally, the estimated MEA impact becomes even larger when lagged effect is taken into account.

[Insert Table 8 about here]

Table 8 presents the estimated categorical impact within the sub-group of small size MEAs. The interesting finding here is that in the sub-group of small-size MEAs, both the pollution and resource type show a significantly positive impact on trade flows more immediately as compared to the lagged categorical impacts when using all sizes of MEAs. Specifically, when a country pair has both a free trade agreement and a pollution-type MEA, the combined effect would be an immediate increase in the country members' bilateral trade volume of 30.47% ($e^{0.152+0.114} - 1 \approx 0.3047$). While if countries have both a free trade agreement and a resource-type MEA signed at the same year, there would be a 5-year lagged increase on their trade flows of 33.24% ($e^{0.150+0.137} - 1 \approx 0.3324$). Intuitively, small-size MEAs are more likely to be regional agreements signed to address a particular environmental issues.

5.2 FE Estimation of Large-size MEAs

[Insert Table 9 about here]

Our estimation results of large-size MEAs influence are reported in Table 9. "$MEA68$" indicates a binary variable when there exist at least one MEA with more than 68 signatories that both countries in a country pair have also signed. According to column 2, the presence of large size MEA is reducing a country pair's bilateral trade flow by 17.3% ($e^{-0.190} - 1 \approx -0.173$). The results here indicate that small size MEAs and large size ones actually have differential impacts on trade flows, which confirms previous findings in Besedeš, Johnson, and Tian (2016) that large size MEAs are more likely to be "presence" or "statement" agreements, and actually has no strict commitments.

[Insert Table 10 about here]

We find the impact of large-size MEAs are actually insignificant from Table 10, in which we look at the categorical impacts of large size MEAs. For the pollution type, the estimated coefficient is close to Table 5 when using all MEAs in different sizes: the existence of a pollution-type MEA would be increasing countries' bilateral trade flow by 10.35% ($e^{0.0985} - 1 \approx 0.1035$) after 10 years, which confirms our previous results when using all-size MEAs. The impact of resource-type MEA is insignificant, although we find the interaction term of resource agreement and FTA has a positive coefficient, indicating a positive relationship between resource-type MEA and trade growth. The results here confirm our assumption that large-size MEAs are less influential than small-size ones, because of their difficulty in implementation. Our finding of such a differential impact of MEAs in different sizes is consistent with the previous conclusion by Williams (2008), in which he addresses four critical factors to the success of most international environmental initiative: public participation, enforcement and monitoring, conflict management, and institutional arrangements – the absence of which can impede effective environmental management to a large extent.

6 Concluding Remarks

Due to limited data availability on international environmental agreements and policies, existing studies addressing the effect of MEAs are quite rare. Our work attempts to answer the question whether MEAs are decreasing international trade flow. Same as evaluating the effects of free trade agreements, estimating the effects of environmental agreements with gravity equation suffers from the bias caused by the endogeneity due to unobserved heterogeneity. Using fixed effects panel gravity equations and 1965-2005 panel data, our results imply that environmental agreements place a small deterring impact on member countries' trade growth. However, when we take into account the positive effect of trade agreements, we find that country pairs signing a free trade agreement and an environmental agreement together seem to have an even larger increase in trade volume than their counterpart. From which we can infer that countries have more environmental cooperation are more likely to be trading with each other. We further study the different types of free trade agreements and their interactions with environmental agreements. Our results confirm the mutual supportiveness between environmental agreements and trade growth. Additionally, we separate our MEAs into groups of different sizes, and find differential impacts between MEAs of small and large size. Countries are more likely to have multilateral environmental agreements when they expect smaller effects on international trade, or comparative advantage.

