THE ROLE OF ENVIRONMENTAL AGREEMENTS ON TRADE MARGINS AND INVESTMENT FLOWS

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THE ROLE OF ENVIRONMENTAL AGREEMENTS ON TRADE MARGINS AND INVESTMENT FLOWS

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To my beloved husband Ke,

my precious daughter Emma,

and my dearest mom and dad.

Life is so great with you around.

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SUMMARY

This dissertation consists of three essays that examine the impact of environmental agreements on member countries' trade flows and bilateral trade margins. The precise relationship between environmental regulation, the location of production, aggregate trade flows and subsequent bilateral trade margins remains an open and widely debated issue. By using panel data estimation techniques on a large number of global environmental regulations and their accompanying standards, this dissertation finds that environmental agreements and trade are reinforcing each other. Furthermore, it also takes into account the differential impacts of agreements by category/size, and pays attention to the heterogenous design of individual environmental agreements when assessing their specific effects on trade.

After introductory remarks of the first chapter, the second chapter analyses the consequences of multi-lateral environmental agreements (MEAs) on international bilateral trade. To mitigate potential bias caused by the endogeneity, I apply a five-year first-differencing method 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, I divide all complete trade agreements into two categories; (i) free trade agreements and (ii) custom and economic unions, and environmental agreements into those dealing with (i) pollution and (ii) natural resources. I also look at the differential impact of small and large size MEAs on trade flows, and estimate an effect specific to each agreement as a further robustness check.

The third chapter focuses on the specific role of international environmental agreements (IEAs) and accompanying regulations and standards on bilateral extensive and intensive margins in international trade. Similar to the previous chapter, it uses panel data estimation techniques along with a 1962-2000 bilateral trade flows data set at the product-sector level and a full list of IEA membership along with agreement lineage of 198 countries. The estimation results show that the tightening of environmental standards between a pair of countries reduces trade margins to a small extent only. To identify the specific deterring effects of different environmental agreements, I divide all IEAs into three categories: (i) pollution, (ii) resource, and (iii) other. Small effects for specific type of IEAs are confirmed as well. Such an empirical finding of the small magnitude of negative IEA impact remains consistent with various robustness checks.

The fourth chapter investigates the effect of one particular environmental policy that introduces stricter regulations on sulfur dioxide emissions in China. The Two Control Zones (TCZ) policy was instituted by the Chinese government in 1998. By focusing on the amount of foreign direct investment inflows of 31 provinces between 1988 and 2012, I find that an average of ten percent of the provinces that have been designated as TCZ areas have attracted about 26.5% less capital investment than their non-attainment counterparts. Such a negative impact of the environmental stringency on investment inflows in these provinces is consistent with various robustness checks. However, ignoring the spatial correlation of provincial capital inflows leads to an over-estimated policy effect. The subsequent spatial-analysis results further confirm the presence of third-region effects in estimating the impact of environmental regulations. The final chapter provides concluding remarks and future outlook based on current research.

CHAPTER I

INTRODUCTION

The international trade literature has increasingly addressed the relationship between environmental regulation and trade growth in the recent decades. While most free trade agreements reduce bilateral trade barriers and to a lesser or greater extent lower trade costs for multinational enterprises, environmental agreements are considered to work in the very opposite direction. Despite several theoretical results (Taylor, 2004; Copeland and Taylor, 2004) supporting evidence of the pollution haven effect, the notion of a deterring effect of environmental regulations on trade, empirical evidence of the negative impact of environmental stringency is quite limited. This dissertation focuses on investigating whether a pair of countries signing an international environmental agreement (IEA) would actually result in a decrease in their trade flows as well as bilateral trade margins. It makes several important contributions to the intersection area of trade and environment studies.

First, this dissertation uses the IEA Database Project by Ronald B. Mitchell to provide a truly systematic, comprehensive and up to date list of environmental agreements and their accompanying regulations and standards. Due to limited data availability on existing environmental agreements and the endogeneity problem which exists commonly in most assessments of the effect of environmental regulation, previous studies addressing the economic consequences of environmental regulations focus on specific agreements and therefore have limited findings. The unique IEA data enable me to take a large number of IEAs into account and test the general relationship between environmental regulations and trade growth. Same as evaluating the effects of free trade agreements, estimating the effects of environmental agreements using traditional gravity equation approach suffers from the potential bias caused by the endogeneity. Following the panel estimation framework in Baier and Bergstrand (2007) I use a five-year first-differencing method to alleviate the potential bias. As results show, while trade agreements have a significant positive effect on trade growth, there is little evidence of the oft-supposed negative effect of environmental agreements which either have no significant effect or have a positive statistically significant effect.

Second, it also has a more detailed investigation of the differential effects of IEAs in each category. By dividing IEAs into different categories: (i) pollution, (ii) resource, and (iii) other, I find the categorical impacts of IEAs are consistent with the overall effect. By separating all IEAs into sub-groups according to the number of signatories specific to every agreement, I find small-size agreements with less than 26 (sample median) signatories are more likely to have significant impact than the large-size ones with more than 68 (3rd quartile) signatories. Moreover, this dissertation investigates not only an aggregate impact of all IEAs but also an individual impact specific to every agreement. By analysing both aggregated and individual impact of environmental regulations, I find that a small portion of IEAs have had significant effects on member countries' trade flows, and when ignoring the heterogenous design of different IEAs, such significant effects are likely to be absorbed by the rest of the sample in which most agreements have had an insignificant effect.

Third, this dissertation is the first one to my knowledge that has been looking into the impact of environmental stringency on bilateral trade margins, whereas previous studies have been limited to aggregate trade flows. I follow the margin-decomposition approach in Hummels and Klenow (2005) to construct bilateral trade margins from each country pair's yearly trade flows. My findings here are consistent with the results from the previous chapter: while environmental agreements and the regulations and standards they introduce have a detrimental effect on trade in some cases, that effect is small in magnitude. Specifically, even though the environmental stringency caused by regulatory agreements between trading countries would increase their pollution abatement cost, and then reduce the trading volume on a particular sector (intensive margin), the environmental cooperation between trading partners would always be beneficial by stimulating incentive for innovation and green technology, hence increasing the value-weighted variety of trading goods (extensive margins).

Finally, it examines the joint effect that global 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 IEAs encourage or discourage the growth of trading volume between each country pair that shares the agreement. Previous studies failing to control the trade effect would face potential bias in their results. By simultaneously taking into account the effect of trade agreements, my dissertation confirms that environmental agreements and trade growth are reinforcing each other. Alongside with the globalized economy and free trade development, there is a lot of concern with environmental agreements that they are unfavorable to firms since most binding commitments fundamentally increase costs of production. This can have a negative effect on employment and many firm outcomes. In the sphere of international trade, binding commitments may reduce a country's comparative advantage and reduce its export potential, as their firms have higher costs of production and are less able to compete on world markets. After various assessments of IEA impact on trade flows as well as trade margins, I find that environmental agreements have little effect on the extensive margin, so even if the costs of firms are increasing, it does not drive them out of exporting. I do find more consistent negative effects on the intensive margin, but they are relatively small and not always present. So while environmental agreements do decrease the volume of trade, the effect is small. And it is always more than offset if the two countries have a trade agreement as well.

The dissertation is structured as follows. The next Chapter[1] starts with assessing the economic consequences of multi-lateral environmental agreements (MEAs) on bilateral trade flows between each pair of member countries. Following Baier and Bergstrand (2007) I use panel estimation techniques to alleviate the potential endogeneity bias caused by unobserved heterogeneity. After taking a first step to estimate the general impact of IEAs on trade growth, Chapter 3[2] uses the same dataset of environmental agreements as the previous chapter and conducts a more detailed investigation of their impact on trade margins decomposed from aggregate trade flows. Chapter 4 addresses the role of a specific environmental agreement, the Two Control Zones policy in China, on the foreign direct investment inflows in policy treatment areas. The last Chapter provides concluding remarks of the current work done and an outlook to future research challenges.

[1]This chapter is co-authored with Prof. Tibor Besedeš, Xinping Tian, and Mingge Wu.
[2]This chapter is co-authored with Prof. Tibor Besedeš.

CHAPTER II

THE EFFECT OF MULTI-LATERAL ENVIRONMENTAL AGREEMENTS ON MEMBER COUNTRIES' BILATERAL TRADE

2.1 Introduction

A central preoccupation of the international trade-environment debate is the impact of environmental regulations on trade growth. 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.

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) argue that 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 multilateral environmental agreements (MEAs), which serve as one of the most adopted measures to introduce and coordinate stringent environmental policies in international trade. 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 the recent decades. When a country

[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.

makes a decision whether to engage in a multilateral trade or environmental agreements, 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 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 threefold. Firstly, it aims to examine how multilateral environmental agreements affect international trade. Secondly, it examines 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. I also attempt to test the categorical impact of MEAs on trade flows when taking free trade agreements into account simultaneously, which to my knowledge has not been explored before. Besides various assessments of an aggregate MEA impact, I follow Kohl (2014) to estimate an individual effect specific to each environmental agreement as well.

This paper is distinguished from other papers in this literature in several aspects. First, the basis of the 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. This 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, I take into account the endogeneity of FTAs as well as MEAs. Furthermore, I separate the different types of FTAs to capture the effects of trade liberalization rather than using a single dummy. I also separate MEAs into the two types, pollution and resource management agreements, and take into account the number of MEAs a pair of countries has as well. Finally, I estimate an individual effect specific to each environmental agreement. This provides me 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 economic integration agreements (EIAs) have a significant positive effect on trade growth, I 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, I find that the simultaneous presence of trade and environmental agreements increases bilateral international trade a lot, an economically and statistically significant result. Third, to have a detailed investigation of the differential effects of each type of environmental agreement, I separate them into two categories: resource type and pollution type. I find that both types either have no effect or have a small positive impact on bilateral trade flows. To see if the size of MEAs will have any influence, I count the number of signatories of each agreement as well. I find that small-size MEAs have more significantly positive impact than large-size MEAs. Finally, the results of an individual-effect approach show that only a small portion (9.97%) of the MEAs have significant impact on trade flows. I also find that small-size MEAs are more influential on trade, which is consistent with the previous conclusion when checking the aggregate MEA impact.