There is much more work to be done in the future. In this paper we put more weight on considering the presence of environmental agreements rather than the number of them. By using the number of IEAs as independent variables we could obtain more detailed results. Moreover, the types, subjects, coverage, and lineage of environmental agreements may have different effects on international trade. A single dummy variable standing for EIAs provides us with a limited capacity to examine the effects. For instance, agreements on pollution of air and oceans may have larger effect on bilateral trade in energy intensive sectors, while agreements on species and habitats have relatively smaller effects on international competitiveness. Highly aggregate data on either trade volume or numbers of environmental agreements provides limited results. Additionally, the lineage of environmental agreements may bias the results. The upgrade or amendment of existing agreements may or may not affect firms' behavior, hence the influences on international trade are quite unclear. Moreover, we consider only the volume of trade but ignore the extensive or intensive margins. It is plausible that environmental agreements create some trade and terminate other trade. This topic has political significance in evaluating social welfare rather than the volume of trade. A lot of research focuses on how trade liberalization changes the environment; hence, another way to use this data is to study how the trade flows and FTAs change the numbers of environmental agreements. Nevertheless, our work provides a result of the average treatment effect of environmental agreements on trade, isolating the effects FTAs and adjusting for possible endogeneity and serves as a starting point for a new research agenda.

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Table 1: Summary Statistics of Full FTAs and MEA variables

Variable	Obs.	Mean	Std.	Min	Max
Value of imports (Thousands of US dollars)	94808	1.34e+08	1.39e+09	1	1.73e+11
Full FTAs ($eia \geq 3$)	81730	.072	.258	0	1
MEA (pol. and res. type)	94808	.821	.383	0	1
Both FTA and MEA ($FTA \times MEA$)	94808	.06	.237	0	1
MEA with less than 26 signatories	94808	.214	.41	0	1
MEA with more than 68 signatories	94808	.816	.388	0	1

Table 2: Summary Statistics of Trade and MEA Agreements by type(1965-2005)

Dummy Variable	Observations	Mean	Std. Dev.
Common Union	94808	.026	.159
Free Trade Agreement	94808	.036	.185
Pollution-type MEA	94808	.606	.489
Pollution-type MEA with less than 26 signatories	94808	.173	.378
Pollution-type MEA with more than 68 signatories	94808	.604	.489
Resource-type MEA	94808	.82	.384
Resource-type MEA with less than 26 signatories	94808	.213	.409
Resource-type MEA with more than 68 signatories	94808	.816	.388

Table 3: **Panel Gravity equations with bilateral fixed and Country-and-time effects**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
eia	0.225***		0.225***	-0.391*	0.0620		0.0629	-0.461	0.0143		0.0149	-2.010*
	(0.0395)		(0.0396)	(0.226)	(0.0429)		(0.0429)	(0.444)	(0.0465)		(0.0465)	(1.030)
mea		-0.0180	0.0460	0.0379		0.210	0.363**	0.347*		0.327**	0.470**	0.365*
		(0.0974)	(0.124)	(0.123)		(0.139)	(0.184)	(0.183)		(0.160)	(0.230)	(0.220)
eia_mea				0.626***				0.529				2.035**
				(0.224)				(0.445)				(1.029)
$eia_{(t-1)}$					0.209***		0.207***	0.175	0.106**		0.104**	-0.761
					(0.0396)		(0.0395)	(0.354)	(0.0437)		(0.0436)	(0.673)
$mea_{(t-1)}$						-0.0907	0.0026	0.0008		-0.150	-0.125	-0.182
						(0.115)	(0.137)	(0.137)		(0.133)	(0.174)	(0.175)
$eia\_mea_{(t-1)}$								0.0326				0.867
								(0.355)				(0.674)
$eia_{(t-2)}$									0.244***		0.244***	0.589*
									(0.0466)		(0.0466)	(0.339)
$mea_{(t-2)}$										-0.126	-0.0519	-0.0432
										(0.143)	(0.178)	(0.177)
$eia\_mea_{(t-2)}$												-0.360
												(0.335)
Fixed effects												
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	76,987	87,855	76,987	76,987	50,323	56,208	50,323	50,323	33,935	37,626	33,935	33,935
R-squared	0.886	0.885	0.886	0.886	0.904	0.903	0.904	0.904	0.914	0.913	0.914	0.914