The remainder of this paper is organized as follows. Section 2.2 presents a detailed description of the empirical methodology to assess the impact of environmental agreements, following the panel gravity estimation approach from Baier and Bergstrand (2007). Section 2.3 discusses the three data sources and related work. Section 2.4 explains the empirical findings of a general MEA influence and also categorical impacts on trade flows, from which I confirm the mutual supportiveness between MEAs and trade growth. Section 2.5 provides additional robustness checks by separating MEAs according to their number of signatories and, followed by further discussion in Section 2.6 of individual MEA effect specific to each agreement and concluding remarks in Section 2.7.

2.2 Methodology

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

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

Ever since its introduction by Tinbergen et al. (1962), the gravity equation[2] 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 in a survey 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

[2]The gravity equation is typically used to explain cross-sectional variation in country pairs' trade flows in term of countries' incomes, bilateral distance, common language, common borders, and for the presence or absences of an FTA (Trefler, 1993; Cheng and Wall, 1999; Anderson and van Wincoop, 2003; Baier and Bergstrand, 2004, 2007; Anderson and Yotov, 2008; Egger, Egger, and Greenaway, 2008; Baier, Bergstrand, and Feng, 2014).

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. Being concerned with the potential endogenous self-selection of country pairs into EIAs, earlier studies use the instrumental variables approach and cross-sectional data to account for the endogeneity bias.

Several econometric approaches have been applied to deal with the endogeneity problem, inlcuding 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 to 1 if the two trading countries share a common land border (and 0 otherwise); $LANG_{ij}$ is a dummy variable which equals to 1 if a common language is shared between the two countries; and EIA_{ijt} is a dummy variable, taking the value to 1 if a complete free trade agreement exists 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.

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

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 and the trade flows. 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. It is expected that taking first difference would increase the 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.

2.2.2 Estimating the general MEA impact

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

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

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

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

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

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. I 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, I follow Baier and Bergstrand (2007) and add both 5-year and 10-year lagged terms into my 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 the sample), the FD approach would be increasing estimation efficiency than using FE method. To avoid potential over-rejection problems, I use clustered standard errors at the country-pair level in each set of FD estimation.

Following the FD approach in Baier and Bergstrand (2007), I take a first step to difference: (i) the natural logarithm of $TRADE_{ijt}$; (ii) EIA_{ijt}; and (iii) MEA_{ijt}. Then I regress these differenced variables on all country-and-time dummies and predict the residuals. Finally, I 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 me to account for the changes in the unobservable theoretical multilateral resistance terms $d\ln P_{it}$ and $d\ln P_{jt}$, therefore to eliminate the potential estimation bias.

2.2.3 Estimating the categorical impact of MEAs

After testing the general effect of all environmental agreements, I 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 this work I do not take into account the last MEA category, "Other" type, due to the limited number of MEAs in that category.[3] Moreover, I also divide all trade agreements in the sample into two categories: free trade agreements and custom unions. Following Baier, Bergstrand, and Feng (2014), these complete preferential trade agreements refer to EIA type equal to or greater than Type 3.[4] The estimating equations for each MEA type on member countries' bilateral trade flows are:

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

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

[3] "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 environments such as the nuclear bomb as well as bacteriological, chemical, and toxin weapons.

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

belong to the same free trade agreement in year t. Following Baier, Bergstrand, and Feng (2014), I combine custom union, common border, and economic union into one dummy CUC_{ijt}, denoting the status of "deeper EIA." Additionally, I 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 an 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. And I also use FD approach to check the effects of changes in each agreement type and their interaction terms on trade flows:

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

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

2.2.4 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, I divide 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, I 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 my 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, the 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.

2.3 Data Description

The 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, I 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 I 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 me 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.

The 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).[5] I 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 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. In another study Baier, Bergstrand, and Feng (2014), they 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.

The environmental agreements data are obtained from the Ronald B. Mitchell (2002-2015) IEA Database project.[6] 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, my 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,[7] and sequences.[8] To control the change in intensity of international environmental cooperation within the sample period 1965-2000, I use the count of all agreements between each trading pair

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

[6] Data from Ronald B. Mitchell. 2002-2015. International Environmental Agreements Database Project (Version 2014.3). Available at: http://iea.uoregon.edu/ Date accessed: June 2015

[7] 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.

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

by year. As some agreements are updated and amended over time, I adjust all my counts of the IEA members by their lineages to avoid any potential duplication.

Table 1: Summary Statistics of Full FTAs and MEA variables

Variable	**Obs.**	**Mean**	**Std.**	**Min**	**Max**
Value of imports (Thousands of USD)	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 1 summarizes my multilateral environmental agreements data collected from the IEA database. As I focus on the multilateral agreements only and use them to represent all IEAs in my 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 in a specific year, summing over all sectors. I 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. By taking into account the number of signatories for each environmental agreement, I 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 the MEA dataset covers almost all environmental agreements in the sample period, I recode those missing observations as zero MEAs in the combined data.

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, I 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. This data set allows me to alleviate the aggregation bias to some extent because of the precise disaggregated categories of IEAs. Under such circumstance I am able to control for unobserved heterogeneity caused by category-specific effects.

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 2 provides a list of categorical dummies used in the 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-size (number of signatories small than 26) and large-size (number of signatories greater than 68), I also separate them into different agreement types to have a more detailed investigation.

2.4 Empirical Results

2.4.1 FE and FD Results without Specific Agreement Types

Table 3 presents the main empirical results from Equations (4) to (7). Columns 1 to 4 present 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, I allow 5-year lagged terms in columns 5 to 8, and 10-year lags in columns 9 to 12. I 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 indicating 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.

As the robustness check of the FE results in Table 3, Table 4 reports the estimation results from Equation (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, I 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 I find comparable estimation results from the FE and FD approach in addressing the overall MEA impact: When all MEAs are tested as a group, I see a small and negative impact of environmental agreements on trade flows. However when taking 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 I can infer that countries have more environmental cooperation seem to be more likely trading with each other.

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												
$Ctry-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Ctry-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	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-sq	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	-0.02***	-0.02***	-0.02***	-0.02***	-0.03***	-0.03***	-0.03***	-0.03***
	(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.

2.4.2 FE and FD Results with Specific Agreement Types

After taking the first step to estimate the general MEA effect, I then turn to look at the differing MEA effect in each sub-category. With the rationale explained in the previous section, I 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, I follow Baier, Bergstrand, and Feng (2014) to separate trade agreements into two sub-groups. Table 5 presents the results from Equations (9) to (10). Columns 1 to 4 report the estimated coefficients on each type of agreements when no lagged terms are being considered. From which I can see that both type of trade agreements have a positive effect on trade flows, and those "deeper" trade agreements *CUC* have an even larger impact in magnitude. With no lagged effect, The ATE estimation of having both type of trade agreements is an increase by 74.02% ($e^{0.176+0.378} - 1 \approx 0.7402$) and there seems to be no significant impact from MEAs. After allowing 5-year lagged changes, I 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, I find the resource type of MEAs consistently show positive cumulative ATEs, with a further increase at 53.42% ($e^{0.428} - 1 \approx 0.5342$), and the pollution-type MEAs show a small and positive impact at 10.13% ($e^{0.0965} - 1 \approx 0.1013$) after 10 years. My finding of the lagged IEA effect is consistent with the empirical evidence found in Rose and Spiegel (2009).

Table 6 presents my estimation results from Equations (11) to (12) when I use the 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 growth, and allowing lagged changes I find the positive effects from both EIA type increase with time. I see no significant impact immediately from either type of MEAs in the short run. However when I relax the timing by adding 5-year and 10-year lagged terms in the last four columns, I find that the pollution-type MEAs report positive impact on trade growth. Specifically, increasing a pollution-type MEA would increase the country members' bilateral trade volume by 9.78% ($e^{0.0933} - 1 \approx 0.0978$) after 10 years.

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

	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)

Continued on next page

Table 5 (continued)

$fta_{(t-1)}$	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

Continued on next page

Table 5 (continued)

									(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-sq	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: 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.
$dfta$	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

Continued on next page

Table 6 (continued)

	(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)

Continued on next page

Table 6 (continued)

$dcures_{(t-1)}$	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

Continued on next page

Table 6 (continued)

												(0.435)
Cons.	1.08e-08	-2.58e-09	8.27e-09	9.36e-10	-0.02***	-0.02***	-0.02***	-0.02***	-0.03***	-0.03***	-0.03***	-0.03***
	(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.

2.5 *Sensitivity Analysis*

To check whether the number of signatories would influence the estimated impact of environmental agreements, I re-estimate all the fixed effects specifications by measuring the size of environmental agreements. I divide all 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 the results shown in Tables 7 to 10, I find the categorical EIA and MEA effects are consistent with the FE estimation results in Table 3 and Table 5 when MEAs of all sizes are included.

2.5.1 FE Estimation of Small-size MEAs

Table 7 presents the estimated coefficients when I 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. I 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.

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 bilateral or regional agreements, on a basis to address some particular environmental issues.

2.5.2 FE Estimation of Large-size MEAs

The estimation results of large-size MEAs influence are reported in Table 9. "$MEA68$" indicates a binary variable when there exists at least one MEA with more than 68 signatories between a trading country pair. 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.

I find the categorical impacts of large size MEAs are actually insignificant from Table 10. 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 the previous results when using all-size MEAs. The impact of resource-type MEA is insignificant, although I 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 the assumption that large-size MEAs are less influential than their counterparts in small-size, because of their difficulty in implementation. The 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.

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

	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

Continued on next page

Table 8 (continued)

	(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)

Continued on next page

Table 8 (continued)

$cuc_{(t-2)}$									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-sq.	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

	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)

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Table 10 (continued)

$fta_{(t-1)}$	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**

Continued on next page

Table 10 (continued)

									(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-sq.	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.

2.6 Discussion of Individual Effects of MEAs

Several explanations of the lack of an effect of environmental agreements are as follows. There are two important aspects of how environmental agreements are different from trade agreements. First of all, two countries usually have one trade agreement, which tends to be comprehensive (covering all products) or almost comprehensive. Environmental agreements tend to be far more specific dealing with a particular issue and thus not affecting all products. This allows countries to sign multiple environmental agreements. Moreover, it is possible that if one uses data disaggregated at the industry or product level, along with environmental agreements coded for which industries they affect, it could be that those industries affected by a new environmental regulation will be negatively affected. Thus, there are two aggregation issues. One is that I am using bilateral aggregated trade data, while the other is that I am using a single environmental agreement dummy, when in fact I preferably should be using multiple ones. To address the shortcomings of such a general approach, in this section I estimate an individual effect specific to each environmental agreement.

The estimation approach of an agreement-specific effect is motivated by Kohl (2014). While most studies on trade agreements are focusing on the investigation of an overall effect on trade flows common to all agreements, Kohl (2014) provides not only estimated effects of trade agreements at an aggregate level, but also agreement-specific average treatment effects. Using the same FD estimation method as in Baier and Bergstrand (2007), he states that traditional estimates of an aggregated EIA impact seem exaggerated: the individual effect on trade are often zero when endogeneity has been accounted for and only a few agreements increase trade. Such a finding is consistent with Rose et al. (2004), which cast doubt on the assumption that General Agreement on Tariffs and Trade (GATT) and its successor, the World Trade Organization (WTO) actually increased trade. In a subsequent study, Kohl, Brakman, and Garretsen (2016) focus on addressing the heterogeneity in the design of 296 trade agreements and find that for different trade agreements, the contents and scope may to a large extent deviate from each other.

There are 773 environmental agreements in the dataset, with 383 of them having less than or equal to 26 signatories (denoted as small-size MEAs) and 203 having more than or equal to 68 signatories (denoted as large-size MEAs). All statistics of signatories are counted until the year 2013. By creating a dummy variable for each individual environmental agreement in the dataset, I re-run the FD estimation in (i) all-size MEAs, (ii) small-size MEAs, and (iii) large-size MEAs as below:

$$\begin{aligned} d\ln TRADE_{ij,t-(t-1)} &= \beta_0 + \beta_1 \left(dEIA_{ij,t-(t-1)}\right) + \beta_2 \left(dEIA_{ij,(t-1)-(t-2)}\right) \\ &+ \beta_3^1 \left(dMEA^1_{ij,t-(t-1)}\right) + ... + \beta_3^k \left(dMEA^k_{ij,t-(t-1)}\right) \\ &+ \beta_4^1 \left(dMEA^1_{ij,(t-1)-(t-2)}\right) + ... + \beta_4^k \left(dMEA^k_{ij,(t-1)-(t-2)}\right) \\ &+ \beta_{i,t-(t-1)} \left(Dum_{i,t-(t-1)}\right) + \beta_{j,t-(t-1)} \left(Dum_{j,t-(t-1)}\right) \\ &+ \upsilon_{ij,t-(t-1)} \end{aligned} \tag{13}$$

where the subscript ranging from 1 to k denotes each MEA in the dataset.

Generally, the results show that only a small portion of the MEAs have significant impact on trade flows. Specifically, when all-size 773 MEAs are included in the estimation, I find 77 (9.97%) agreements have had a significant impact on trade flows, the number of which being trade-promoting is 40 (5.17%), even slightly larger than the number with a trade-deterring ones at 37 (4.79%). In the sub-group of 383 small-size MEAs, I find 41 (10.7%) agreements are showing significant impact on trade volume. Again, I find the number of MEAs showing a positive effect is 24 (6.27%), outweighing the number with a negative impact at 17 (4.44%). Such a positive MEA impact could be explained in two ways. First, when a pair of countries has an environmental agreement signed, the initial impact could be that they have more incentive to cooperate with each other on trade. Barret (1994) provides a model showing that IEA might lead to a higher degree of cooperation between signatories, when the difference between cooperative and non-cooperative outcome is small. Second, for some particular industries, a higher level of environmental standards brought up by IEAs could serve as a stimulative factor on increasing varieties of products, more inventions of equipment and machinery, and advanced technology in production in order to comply with new regulations, hence indirectly leading to a higher trade volume between trading country pairs.

Table 11 presents the detailed results of checking the specific impact of each MEA when the number of signatories is low. The results show that some of the environmental agreements have large and statistically significant positive impact on trade. The effect of most MEAs is statistically indistinguishable from zero. Comparing to the percentage I find in all-size group, small-size MEAs have a larger effect on trade, and such a finding is consistent with the conclusion when evaluating the aggregate MEA impact in the previous section. Furthermore, this confirms previous findings in Kohl, Brakman, and Garretsen (2016) that overlooking the issue of agreements heterogeneity may be problematic. Because of limited space I am not reporting the agreement-specific results for the full sample and for large MEAs. In the large-size sub-group of 203 MEAs, the number of agreements showing a significant impact is lower than that in the small-size and all-size group: only 9 (4.43%) agreements are found to have significant effects, of which 6 (2.96%) have a positive effect and the other 3 (1.48%) negative.

Table 11: Individual ATE Results: small size MEA group

Ieaid	ATE	Agreement Title
EIA	0.00355	
2601	0.0694	Convention Relating To The Development Of Hydraulic Power Affecting More Than One State
2615	0.446*	Convention On Nature Protection And Wildlife Preservation In The Western Hemisphere
2627	0.106	Convention For The Establishment Of An Inter-American Tropical Tuna Commission
2633	-0.362	International Convention For The Protection Of Birds
2643	-1.397*	Agreement On The Organization Of The Permanent Commission Of The Conference On The Exploitation And Conservation Of The Maritime Resources Of The South Pacific
2644	0.311*	Amendment To The Agreement For The Establishment Of The Indo-Pacific Fisheries Council
2657	-0.920	Agreement Relating To A Special Marine Frontier Zone Under The Permanent Commission Of The South Pacific
2693	-0.185**	Convention On Third Party Liability In The Field Of Nuclear Energy
2708	0.536	Convention On The Liability Of Operators Of Nuclear Ships
2715	-0.125	Agreement Concerning Protection Of The Salmon Stock In The Baltic Sea
2722	0.200	Amendments To The Agreement For The Establishment of a General Fisheries Council for the Mediterranean
2729	-0.318	Act Regarding Navigation And Economic Cooperation Between The States Of The Niger Basin
2734	0.856	Convention Relating to the Status of The Senegal River
2735	-0.100	European Fisheries Convention
2744	0.623	Agreement For The Establishment Of A Commission For Controlling The Desert Locust In The Near East (Central Region)

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Table 11 – continued from previous page

2748	2.390*	Agreement Relating To The International Legal Personality Of The Permanent Commission Of The South Pacific
2750	-0.108	Agreement Regulating Withdrawal Of Water From Lake Constance
2755	0.0479	Additional Protocol I To The Treaty For The Prohibition Of Nuclear Weapons In Latin America
2758	0.0450	Convention On The Conduct Of Fishing Operations In The North Atlantic
2760	0.115	Phytosanitary Convention For Africa
2763	0.201	Agreement Between Denmark, Finland, Norway, And Sweden Concerning Cooperation To Ensure Compliance With The Regulations For Preventing The Pollution Of The Sea By Oil
2764	0.329	Agreement Establishing The Southeast Asian Fisheries Development Center
2766	0.222	Protocol Amending The Agreement Establishing The Southeast Asian Fisheries Development Center
2768	-0.450	Agreement For The Establishment For Arab Centre For The Studies Of Dry And Barren Land
2770	0.0874	European Agreement On The Restriction Of The Use Of Certain Detergents In Washing And Cleaning Products
2772	0.0737	Agreement On Administrative Arrangements For The Prek Thnot (Cambodia) Power And Irrigation Development Project
2775	-0.0216	Treaty On The Rio De La Plata
2776	0.267***	Agreement For Cooperation In Dealing With Pollution Of The North Sea By Oil
2777	-0.329	Agreement Establishing A Food And Fertilizer Technology Centre For The Asian And Pacific Region
2779	0.281	Convention For The Conservation Of Vicuna
2780	0.0272	Exchange Of Notes Constituting An Agreement To Continue In Force The Interim Convention Between The U.S., Canada, Japan And The Union Of Soviet Socialist Republics On Conservation Of North Pacific Fur Seals
2783	0.0530	Convention On The Conservation Of The Living Resources Of The Southeast Atlantic
2787	-0.512***	Benelux Convention On The Hunting And Protection Of Birds