t statistics in parentheses.
Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 4: **First-differenced panel gravity equations with country-and-time effects**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
deia	0.126***		0.125***	-0.0570	0.115***		0.116***	-0.426	0.135***		0.135***	-1.007
	(0.0411)		(0.0411)	(0.316)	(0.0430)		(0.0430)	(0.502)	(0.0487)		(0.0487)	(0.811)
dmea		-0.109	-0.109	-0.112		-0.0052	0.0818	0.0684		-0.0132	0.0800	0.0267
		(0.106)	(0.128)	(0.128)		(0.131)	(0.173)	(0.171)		(0.142)	(0.203)	(0.194)
deia_mea				0.185				0.545				1.148
				(0.312)				(0.499)				(0.809)
$deia_{(t-1)}$					0.0357		0.0355	-0.315	0.0998**		0.0987**	-0.555
					(0.0380)		(0.0380)	(0.356)	(0.0394)		(0.0394)	(0.521)
$dmea_{(t-1)}$						-0.0489	0.0197	0.0105		-0.149	-0.175	-0.220
						(0.118)	(0.140)	(0.140)		(0.156)	(0.207)	(0.207)
$deia\_mea_{(t-1)}$								0.352				0.654
								(0.353)				(0.519)
$deia_{(t-2)}$									0.0665		0.0671	0.0696
									(0.0449)		(0.0450)	(0.330)
$dmea_{(t-2)}$										-0.307**	-0.165	-0.181
										(0.153)	(0.197)	(0.197)
$deia\_mea_{(t-2)}$												-0.0086
												(0.324)
Cons.	0.0004	-3.03e-08	0.0003	0.0003	-0.021***	-0.021***	-0.021***	-0.021***	-0.034***	-0.031***	-0.034***	-0.034***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)
N. Obs	54,592	61,573	54,592	54,592	37,683	41,886	37,683	37,683	26,685	29,388	26,685	26,685

t statistics in parentheses.

Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 5: **Panel Gravity eqs. with bilateral fixed and Country-time effects by type**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
fta	0.173***		0.176***	-0.387	0.0424		0.0438	-0.617	-0.0298		-0.0244	-1.927
	(0.0404)		(0.0404)	(0.363)	(0.0434)		(0.0434)	(0.538)	(0.0474)		(0.0473)	(1.318)
cuc	0.372***		0.378***	-0.208	0.164***		0.169***	-0.0208	0.181***		0.190***	-0.220
	(0.0530)		(0.0532)	(0.299)	(0.0599)		(0.0600)	(0.789)	(0.0661)		(0.0664)	(0.370)
pol		0.0116	0.0314	0.0379		-0.0308	-0.0176	-0.0214		-0.0714	-0.0616	-0.0636
		(0.0360)	(0.0361)	(0.0362)		(0.0406)	(0.0406)	(0.0411)		(0.0474)	(0.0473)	(0.0480)
res		0.0284	0.0314	0.0232		0.383***	0.383***	0.360**		0.431***	0.428***	0.366**
		(0.0984)	(0.0983)	(0.0978)		(0.145)	(0.145)	(0.143)		(0.155)	(0.154)	(0.148)
$ftpol$				-0.151				-0.261				-1.772**
				(0.173)				(0.401)				(0.849)
$ftres$				0.724*				0.933				3.684**
				(0.412)				(0.681)				(1.488)
$cupol$				0.322*				0.494**				0.430
				(0.194)				(0.247)				(0.356)
$fta_{(t-1)}$					0.155***		0.155***	-0.0513	0.110**		0.105**	-2.333
					(0.0425)		(0.0426)	(0.452)	(0.0464)		(0.0464)	(1.840)
$cuc_{(t-1)}$					0.223***		0.227***	0.657	0.0235		0.0294	-0.416
					(0.0590)		(0.0592)	(0.523)	(0.0598)		(0.0598)	(1.206)
$pol_{(t-1)}$						0.0400	0.0544	0.0612*		0.0146	0.0286	0.0222
						(0.0364)	(0.0366)	(0.0368)		(0.0398)	(0.0399)	(0.0406)
$res_{(t-1)}$						-0.215*	-0.214*	-0.227**		-0.110	-0.110	-0.142
						(0.114)	(0.114)	(0.114)		(0.135)	(0.135)	(0.136)
$ftpol_{(t-1)}$								-0.420***				0.288
								(0.154)				(0.307)
$ftres_{(t-1)}$								0.615				2.159
								(0.467)				(1.832)
$cupol_{(t-1)}$								-0.332				-0.177
								(0.235)				(0.314)
$cures_{(t-1)}$								-0.113				0.630
								(0.480)				(1.158)
$fta_{(t-2)}$									0.164***		0.170***	-2.718
									(0.0487)		(0.0487)	(3.370)
$cuc_{(t-2)}$									0.241***		0.251***	0.957**
									(0.0621)		(0.0625)	(0.488)
$pol_{(t-2)}$										0.0819**	0.0965***	0.0989***
										(0.0365)	(0.0366)	(0.0369)
$res_{(t-2)}$										-0.149	-0.146	-0.135
										(0.147)	(0.147)	(0.147)
$ftpol_{(t-2)}$												-0.306**
												(0.132)
$ftres_{(t-2)}$												3.158
												(3.368)
$cupol_{(t-2)}$												-0.318
												(0.239)
$cures_{(t-2)}$												-0.419
												(0.461)
N. Obs	87,855	87,855	87,855	87,855	56,208	56,208	56,208	56,208	37,626	37,626	37,626	37,626
R-squared	0.885	0.885	0.885	0.885	0.903	0.903	0.903	0.903	0.913	0.913	0.913	0.913