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2791	-0.982	Agreement For The Establishment Of A Commission For Controlling The Desert Locust In Northwest Africa
2792	0.115	Agreement On The Regulation Of North Pacific Whaling
2795	-0.457*	Agreement On The Regulation Of North Pacific Whaling
2796	0.0834	Agreement Between Denmark, Finland, Norway, And Sweden Concerning Cooperation To Deal With Sea Pollution By Oil
2799	-0.00310	Convention Relating To Civil Liability In The Field Of Maritime Carriage Of Nuclear Material
2801	0.347**	Protocol Amending The Agreement Concerning Protection Of The Salmon Stock In The Baltic Sea
2802	-0.0498	Convention For The Prevention Of Marine Pollution By Dumping From Ships And Aircraft
2804	2.709*	Convention Concerning The Status Of The Senegal River
2806	-0.687***	Agreement Between Canada, The Republic Of Iceland And The Kingdom Of Norway Concerning An International Observer Scheme For Land-Based Whaling Stations In The North Atlantic Area
2808	0.0519	Convention For The Conservation Of Antarctic Seals
2810	-0.0688	Technical Arrangement Between The United Kingdom Of Great Britain And Northern Ireland, The French Republic And Belgium Made Under Article 6 (4) Of The Agreement For Cooperation In Dealing With Pollution Of The North Sea By Oil
2818	1.116	Agreement Revising The Agreement Concerning The Niger River Commission And The Navigation And Transport
2821	-0.506	Convention Establishing A Permanent Inter-State Drought Control Committee For The Sahel
2827	0.195	Agreement On Conservation Of Polar Bears
2828	0.0316	Arrangement Relating To Fisheries In Waters Surrounding The Faeroe Island
2830	-0.123	Agreement Between The United Kingdom, Norway And The Union Of Soviet Socialist Republics On The Regulation Of The Fishing Of North-East Arctic (Arcto-Norwegian) Cod
2837	-0.105	First Protocol Amending The Convention On The Canalization Of The Mosel

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2846	0.344	Agreement Regarding Monitoring Of The Stratosphere
2847	-0.129	Protocol Amending And Extending The Interim Convention Between The U.S., Canada, Japan And The Union Of Soviet Socialist Republics On Conservation Of North Pacific Fur Seals
2848	-0.304*	Agreement Concerning The Protection Of The Waters Of The Mediterranean Shores
2849	0.564	Convention On Conservation Of Nature In The South Pacific
2853	-0.316**	Exchange of Notes between Denmark, Finland, Norway, and Sweden on the borders between the vicinity of nuclear installations safety issues associated with connecting to the guidelines related to the Convention on the Protection of the Environment between Denmark, Finland, Norway, and Sweden
2857	-0.00908	Convention On The Protection Of The Rhine Against Pollution By Chlorides
2861	0.0884	Amendments To The Agreement For The Establishment Of A Commission For Controlling The Northwest Africa Desert Locust
2862	0.214*	Agreement Between France, The U.S., Denmark, Finland, Norway, Sweden And The Netherlands On Reactor Safety Experiments
2867	0.0401	Protocol Amending The Benelux Convention On The Hunting And Protection Of Birds
2870	-1.155	Amendments To The Agreement For The Establishment Of A Commission For Controlling The Near East Desert Locust
2875	0.534	Kuwait Regional Convention For Cooperation On The Protection Of The Marine Environment From Pollution
2877	0.288	Protocol Amending The International Convention For The High Seas Fisheries Of The North Pacific Ocean
2880	1.793*	Convention Relating To The Status Of The River Gambia
2883	0.307	Treaty For Amazonian Cooperation
2885	-0.141	Amendments To The Convention On The Prevention Of Marine Pollution By Dumping Of Wastes And Other Matter
2899	-0.127	South Pacific Forum Fisheries Agency Convention
2901	-1.467	Agreement Incorporating Colombia Into The System Of The Permanent Commission Of The South Pacific

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2907	-0.279	Convention For The Conservation And Management Of The Vicuna
2908	0.0676	Amendments To The Convention Concerning Fishing In The Waters Of The Danube
2912	-0.116	Amendments To The Convention On The Protection Of The Marine Environment Of The Baltic Sea Area
2924	0.230**	Amendments To The Convention On The Protection Of The Marine Environment Of The Baltic Sea Area
2925	-0.194	Articles Of Association Of The South Asia Cooperative Environment Programme
2926	-1.046	Convention For Cooperation In The Protection And Development Of The Marine And Coastal Environment Of The West And Central African Region
2931	0.604	Convention For The Protection Of The Marine Environment And Coastal Area Of The Southeast Pacific
2935	-0.602	Regional Convention For The Conservation Of The Red Sea And Gulf Of Aden Environment
2942	0.325	Constitutional Agreement Of The Latin American Organization For Fisheries Development
2944	0.167	Protocol To Amend The Convention On Third Party Liability In The Field Of Nuclear Energy
2950	-0.356**	Protocol Amending The Convention For The Prevention Of Marine Pollution By Dumping From Ships And Aircraft
2958	-0.449***	Second Protocol Amending The Convention On The Canalization Of The Mosel
2963	0.269**	Protocol Amending The European Agreement On The Restriction Of The Use Of Certain Detergents In Washing And Cleaning Products
2968	0.157	Protocol To Amend The International Convention On Civil Liability For Oil Pollution Damage
2973	0.512***	Provisional Understanding Regarding Deep Seabed Matters
2980	-0.272	Agreement On The Protection Of Confidentiality Of Data Related To Deep Seabed Areas For Which Application Of Authorisation Has Been Made
2984	0.284**	Amendments to The Convention For The Prevention Of Marine Pollution By Dumping From Ships And Aircraft

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2988	0.0665	Agreement Establishing An International Foot And Mouth Disease Vaccine Bank
2990	-0.883**	ASEAN Agreement On The Conservation Of Nature And Natural Resources
2992	0.317	South Pacific Nuclear Free Zone Treaty
2997	0.409***	Amendments To Articles Of The Convention On The Conservation Of The Living Resources Of The Southeast Atlantic
2998	-0.191	Agreement For The Establishment Of The Intergovernmental Organization For Marketing Information And Technical Advisory Services For Fishery Products In The Asia And Pacific Region
3001	0.00502	Amendments To The Annex To The International Convention For The High Seas Fisheries Of The North Pacific Ocean
3005	0.361	Convention For The Protection Of The Natural Resources And Environment Of The South Pacific Region
3009	-0.780*	Protocol I To The South Pacific Nuclear Free Zone Treaty
3010	0.866**	Protocol II To The South Pacific Nuclear Free Zone Treaty
3014	0.0434	Treaty On Fisheries Between The Governments Of Certain Pacific Island States And The Government Of The U.S.
3015	-0.413	Third Protocol Amending The Convention On The Canalization Of The Mosel
3020	0.365***	Agreement On The Resolution Of Practical Problems With Respect To Deep Seabed Mining Areas
3030	-0.178	Agreement On The Network Of Aquaculture Centres In Asia And The Pacific
3037	-0.0528	Agreement On Transboundary Cooperation With A View To Preventing Or Limiting Harmful Effects For Human Beings, Property Or The Environment In The Event Of Accidents
3043	0.865	Protocol Concerning Marine Pollution Resulting From Exploration And Exploitation Of The Continental Shelf to the Kuwait Regional Convention For Cooperation On The Protection Of The Marine Environment From Pollution
3048	0.328	Agreement Between Germany, Poland, Slovakia On Cooperation In The Field Of Environmental Protection
3050	-0.497	Protocol For The Protection Of The Southeast Pacific Against Radioactive Contamination

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3055	-1.093***	Convention For The Prohibition Of Fishing With Long Driftnets In The South Pacific
3057	-0.0321	Constitutional Agreement Of The Central American Commission On Environment And Development
3060	0.132	Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region
3061	1.722**	Protocol For The Protection Of The Marine Environment Against Pollution From Land-Based Sources to the Kuwait Regional Convention For Cooperation On The Protection Of The Marine Environment From Pollution
3063	0.00334	Agreement On The Establishment Of A Nordic Environment Finance Corporation
3069	0.0799	Agreement On The Status Of The International Aral Sea Fund And Its Organizations
3075	0.449	Agreement On The Organization For Indian Ocean Marine Affairs Cooperation
3078	-0.116	Agreement On The Conservation Of Seals In The Wadden Sea
3084	0.0773	Convention For A North Pacific Marine Science Organisation
3088	0.621	Treaty Establishing A Common Market Between The Argentine Republic The Federal Republic Of Brazil The Republic Of Paraguay And The Eastern Republic Of Uruguay
3090	0.0478	Amendment To The Treaty For The Prohibition Of Nuclear Weapons In Latin America
3096	0.771	Agreement For The Establishment Of Southern African Centre For Ivory Marketing
3100	-0.188	Convention On Fisheries Cooperation Among African States Bordering The Atlantic Ocean
3101	0.140	Protocol To The Constituent Agreement Of The Central American Commission On Environment And Development
3102	0.0385	Protocol Additional To The Convention For The Protection Of The Rhine From Pollution By Chlorides
3111	0.0999*	Protocol Of Amendment To The European Convention For The Protection Of Animals Kept For Farming Purposes
3112	0.235	Convention For The Conservation Of Anadromous Stocks In The North Pacific Ocean

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3121	1.282***	Protocol On Cooperation In Combating Pollution Of The Black Sea Marine Environment By Oil And Other Harmful Substances In Emergency Situations
3125	-0.142	La Jolla Agreement On The Reduction Of Dolphin Mortality In The Eastern Pacific Ocean
3127	-0.103	Agreement Establishing The Inter-American Institute For Global Change Research
3130	0.113	Convention For The Conservation Of The Biodiversity And The Protection Of Priority Wilderness Areas In Central America
3132	0.845**	Niue Treaty On Cooperation In Fisheries Surveillance And Law Enforcement In The South Pacific Region
3134	-0.0742	Amendment To The Treaty For The Prohibition Of Nuclear Weapons In Latin America
3142	0.664	Protocol On The Programme For The Regional Study On The El Nino Phenomenon (ERFEN) In The Southeast Pacific Under The Permanent Commission Of The South Pacific
3147	-0.129	Central American Regional Agreement On The Transboundary Movement Of Hazardous Wastes
3148	0.414	North American Free Trade Agreement
3158	0.213	Convention For The Conservation Of Southern Bluefin Tuna
3161	0.155	Agreement Establishing The South Pacific Regional Environment Programme
3165	1.571	Amendment To The Convention For The Establishment Of A Sub-Regional Commission On Fisheries
3169	-0.453	Regional Convention For The Management And Conservation Of The Natural Forest Ecosystems And The Development Of Forest Plantations
3179	0.133	Revised Convention Of The Permanent Inter-State Drought Control Committee For The Sahel
3180	-0.300**	Agreement On The Protection Of The Scheldt/L'escaut
3181	-0.0199	Agreement On The Protection Of The Maas/Meuse
3187	-0.248*	Convention On The Conservation And Management Of Pollock Resources In The Central Bering Sea