t statistics in parentheses.

Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 6: **First-differenced panel gravity equations with country-time effects by type**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
$dfta$	0.120***		0.120***	-0.001	0.109***		0.109***	-1.067	0.114**		0.117**	0.057
	(0.0404)		(0.0404)	(0.529)	(0.042)		(0.0422)	(0.732)	(0.048)		(0.0481)	(1.083)
$dcuc$	0.153**		0.153**	-0.218	0.140**		0.141**	0.211	0.276***		0.286***	0.0158
	(0.0634)		(0.063)	(0.415)	(0.064)		(0.0636)	(0.600)	(0.0746)		(0.0746)	(2.181)
$dpol$		-0.005	-0.004	-0.005		-0.005	-0.004	-0.003		0.004	0.008	0.010
		(0.037)	(0.037)	(0.037)		(0.040)	(0.040)	(0.0404)		(0.047)	(0.0471)	(0.047)
$dres$		-0.010	-0.009	-0.011		0.0781	0.080	0.0547		0.0988	0.101	0.0447
		(0.108)	(0.108)	(0.108)		(0.133)	(0.133)	(0.131)		(0.141)	(0.141)	(0.136)
$dftpol$				0.101				-0.387				-3.854**
				(0.192)				(0.462)				(1.515)
$dftres$				0.023				1.572*				3.921***
				(0.576)				(0.832)				(1.502)
$dcupol$				0.084				0.360				0.414
				(0.259)				(0.320)				(0.399)
$dcures$				0.289				-0.421				-0.135
				(0.306)				(0.485)				(2.113)
$dfta_{(t-1)}$					0.0344		0.0345	-0.655	0.105***		0.105***	-1.028
					(0.0387)		(0.0388)	(0.511)	(0.0402)		(0.0404)	(1.654)
$dcuc_{(t-1)}$					0.0171		0.0174	-0.268	0.0586		0.0682	-0.572
					(0.0575)		(0.0576)	(0.535)	(0.0558)		(0.0561)	(0.960)
$dpol_{(t-1)}$						0.0129	0.0144	0.0172		0.0476	0.0546	0.0540
						(0.0374)	(0.0375)	(0.0376)		(0.0430)	(0.0431)	(0.0436)
$dres_{(t-1)}$						-0.157	-0.156	-0.176		-0.172	-0.170	-0.211
						(0.115)	(0.115)	(0.115)		(0.155)	(0.155)	(0.155)
$dftpol_{(t-1)}$								-0.174				0.0114
								(0.130)				(0.339)
$dftres_{(t-1)}$								0.860*				1.119
								(0.500)				(1.691)
$dcupol_{(t-1)}$								-0.0427				-0.0451
								(0.232)				(0.271)
$dcures_{(t-1)}$								0.329				0.688
								(0.480)				(0.922)
$dfta_{(t-2)}$									0.0283		0.0361	-0.345
									(0.0460)		(0.0461)	(3.372)
$dcuc_{(t-2)}$									0.0760		0.0824	0.522
									(0.0582)		(0.0584)	(0.486)
$dpol_{(t-2)}$										0.0880**	0.0933**	0.0945**
										(0.0372)	(0.0373)	(0.0375)
$dres_{(t-2)}$										-0.299*	-0.298*	-0.304*
										(0.158)	(0.158)	(0.158)
$dftpol_{(t-2)}$												-0.145
												(0.128)
$dftres_{(t-2)}$												0.508
												(3.378)
$dcupol_{(t-2)}$												-0.173
												(0.250)
$dcures_{(t-2)}$												-0.281
												(0.435)
Cons.	1.08e-08	-2.58e-09	8.27e-09	9.36e-10	-0.021***	-0.0208***	-0.0210***	-0.0210***	-0.0316***	-0.0312***	-0.0316***	-0.0321***
	(0.0068)	(0.0068)	(0.0068)	(0.0068)	(0.0074)	(0.0074)	(0.0074)	(0.0074)	(0.0084)	(0.0084)	(0.0084)	(0.0085)
N. Obs	61,573	61,573	61,573	61,573	41,886	41,886	41,886	41,886	29,388	29,388	29,388	29,388