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3191	0.356	Convention For The Establishment Of The Lake Victoria Fisheries Organization
3194	-0.143	Agreement On The Preparation Of A Tripartite Environmental Management Programme For Lake Victoria
3199	1.174**	Amendments To The Agreement For The Establishment Of A Commission For Controlling The Desert Locust In The Near East
3208	-0.0107	Agreement Constituting The Trilateral Commission For The Development Of The Riverbed Rio Pilcomayo
3210	-2.428*	Agreement On The Cooperation For The Sustainable Development Of The Mekong River Basin
3219	-0.112	Amendment To The Agreement On The Conservation Of Populations of European Bats
3222	0.637	Protocol On Shared Watercourse Systems To The Treaty Of The Southern African Development Community
3224	0.207	Convention To Ban The Importation Into The Forum Island Countries Of Hazardous And Radioactive Wastes And To Control The Transboundary Movement And Management Of Hazardous Wastes Within The South Pacific Region
3226	0.0977	Additional Protocol To The European Outline Convention On Transfrontier Cooperation Between Territorial Communities Or Authorities
3227	-0.293	Treaty On The Southeast Asia Nuclear Weapon Free Zone
3229	-0.0997	European Agreement On Main Inland Waterways Of International Importance
3230	-0.0793	Agreement Regarding Transfrontier Cooperation Between Territorial Communities Or Authorities
3232	0.101	Protocol For The Implementation Of The Alpine Convention Concerning Mountain Forests
3239	-0.509	Agreement On The Control Of Transboundary Shipments Of Hazardous And Other Wastes Between States Members Of The Commonwealth Of Independent States
3241	-0.211	Protocol On The Conservation Rational Utilization And Management Of Norwegian Spring Spawning Herring (Atlanto-Scandian Herring) In The Northeast Atlantic
3255	-0.329	Inter-American Convention For The Protection And Conservation Of Sea Turtles

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3265	-0.294	Protocol To Amend The Vienna Convention On Civil Liability For Nuclear Damage
3277	0.135	Protocol On The Control Of Marine Transboundary Movements And Disposal Of Hazardous Wastes and Other Wastes to the Kuwait Regional Convention For Cooperation On The Protection Of The Marine Environment From Pollution
3279	0.175	Agreement On The Use Of Water And Energy Resources Of The Syr Darya Basin
3280	0.0685	Protocol No 2 To The European Outline Convention On Transfrontier Cooperation Between Territorial Communities Or Authorities Concerning Interterritorial Cooperation
3284	0.231	Agreement Between Norway, Greenland/Denmark, And Iceland About The Capelin Stock In The Area Between Greenland, Iceland, And Jan Mayen
3296	0.453	Protocol Of Amendment To The Treaty For Amazonian Cooperation
3300	0.109	Protocol Between Iceland And Norway To The Agreement Between Iceland, Norway And Russia Concerning Certain Aspects Of Cooperation In The Area Of Fisheries
3302	0.246	Protocol To Amend The Convention For The Establishment Of An Inter-American Tropical Tuna Commission
3309	0.148	Agreement For The Establishment Of The Regional Commission For Fisheries
3310	0.0200	Agreement Concerning The Creation Of A Marine Mammal Sanctuary In The Mediterranean
3313	0.678	Protocol On Liability And Compensation For Damage Resulting From Transboundary Movements Of Hazardous Wastes And Disposal
3318	0.00838	Amendment To The Agreement On The Conservation Of Populations of European Bats
3319	-0.561	Revised Protocol On Shared Watercourses To The Treaty Of The Southern African Development Community
3320	0.0122	Framework Agreement For The Conservation Of The Living Marine Resources Of The High Seas Of The South Pacific
3322	-1.619*	Amendments To The Agreement For The Establishment Of A Commission For Controlling The Desert Locust In Southwest Asia
3323	-0.0731	Convention On The Contract For The Carriage Of Goods By Inland Waterway

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3334	0.188	Agreement For The Establishment Of A Commission For Controlling The Desert Locust In The Western Region
3336	-0.138	Agreement On An Environmental Framework Of Mercosur
3342	-0.227	Agreement On The Conservation Of Albatrosses And Petrels
3349	0.293	Protocol On The Provisional Application Of The Agreement Establishing The Caribbean Community Climate Change Centre
3394	-0.186	Arrangements For The Regulation Of Antarctic Pelagic Whaling
3679	0.0147	Convention Concerning Safety And Health In Mines
3857	-0.382	Treaty Of The Southern African Development Community
3877	-0.293	Agreement On Cooperation In The Field Of Building, Sustainable Housing And Spatial Planning
4054	-0.0218	Convention for Regulating the Police of the North Sea Fisheries (Overfishing Convention)
4146	-0.502	Protocol to the International Convention for the Northwest Atlantic Fisheries Regarding Payments under the Annual Administrative Budget
4160	0.394	Protocol to the International Convention for the Northwest Atlantic Fisheries relating to Functioning of the Commission
4198	0.104	Agreement for the Establishment of the International Organisation for Fisheries in Eastern and Central Europe
4248	0.0298	Agreement between Denmark (on behalf of Greenland), Iceland and Norway concerning the Stock of Capelin in the Waters between Greenland, Iceland and Jan Mayen
4264	-2.651**	Convention regarding the Determination of Conditions of Access to and Exploitation of Fisheries Resources off the Coasts of the Sub-Regional Fisheries Commission Member States
4267	0.111	Amendments to Articles of The Convention On The Protection And Use Of Transboundary Watercourses And International Lakes
4276	0.498*	Black Sea Biodiversity and Landscape Conservation Protocol to the Convention on the Protection Against Pollution
4282	-0.127	Amendments To The Agreement For The Establishment Of The Asia-Pacific Fishery Commission

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4284	0.458	Agreement establishing the Caribbean Regional Fisheries Mechanism
4311	0.250	Protocol On The Navigation Regime To The Framework Agreement On The Sava River Basin
4349	-0.557	Agreement Among Pacific Island States Concerning The Implementation And Administration Of The Treaty On Fisheries Between The Governments Of Certain Pacific Island States And The Government Of The United States Of America
4357	-0.0693	Amendments To The Agreement For The Establishment Of The Asia-Pacific Fishery Commission
4358	-0.223	Amendments To The Agreement For The Establishment Of The Indo-Pacific Fisheries Council
4391	0.580*	Regional Convention On Climate Change
4394	-0.131	Convention Establishing The Sustainable Tourism Zone Of The Caribbean
4399	-0.351	Protocol for Sustainable Development of Lake Victoria Basin to the Treaty for the Establishment of the East African Community
4406	-0.155	Agreement between Denmark, Finland, Iceland, Norway and Sweden on the Nordic Environment Finance Corporation
4442	1.048***	Amendments To The Agreement For The Establishment Of A Commission For Controlling The Desert Locust In The Near East
4452	0.217	Agreement relative to the establishment of the Limpopo Basin Permanent Technical Committee
4455	-1.723**	Convention on the Sustainable Management of Lake Tanganyika
4462	0.814	Charter of Waters of the Senegal River
4465	-0.0725	Amendments to the Statutes of the Nordic Environment Finance Corporation (Amendments to Sections 2 and 5)
4487	-0.260	Protocol Amending The Framework Agreement For The Conservation Of The Living Marine Resources Of The High Seas Of The South Pacific
4491	-0.360	Treaty between El Salvador, Guatemala and Honduras for Execution of the Plan Trifinio
4494	0.285	Amendment to the Agreement On The Network Of Aquaculture Centres In Asia And The Pacific
4510	0.126	Agreement on eternal friendship between Uzbekistan, Kazakhstan and Kyrgyzstan

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4511	1.035	Agreement Amending the Treaty Of The Southern African Development Community
4573	0.146	Agreement between Denmark, Norway and Sweden on the modification of the Annex to the Agreement For Cooperation In Dealing With Pollution Of The North Sea By Oil And Other Harmful Substances
4610	-0.0289	Amendments To Articles XIII, paragraph 1 of The Convention On The Conservation Of The Living Resources Of The Southeast Atlantic
4645	0.139	Agreement between Denmark (on behalf of Greenland), Iceland and Norway concerning the Stock of Capelin in the Waters between Greenland, Iceland and Jan Mayen
4650	0.422**	Amendments to the Agreement For The Establishment Of The Intergovernmental Organization For Marketing Information And Technical Advisory Services For Fishery Products In The Asia And Pacific Region
4656	0.120	Agreement [among the CIS states] on social security and health of citizens exposed to radiation from the Chernobyl and other radiation accidents and disasters, as well as nuclear testing
4657	-0.830	Agreement on information cooperation in the area of ecology and environment protection
4659	-0.238	Agreement on basic principles of mutual activity in the area of the rational use and protection of transboundary water bodies
4660	-0.176	Agreement on cooperation in the area of environmental monitoring
4661	-0.544*	Agreement on cooperation in the area of preservation and use of genetic resources of cultured plants of member states of the CIS
4662	0.245	Agreement on applying technological, medical, pharmaceutical, sanitary, veterinary, and phytosanitary norms, rules, and requirements in relation to merchandise imported to member states of the CIS
4663	-0.708	Agreement on mutual assistance in case of accidents and other extraordinary situations at the electric energy sites of member states of the CIS
4664	1.179*	Agreement on cooperation of the CIS member-states in the field energy efficiency and energy saving

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4779	-0.283	Arrangement Between Japan, Norway And The Union Of Soviet Socialist Republics For The Regulation Of Antarctic Pelagic Whaling
4784	-0.174	Arrangement Between Japan, Norway And The Union Of Soviet Socialist Republics For The Regulation Of Antarctic Pelagic Whaling
4846	-0.251	Amendments To The Benelux Convention On The Hunting And Protection Of Birds
4850	0.000144	Proces-Verbal on the denunciation of the International Convention for regulating the police of the North Sea fisheries
4866	0.148	Agreement of Unified Terms of Transit [of Hazardous Wastes] through the Territories of States-Members of the Custom Union
4946	0.0207	Amendments to the Convention On The Protection Of The Rhine Against Pollution By Chlorides
4953	-0.186	Agreement on cross-border cooperation in the field of research, development and protection of natural resources
Obs.	14,131	
R-sq.	0.298	

t statistics in parentheses.

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

2.7 Concluding Remarks

Due to limited data availability on international environmental agreements and policies, existing studies addressing the effect of MEAs are quite rare. This work attempts to answer the question of whether MEAs have a negative effect on international trade as is often thought. Same as evaluating the effects of free trade agreements, estimating the effects of environmental agreements using traditional gravity equation approach suffers from the potential bias caused by the endogeneity. Using fixed effects panel gravity equations and 1965-2005 panel data, the results show that on average environmental agreements have no effect on trade. I further study categorical impacts of both free trade agreements and environmental agreements, as well as their interaction terms. My findings are consistent with the baseline results that environmental agreements have no effect on trade.

Additionally, I separate all MEAs into groups of different sizes, and find differential impacts between MEAs of small and large size. Countries are potentially more likely to have environmental agreements when they expect smaller effects on international trade, or comparative advantage. As a further robustness check I also address the specific impact of every environmental agreement. I find that a large portion of MEAs have insignificant impact on trade flows. Only a small percentage of MEAs present a statistically significant stimulating or deterring impact on trade. Such a finding to some extent explains why the estimation of an aggregate impact of a large number of MEAs has mixed results: some MEAs have significant impact on trade flows while others not. When I evaluate the general impact by including all of them together, the significance in some individual estimation results might be absorbed by a large number of insignificance from the rest of the sample.

For future research, I wish to go broadly further in the following aspects. First, this paper places more emphasis on investigating the aggregate effect of MEAs by considering the presence of environmental agreements rather than the number of MEAs between each country pair. It is possible that using the number of MEAs as indicators in the generalist approach could generate more detailed results of the overall MEA impact. Also, different MEAs have diversified characteristics such as the types, subjects, coverage, signature date, lineages, and number of signatories. All of which may have a differential impact on international trade. Conducting more detailed investigations on these heterogenous design of MEAs as well as their statuses of regulation implementation could provide more insights on the specialist approach. Additionally, the difference between the announcement and ratification date of every environmental agreement 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. There is also one more approach to be fulfilled. The environmental agreement dummies could be further separated to indicate whether the agreement in question is the first, second, third, and so on agreement between the two countries, so as to enable future work to have a more detailed investigation of the differential timing impact for each IEA.

When it comes to the evaluation of trade impact, using a single dummy variable standing for environmental agreements provides me with a limited capacity to examine their effects in detail. For instance, MEAs dealing with pollution of air and oceans may have a larger effect on bilateral trade in energy-intensive sectors, while agreements on species and habitats will have relatively smaller effects on international competitiveness. Using highly aggregated data on either trade volume or numbers of environmental agreements provides me with limited results. I could either recode the data to associate industries with agreements, or use data disaggregated to the SITC 4-digit data level, which would address the data aggregation issue and lead to some new findings. Furthermore, I take into account only the volume of trade but ignore the bilateral extensive and intensive margins which the following chapter estimates. It is reasonable to infer that MEAs have differential impacts on growth in trade varieties and trade volumes. This topic has political significance in evaluating social welfare rather than the volume of trade. Finally, existing studies are starting to place emphasis on how global trade policies are affecting the environment; therefore another direction to investigate with the current datasets is to study how the trade flows and EIAs change the numbers of environmental agreements. All these above are challenging but worthwhile extensions for the subsequent work.

All in all, this paper not only provides a result of the average treatment effect of environmental agreements on trade isolating the effects of EIAs and adjusting for possible endogeneity, but also addresses an individual impact specific to every environmental agreement in the current dataset. My work serves as a starting point for a new research agenda.

CHAPTER III

THE ROLE OF INTERNATIONAL ENVIRONMENTAL AGREEMENTS ON THE EXTENSIVE AND INTENSIVE MARGINS OF INTERNATIONAL TRADE

3.1 Introduction

This paper centers on the specific impact of international environmental agreements (IEAs) on bilateral extensive and intensive margins of international trade flows. Existing studies in trade literature have provided insights regarding ways to define the extensive margin.[1] This study follows the trade-margin-decomposition approach by Hummels and Klenow (2005) to define the extensive margin of bilateral exports as a weighted count of exporter's varieties exported to the importer, and the intensive margin as the exporter's relative volume of exports. A large number of empirical studies have addressed the impact of trade-liberalizing policies on trade growth (see Trefler, 2004; Baier and Bergstrand, 2007; Magee, 2003; Goldberg et al., 2009). A recent paper Baier, Bergstrand, and Feng (2014) builds on the analysis of Baier and Bergstrand (2007) and investigates the impact of the formation of an economic integration agreement (EIA) on trade margins. They find not only evidence of differential impacts of EIAs by type, but also a novel "timing" difference between the intensive- and extensive-margin effects, with the former occurring sooner than the latter but finally being outweighed in magnitude.

[1]In particular, different levels of disaggregation were used when defining the extensive margin. See, for example, Hillberry and McDaniel (2002) and Hummels and Klenow (2005) decompose trade growth at the product-sector level, Eaton, Kortum, and Kramarz (2004) conduct their data at the level of individual producers, and Helpman, Melitz and Rubinstein (2008) provide estimates of the extensive margin at the country level.

My investigation is motivated by Baier, Bergstrand, and Feng (2014) and follows their panel estimation framework. While most free trade agreements reduce bilateral trade barriers and to a lesser or greater extent lower trade costs for multinational enterprises, environmental agreements are considered to work in the very opposite direction. Despite several theoretical results supporting the notion of a deterring effect of environmental regulations on trade (e.g., Taylor, 2004; Copeland and Taylor, 2004), empirical evidence of the negative impact of environmental stringency is quite limited (e.g., Becker and Henderson, 2000; Xing and Kolstad, 2002; Keller and Levinson, 2002). Others suggest no supporting evidence of a deterring effect of pollution regulation on foreign direct investment inflows, for example.[2] Due to data constraint, Kellenberg and Levinson (2014) study one particular IEA[3] to identify the effects on waste shipments among countries, and find almost no evidence that the treaty has actually resulted in less waste being shipped.

Aiming to reconcile such mixed results in previous literature, this paper takes a first step to estimate the general impact of IEAs on trade margins using panel data methods. To begin with, I follow Hummels and Klenow (2005) to construct bilateral trade margins from each country pair's yearly trade flows. To avoid potential estimation bias caused by unobserved heterogeneity, I then apply a five-year first-differencing approach following Baier and Bergstrand (2007). The first set of our first-differencing (FD) panel estimation results, including all IEAs without distinction of types, indicates a negative impact of IEA membership on the intensive margin. After adding lagged IEA terms to allow for time effects, I find the initial negative IEA impact on the intensive margin eventually becomes smaller within a 10–15 year time frame. I find no effects on the extensive margin. To provide a detailed investigation

[2]See Friedman, Gerlowski, and Silberman (1992), List (1999), Javorcik and Wei (2004), and Dean, Lovely, and Wang (2009).

[3]The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

of the differential effects of each type of environmental agreements, I divide IEAs into three categories: resource, pollution, and others. To see whether the number of IEAs two countries share has any influence, I count the total number of IEAs between each country pair by year, and the numbers of IEAs belonging to each distinct type as well. My results are consistent irrespective of how I look at the data. While environmental agreements and the regulations and standards they introduce have a detrimental effect on trade in some cases, that effect is small in magnitude.

The contribution of this study is threefold. First, this paper is the first one to my knowledge that has been looking into the impact of environmental agreements on the margins of trade. Few papers to date have successfully investigated the effect of environmental agreements on trade margins due to limited data availability on existing environmental agreements. The unique IEA data enable me to take a large number of IEAs into account and test the general relationship between the variety and volume of trading goods and environmental regulations.

Second, looking into various IEA types, I provide the first evidence of the differential impact of IEAs by category. Specifically, I find that both the pollution and resource type of IEAs have a negative effect on the intensive margin as well as overall trade. My finding that the intensive margin is more sensitive to changes in trade barriers than corresponding extensive margin is consistent with the predictions of a few theoretical models. One supporting example is the national differentiation model of Armington (1969), in which it assumes that each country produces a single variety in each category so there is no extensive margin. And a modified version predicts that competitive trade in goods is differentiated by country of origin. Another matching model is the simple quality differentiation model (see Flam and Helpman, 1987; Grossman and Helpman, 1993). In which there's no extensive margin, and richer economies, by exporting higher-quality goods, can export higher quantities without lowering their prices. In addition to these theoretical perspectives, my finding is also consistent with the Melitz-type model in Chaney (2008), which suggests that a higher elasticity of substitution magnifies the sensitivity of the intensive margin to changes in trade barriers, whereas it dampens the sensitivity of the extensive margin. In parallel, a large strand of empirical literature on the role of intensive versus extensive margins has also reached a consensus of the primacy of the intensive margin, as the latter is considered largely dependent on new export relationships and therefore more frail and less sensitive than the former to changes in trade costs, especially in a short-run analysis (Felbermayr and Kohler, 2006; Helpman, Melitz, and Rubinstein, 2008; Eaton et al., 2008; Besedeš and Prusa, 2011).