t statistics in parentheses.

Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 7: **Panel Gravity eqs. with bilateral fixed and Country-and-time effects: IEA with less than 26 signatories**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
eia	0.225***		0.215***	0.172***	0.0620		0.0611	0.0756	0.0143		0.0143	0.0529
	(0.0395)		(0.0395)	(0.0581)	(0.0429)		(0.0429)	(0.0623)	(0.0465)		(0.0465)	(0.0730)
$mea26$		0.154***	0.138***	0.129***		-0.0478	-0.0309	-0.0175		-0.0361	-0.0085	-0.0027
		(0.0427)	(0.0426)	(0.0441)		(0.0468)	(0.0461)	(0.0489)		(0.0537)	(0.0529)	(0.0543)
eia_mea26				0.0599				-0.0247				-0.0578
				(0.0605)				(0.0655)				(0.0783)
$eia_{(t-1)}$					0.209***		0.204***	0.0873	0.106**		0.105**	0.0616
					(0.0396)		(0.0397)	(0.0688)	(0.0437)		(0.0437)	(0.0800)
$mea26_{(t-1)}$						0.169***	0.142***	0.123**		0.123**	0.129**	0.118*
						(0.0520)	(0.0510)	(0.0530)		(0.0623)	(0.0622)	(0.0646)
$eia\_mea26_{(t-1)}$								0.151**				0.0621
								(0.0700)				(0.0809)
$eia_{(t-2)}$									0.244***		0.238***	0.350***
									(0.0466)		(0.0466)	(0.103)
$mea26_{(t-2)}$										0.0497	0.0421	0.0542
										(0.0600)	(0.0605)	(0.0619)
$eia\_mea_{(t-2)}$												-0.132
												(0.0996)
Fixed effects												
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	76,987	87,855	76,987	76,987	50,323	56,208	50,323	50,323	33,935	37,626	33,935	33,935
R-squared	0.886	0.885	0.886	0.886	0.904	0.903	0.904	0.904	0.914	0.913	0.914	0.914