Third, this paper confirms the mutual supportiveness between IEAs and trade growth, by taking into account the effect of trade agreements. When countries agree on environmental agreements alongside with trade agreements, the negative effect of IEAs are either insignificant or marginally negative, and dominated by the stimulating effect of trade agreements. Specifically, even though the environmental stringency caused by regulatory agreements increase pollution abatement cost or restrict the exploitation of a natural resource, reducing the trading volume (intensive margin), the positive effects of trade agreements outweigh such negative effects either by simply enabling an increase in the traded volume through lower trade costs or by environmental regulation potentially stimulating innovation and green technology, hence increasing the value-weighted variety of trading goods (extensive margin). Additionally, the increased environmental stringency in those pollution-intensive sectors would act as a second trade barrier for foreign polluting enterprises to enter the local market, and the local firms with less competition pressure could increase their production and export volume eventually.

The remainder of this paper is organized as follows. Section 3.2 presents a detailed description of the empirical methodology to assess the impact of environmental agreements, following the margins decomposition method by Hummels and Klenow

(2005) and the panel estimation approach from Baier and Bergstrand (2007). Section 3.3 discusses the three data sources and related work. Section 3.4 explains the empirical findings of a deterring impact of IEAs on trade margins, from which I confirm a deterring impact of IEAs on trade margins. Section 3.5 provides several robustness checks by switching between different estimation models and sample periods, followed by concluding remarks in Section 3.6.

3.2 Methodology

3.2.1 The Hummels-Klenow Margin-Decomposition Methodology

Feenstra (1994) applies a constant-elasticity-of-substitution (CES) aggregator function that identifies the gains from variety by keeping track of only two factors: the elasticity of substitution among different categories of goods, and shifts in expenditure shares among new and disappearing product varieties. His work demonstrates that increasing the number of varieties does not increase productivity much if new varieties are close substitutes to existing varieties or if the share of new varieties is small relative to existing ones. With such micro-foundations developed for measuring the impact of new varieties on productivity, Hummels and Klenow (2005) investigate the extent to which a country with a higher volume of exports does so because it exports a wider variety of goods (extensive margin) or because it exports larger quantities of each variety (intensive margin).

Starting with the Dixit-Stiglitz formulation of consumers' utility maximization and assuming that X_{ijt} denotes the value of country i's exports to country j in year t, Hummels and Klenow (2005) define the extensive margin of goods exported from i to j as:

$$EM_{ijt} = \frac{\sum_{m \in M_{ijt}} X_{Wjt}^{m}}{\sum_{m \in M_{Wjt}} X_{Wjt}^{m}} \tag{14}$$

where X^m_{Wjt} denotes the trade value of country j's imports from the world in a particular product m in year t, M_{Wjt} is the set of all categories of products exported by the world to j in year t, and M_{ijt} is the subset of all products exported from i to j in year t. Therefore, EM_{ijt} is a measure of the fraction of all products that are exported from i to j in year t , where each product is weighted by the importance of its category in world exports to j in year t.

The corresponding intensive margin, comparing nominal shipments from i to j in a common set of goods, is defined as:

$$IM_{ijt} = \frac{\sum_{m \in M_{ijt}} X^m_{ijt}}{\sum_{m \in M_{ijt}} X^m_{Wjt}} \tag{15}$$

where X^m_{ijt} denotes the value of exports from i to j in category m in year t. Therefore, IM_{ijt} represents the market share of country i in country j's imports from the world within the set of products that i exports to j in year t. Note that the numerator of Equation(14) is equal to the denominator of Equation(15). Hence, one of the notable properties of their trade-margin-decomposition methodology is that the product of the two margins equals the ratio of exports from i to j relative to country j's total value of imports:

$$EM_{ijt} IM_{ijt} = \frac{\sum_{m \in M_{ijt}} X_{ijmt}}{\sum_{m \in M_{Wjt}} X_{Wjmt}} = \frac{X_{ijt}}{X_{jt}} \tag{16}$$

where X_{jt} denotes j 's imports from the world. Taking the natural logarithms of Equation(16) along with some algebra yields:

$$\ln EM_{ijt} + \ln IM_{ijt} = \ln \frac{X_{ijt}}{X_{jt}} = \ln OVER_{ijt} \tag{17}$$

from which they decompose overall exports from exporter i to importer j in any year t linearly into extensive margin and intensive margin. The overall margin between a bilateral country pair is defined as the proportion of j's imports from country i to j's imports from the world.

Several empirical studies have followed the Hummels and Klenow (2005) decomposition methodology to investigate the effects of trade liberalizations on the intensive and extensive margins of trade. Kehoe and Ruhl (2006) find significant evidence of growth in the extensive margin following a decrease in trade barriers. Hillberry and McDaniel (2002) also use the Hummels and Klenow (2005) approach to offer some basic insights into the nature of U.S. trade growth since NAFTA. They conclude that the United States is trading more of the same goods with NAFTA partners since 1993, and increasing the variety of products imported from Mexico, implying that a new set of industries has had to face competition from Mexican varieties. Baier, Bergstrand, and Feng (2014) are the first among them to find economically and statistically significant effects of economic integration agreements (EIAs) on both the intensive and extensive (goods) margins in the context of a large number of country pairs, EIAs, and years.

3.2.2 Estimating the impact of international environmental agreements

To empirically estimate the precise effects of international environmental agreements on trade using panel data of trade flows constructed from a 1965 to 2000 sample period and international environmental agreements, following Baier, Bergstrand, and Feng (2014) I use a set of five-year first differenced equations as below.

$$\Delta_5 \ln OVER_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 IEA_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{18}$$

$$\Delta_5 \ln EM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 IEA_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{19}$$

$$\Delta_5 \ln IM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 IEA_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{20}$$

where Δ_5 refers to first-differencing over 5 years. Note that the bilateral country-pair fixed effects are eliminated by taking the first difference. However, the exporter-time $\delta_{5,it}$ and importer-time $\psi_{5,jt}$ fixed effects are retained to capture changes in the time-varying exporter and importer GDP and multilateral price terms over the same five-year period. Otherwise, ignoring such effects would cause potential omitted variable bias (see Foster, Poeschl, and Stehrer, 2011).

As discussed in Baier, Bergstrand, and Feng (2014), the first-difference (FD) approach yields some potential advantages over fixed effects (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 T is large, the spurious regression problem can arise in a panel using FE methods. Therefore, with a large-T panel (T=8 after five-year differencing in the sample), the FD approach would be increasing estimation efficiency than using the FE method. To avoid potential over-rejection problems, I use clustered standard errors at country-pair levels in each set of FD estimation.

After testing the general effect of all environmental agreements, I then separate all IEAs into three types (pollution, resource, and others) to examine whether there's a significant difference between each sub-category of IEAs. 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. As the last IEA category defined in this work, "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 environments such as the nuclear bomb as well as bacteriological, chemical, and toxin weapons. The estimating equations for each IEA type on trade margins are:

$$\Delta_5 \ln OVER_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{21}$$

$$\Delta_5 \ln EM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{22}$$

$$\Delta_5 \ln IM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{23}$$

where POL_{ijt} is a binary variable equal to unity if country i and j belong to one or more IEAs in pollution type and zero otherwise, RES_{ijt} is a binary variable equal to unity if country i and j share the natural resource type of IEA and zero otherwise, and OTH_{ijt} is a binary variable which is unity if country i and j share the other type of IEA and zero otherwise.

According to existing studies on trade liberalization (see Esty, 2001), commitment to free trade may create incentives to distort environmental policy. The empirical findings in Baier, Bergstrand, and Feng (2014) are indicating the significantly stimulative impact of trade integration on the bilateral intensive and extensive margins of each trading country-pair as well. Hence one might be wondering whether ignoring the effect of trade agreements would potentially bias the findings of negative IEA impact on trade margins. Given this concern, I add controls of trade agreements into the regressions to check whether and how the estimated impact of IEA will be influenced by taking them into account. The series of regression equations after adding all trade agreements broadly defined as economic integration agreement (EIA) variables are as below:

$$\Delta_5 \ln OVER_{ijt} = \beta_0 + \beta_1 (\Delta_5 NRP_{ijt}) + \beta_2 (\Delta_5 PTA_{ijt}) + \beta_3 (\Delta_5 FTA_{ijt}) + \beta_4 (\Delta_5 COM_{ijt}) + \beta_5 (\Delta_5 POL_{ijt}) + \beta_6 (\Delta_5 RES_{ijt}) + \beta_7 (\Delta_5 OTH_{ijt}) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{24}$$

$$\Delta_5 \ln EM_{ijt} = \beta_0 + \beta_1 (\Delta_5 NRP_{ijt}) + \beta_2 (\Delta_5 PTA_{ijt}) + \beta_3 (\Delta_5 FTA_{ijt}) + \beta_4 (\Delta_5 COM_{ijt}) + \beta_5 (\Delta_5 POL_{ijt}) + \beta_6 (\Delta_5 RES_{ijt}) + \beta_7 (\Delta_5 OTH_{ijt}) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{25}$$

$$\Delta_5 \ln IM_{ijt} = \beta_0 + \beta_1 (\Delta_5 NRP_{ijt}) + \beta_2 (\Delta_5 PTA_{ijt}) + \beta_3 (\Delta_5 FTA_{ijt}) + \beta_4 (\Delta_5 COM_{ijt}) + \beta_5 (\Delta_5 POL_{ijt}) + \beta_6 (\Delta_5 RES_{ijt}) + \beta_7 (\Delta_5 OTH_{ijt}) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{26}$$

where NRP_{ijt} is a binary variable equal to unity if countries i and j belong to the same non-preferential (or one-way preferential) trade agreement and zero otherwise, PTA_{ijt} denotes another binary variable being unity if i and j belong to the same two-way preferential trade agreement, and FTA_{ijt} is 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) I combine custom unions, common markets, and economic unions into one dummy COM_{ijt}, denoting the status of "deeper EIA," so as to distinguish them from those "partial FTA" (NRP_{ijt} and PTA_{ijt}) and "full FTA" (FTA_{ijt}).