t statistics in parentheses.
Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 8: **Panel Gravity equations with bilateral fixed and Country-time effects by agreement type: IEA with less than 26 signatories**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
fta	0.173***		0.152***	0.191***	0.0424		0.0486	0.0991	-0.0298		-0.0183	0.0432
	(0.0404)		(0.0402)	(0.0574)	(0.0434)		(0.0435)	(0.0610)	(0.0474)		(0.0477)	(0.0719)
cuc	0.372***		0.339***	0.260**	0.164***		0.171***	0.101	0.181***		0.195***	0.398**
	(0.0530)		(0.0531)	(0.127)	(0.0599)		(0.0604)	(0.150)	(0.0661)		(0.0671)	(0.192)
pol		0.142***	0.114**	0.130***		-0.0797	-0.0930	-0.0876		-0.0929	-0.114*	-0.0951
		(0.0489)	(0.0491)	(0.0498)		(0.0577)	(0.0579)	(0.0580)		(0.0680)	(0.0682)	(0.0678)
res		0.0344	0.0403	0.0266		0.0306	0.0349	0.0367		0.0460	0.0680	0.0605
		(0.0589)	(0.0589)	(0.0597)		(0.0713)	(0.0713)	(0.0727)		(0.0846)	(0.0849)	(0.0853)
$ftpol$				-0.516***				-0.405				-2.343***
				(0.184)				(0.453)				(0.872)
$ftres$				0.443**				0.323				2.250**
				(0.194)				(0.463)				(0.878)
$cupol$				0.0819				0.0734				-0.219
				(0.121)				(0.141)				(0.182)
$fta_{(t-1)}$					0.155***		0.150***	0.0816	0.110**		0.110**	0.0827
					(0.0425)		(0.0426)	(0.0692)	(0.0464)		(0.0466)	(0.0854)
$cuc_{(t-1)}$					0.223***		0.222***	0.135	0.0235		0.0272	-0.169
					(0.0590)		(0.0593)	(0.188)	(0.0598)		(0.0600)	(0.179)
$pol_{(t-1)}$						0.0454	0.0207	0.0353		0.0012	-0.003	-0.009
						(0.0498)	(0.0501)	(0.0512)		(0.0568)	(0.0569)	(0.0579)
$res_{(t-1)}$						0.126*	0.137**	0.112		0.131	0.131	0.115
						(0.0676)	(0.0678)	(0.0696)		(0.0824)	(0.0827)	(0.0853)
$ftpol_{(t-1)}$								-0.437***				0.192
								(0.165)				(0.307)
$ftres_{(t-1)}$								0.520***				-0.154
								(0.174)				(0.317)
$cupol_{(t-1)}$								0.0871				0.222
								(0.185)				(0.176)
$fta_{(t-2)}$									0.164***		0.156***	0.292***
									(0.0487)		(0.0485)	(0.0920)
$cuc_{(t-2)}$									0.241***		0.242***	0.410
									(0.0621)		(0.0621)	(0.253)
$pol_{(t-2)}$										0.0398	0.0140	0.0264
										(0.0471)	(0.0473)	(0.0487)
$res_{(t-2)}$										0.0237	0.0298	0.0389
										(0.0705)	(0.0705)	(0.0719)
$ftpol_{(t-2)}$												-0.198
												(0.136)
$ftres_{(t-2)}$												0.0152
												(0.157)
$cupol_{(t-2)}$												-0.196
												(0.245)
Obs.	87,855	87,855	87,855	87,855	56,208	56,208	56,208	56,208	37,626	37,626	37,626	37,626
R-squared	0.885	0.885	0.885	0.885	0.903	0.903	0.903	0.903	0.913	0.913	0.913	0.913

t statistics in parentheses.

Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 9: **Panel Gravity eqs. with bilateral fixed and Country-and-time effects: IEA with more than 68 signatories**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
eia	0.225***		0.224***	-0.313	0.0620		0.0621	-0.383	0.0143		0.0140	-3.076**
	(0.0395)		(0.0395)	(0.216)	(0.0429)		(0.0429)	(0.430)	(0.0465)		(0.0465)	(1.386)
$mea68$		-0.190*	-0.155	-0.153		0.106	0.0813	0.0819		0.0363	-0.0782	-0.0785
		(0.113)	(0.133)	(0.133)		(0.174)	(0.196)	(0.197)		(0.188)	(0.216)	(0.216)
eia_mea68				0.546**				0.449				3.101**
				(0.214)				(0.431)				(1.387)
$eia_{(t-1)}$					0.209***		0.209***	0.255	0.106**		0.106**	-0.568
					(0.0396)		(0.0396)	(0.376)	(0.0437)		(0.0437)	(0.891)
$mea68_{(t-1)}$						-0.136	-0.0187	-0.0137		-0.139	-0.0636	-0.0654
						(0.130)	(0.135)	(0.136)		(0.176)	(0.184)	(0.184)
$eia\_mea68_{(t-1)}$								-0.0452				0.676
								(0.376)				(0.893)
$eia_{(t-2)}$									0.244***		0.244***	0.768**
									(0.0466)		(0.0466)	(0.319)
$mea68_{(t-2)}$										-0.0670	-0.0436	-0.0407
										(0.156)	(0.174)	(0.174)
$eia\_mea68_{(t-2)}$												-0.532*
												(0.316)
Fixed effects												
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	76,987	87,855	76,987	76,987	50,323	56,208	50,323	50,323	33,935	37,626	33,935	33,935
R-squared	0.886	0.885	0.886	0.886	0.904	0.903	0.904	0.904	0.914	0.913	0.914	0.914

t statistics in parentheses.
Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Table 10: **Panel Gravity equations with bilateral fixed and Country-time effects by agreement type: IEA with more than 68 signatories**

	No lag				w. 5-yr lags				w. 10-yr lags			
	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.	Trade	IEA	Both	Inter.
fta	0.173***		0.175***	-0.215	0.0424		0.0439	-0.750	-0.0298		-0.0242	-2.869*
	(0.0404)		(0.0404)	(0.338)	(0.0434)		(0.0434)	(0.555)	(0.0474)		(0.0473)	(1.616)
cuc	0.372***		0.377***	-0.217	0.164***		0.169***	-0.0378	0.181***		0.191***	-0.214
	(0.0530)		(0.0532)	(0.299)	(0.0599)		(0.0600)	(0.788)	(0.0661)		(0.0664)	(0.370)
pol		0.0121	0.0318	0.0377		-0.0233	-0.0100	-0.0149		-0.0612	-0.0513	-0.0546
		(0.0363)	(0.0365)	(0.0365)		(0.0410)	(0.0410)	(0.0415)		(0.0478)	(0.0478)	(0.0485)
res		-0.141	-0.136	-0.138		0.249	0.253	0.257		0.217	0.220	0.219
		(0.111)	(0.111)	(0.111)		(0.172)	(0.172)	(0.172)		(0.175)	(0.176)	(0.176)
$ftpol$				-0.0907				-0.249				-1.947***
				(0.167)				(0.382)				(0.684)
$ftres$				0.488				1.054				4.803***
				(0.376)				(0.674)				(1.756)
$cupol$				0.320*				0.500**				0.425
				(0.193)				(0.247)				(0.356)
$fta_{(t-1)}$					0.155***		0.157***	0.275	0.110**		0.107**	-0.120
					(0.0425)		(0.0426)	(0.578)	(0.0464)		(0.0464)	(1.647)
$cuc_{(t-1)}$					0.223***		0.229***	0.663	0.0235		0.0296	-0.431
					(0.0590)		(0.0592)	(0.524)	(0.0598)		(0.0598)	(1.205)
$pol_{(t-1)}$						0.0424	0.0569	0.0639*		0.0137	0.0280	0.0210
						(0.0367)	(0.0368)	(0.0371)		(0.0401)	(0.0402)	(0.0409)
$res_{(t-1)}$						-0.176	-0.175	-0.174		-0.126	-0.122	-0.125
						(0.125)	(0.125)	(0.125)		(0.165)	(0.165)	(0.165)
$ftpol_{(t-1)}$								-0.432***				0.309
								(0.154)				(0.305)
$ftres_{(t-1)}$								0.302				-0.0739
								(0.596)				(1.675)
$cupol_{(t-1)}$								-0.334				-0.172
								(0.235)				(0.314)
$cures_{(t-1)}$								-0.116				0.637
								(0.480)				(1.158)
$fta_{(t-2)}$									0.164***		0.171***	2.357**
									(0.0487)		(0.0488)	(1.080)
$cuc_{(t-2)}$									0.241***		0.253***	0.967**
									(0.0621)		(0.0625)	(0.487)
$pol_{(t-2)}$										0.0837**	0.0985***	0.101***
										(0.0365)	(0.0367)	(0.0369)
$res_{(t-2)}$										-0.0650	-0.0621	-0.0602
										(0.154)	(0.154)	(0.154)
$ftpol_{(t-2)}$												-0.306**
												(0.132)
$ftres_{(t-2)}$												-1.917*
												(1.088)
$cupol_{(t-2)}$												-0.319
												(0.239)
$cures_{(t-2)}$												-0.423
												(0.460)
Obs.	87,855	87,855	87,855	87,855	56,208	56,208	56,208	56,208	37,626	37,626	37,626	37,626
R-squared	0.885	0.885	0.885	0.885	0.903	0.903	0.903	0.903	0.913	0.913	0.913	0.913

t statistics in parentheses.

Significance at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.