Besides utilizing a set of binary variables to represent the control of IEA membership, I also examine another set of variables by taking the logarithms of the number of international environmental agreements that each country pair is a member of on an annual basis. To avoid a potential missing-variable trap when a pair of countries does not have any common IEAs, I use the transformed independent variable $\ln \left(\sum IEA + 1\right)$.

One advantage of the analysis using IEA numbers to replace IEA dummy variable is that it predicts how the change in the growth rate of the number of IEAs affects the growth rate of bilateral extensive and intensive margins. In addition, relying only on the dummy specification identifying when a pair of countries shares at least one IEA creates problems in the late 1990s and early 2000s, when most countries become members of at least one IEA significantly reducing the variation of interest. No such concern exists if the object of interest is the number of agreements a pair of countries shares. Hence, I take a second step to capture the IEA effect by counting the number of IEAs per year between country i and j.

3.3 Data Description

The trade flow data used to calculate the bilateral extensive and intensive goods margins are from the NBER-United Nations 1962-2000 world trade data constructed by Robert Feenstra and Robert Lipsey.[4] Their NBER-UN data are constructed over two periods: (i) the early years (1962-1983) are taken from UN data collected and originally organized by 4-digit Standard International Trade Classification, Revision 1 (SITC Rev. 1) and (ii) the later years (1984-2000) are from UN Comtrade data, covering 72 reporter countries' trade flows (provided that they exceeded $100,000 per year) classified by SITC Rev. 2, and also include quantities of exports and imports. After converting the SITC Rev. 1 codes to SITC Rev. 2 for the early years and also adjusting the country codes similar to the United Nations classification, the final dataset covers trade flows reported by 192 exporters and 198 importers. For each year, trade flows reported by the importing country were primarily used, as they are assumed to be more accurate than reports by exporters. Only when the importer report is not available for a country-pair then the corresponding exporter report is used instead.

[4] Available at `www.nber.org/data` and documented in Feenstra et al. (2005).

The 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).[5] I 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 according to their indexes. Baier and Bergstrand (2007) choose to include only FTA and customs unions in their assessment of trade agreement impact. In their later study Baier, Bergstrand, and Feng (2014), they 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.

The 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, my research relies mostly on MEAs to grasp a better understanding of the role of IEAs on trade

[5] Data from Database on Economic Integration Agreements (September 2015). Available at: `www3.nd.edu/~jbergstr`. Date accessed: November 2015.

growth. For each agreement, basic information provides signature date, agreement titles, members, agreement type by topic covered, lineage,[6] and sequences.[7] To control the change in intensity of international environmental cooperation within the sample period 1965-2000, I use the count of all agreements between each trading pair by year. As some agreements are updated and amended over time, I adjust all counts of the IEA members by their lineages to avoid any potential duplication.

Table 12: Summary Statistics of IEAs (1951-2013) by category

Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
sum(IEA)	1,580,068	34.951	51.616	1	459
Pollution dummy	1,580,068	0.08	0.488	0	1
Resource dummy	1,580,068	0.976	0.152	0	1
Other dummy	1,580,068	0.542	0.498	0	1

Table 12 shows the multilateral environmental agreements data collected from the IEA database. As I only use the multilateral environmental agreements I use the IEA and MEA designations interchangeably. The variable "$sum(IEA)$" counts the number of agreements recorded between each country pair by year. After merging the IEA dataset together with the trade flow data and trade agreements data, I create a dummy variable indicating whether there exist at least one environmental agreement for each country pair. Since the IEA dataset covers almost all environmental agreements in the sample period, I recode those missing observations as zero IEAs in the combined data.

[6] 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.

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

In the empirical analysis, I first analyze the general effects of the presence of IEAs by generating a binary variable "$dIEA$" to indicate whether a particular country pair has signed some environmental agreements during that year. After estimating the effect on all IEAs combined, I separate IEAs according to the categories listed in the IEA database: (i) pollution, (ii) resource, and (iii) others.

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. The data set allows us to alleviate the aggregation bias to some extent because of the precise disaggregated categories of IEAs. Under such circumstance I am able to control for unobserved heterogeneity caused by category-specific effects.

3.4 Empirical Results

Table 13 provides a list of variables used in the FD specification and sensitivity analysis to test the existence of an IEA impact. Among them, value of imports refer to the bilateral real trade flows between each country pair in a specific year, summing over all sectors. I drop zero trade flows, following the rationale in Baier and Bergstrand (2007). As discussed in the previous section, bilateral intensive and extensive margins are decomposed from the trade flow data using Equations 14 and 15. Overall margin refers to the proportion of country i's exports value to country j relative to country j's total exports value. Following Equation 16 and 17, it is calculated as the product of the extensive margin and intensive margin for a specific country pair ij. The Hummels and Klenow (2005) decomposition structure indicates that for each bilateral country-pair, the sum of variations in the extensive and intensive margins

Table 13: Summary Statistics of Trade Margins and Agreements(1965-2000)

Variable	**Obs.**	**Mean**	**Std. D.**	**Min**	**Max**
Value of imports	106,775	236,144.1	1680,430	0.660	1.54e+08
Overall margins	106,775	0.016	0.048	7.85e-09	0.973
Intensive margins	106,775	0.050	0.107	1.98e-07	1
Extensive margins	106,775	0.238	0.282	2.58e-07	1
sum(IEA)	106,775	17.133	30.254	0	310
IEA dummy	106,775	0.767	0.423	0	1
EIAs	106,775	0.273	0.735	0	6
Common union (4-6)	106,775	0.010	0.102	0	1
Free trade agreement(3)	106,775	0.021	0.144	0	1
Two-way partial trade(2)	106,775	0.022	0.146	0	1
One-way partial trade(1)	106,775	0.119	0.323	0	1

would be equal to the variation in overall margins. From which the relative elasticities of trade margins to IEAs are inferred. The dummy variable of IEA ($dIEA$) takes the value of 1 when $sum(IEA)$ is no less than one in a specific year t and 0 otherwise.

3.4.1 FD Results without and with Specific IEA Agreement Types

Table 14 presents the main empirical results from Eqs. (20) to (22). Panel 14.A gives a first set of estimates using $dIEA$ and their lagged terms. Within a 15-year time frame, I find significant negative correlation between IEAs and the intensive margin. International environmental agreements taken as a whole have no statistically significant effect on the extensive margin, with a coefficient that is usually small and positive. The overall margin estimates display a consistently negative effect of IEAs, somewhat smaller than the effect on the extensive margin, which is solely due to the small effect on the extensive margin.

Table 14: FD Estimation: All IEAs regardless of category differences

Panel A: Using IEA dummy variables in all categories

	No lag			w. 5-yr lags			w. 10-yr lags		
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dIEA_{t-(t-1)}$	-0.0953**	0.0172	-0.113***	-0.0941**	0.0187	-0.113***	-0.105***	0.0209	-0.126***
	(0.0399)	(0.0213)	(0.0416)	(0.0393)	(0.0215)	(0.0411)	(0.0393)	(0.0216)	(0.0414)
$dIEA_{(t-1)-(t-2)}$				0.0077	0.0086	-0.0009	-0.0107	0.0124	-0.0231
				(0.0401)	(0.0198)	(0.0405)	(0.0397)	(0.0200)	(0.0401)
$dIEA_{(t-2)-(t-3)}$							-0.0986**	0.0202	-0.119***
							(0.0437)	(0.0222)	(0.0450)
$Ctry-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731
R-squared	0.169	0.336	0.205	0.169	0.336	0.205	0.169	0.336	0.205

Panel B: Using log(sum(IEA)) in all categories

	No lag			w. 5-yr lags			w. 10-yr lags		
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sIEA_{t-(t-1)}$	-0.0006	0.0007	-0.0013	-0.0043	0.0019	-0.0062	-0.0088	0.0019	-0.0107
	(0.0203)	(0.0104)	(0.0208)	(0.0198)	(0.0104)	(0.0203)	(0.0200)	(0.0104)	(0.0204)
$sIEA_{(t-1)-(t-2)}$				-0.0223	0.0075	-0.0298	-0.0299*	0.0075	-0.0374**
				(0.0183)	(0.0101)	(0.0186)	(0.0178)	(0.0100)	(0.0180)
$sIEA_{(t-2)-(t-3)}$							-0.0400**	-7.05e-05	-0.0400*
							(0.0200)	(0.0109)	(0.0208)
$Ctry-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731
R-squared	0.169	0.336	0.205	0.169	0.336	0.205	0.169	0.336	0.205

t statistics in parentheses.

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

The first three columns show the results allowing only a five-year change of IEAs. To see if there are any time effects, I add a 10-year lag in columns 4 to 6, and then both 10-year and 15-year lagged effects in the last three columns. I find that taking into account both lagged and current changes in IEAs gives even larger estimated effects on both overall and intensive margins. Specifically, IEA membership generally decreases two trading countries' bilateral intensive margin by 10.68% ($e^{-0.113} - 1 \approx -0.1068$) within a 5-10 year time period, which further increases to 21.73% ($e^{-(0.126+0.119)} - 1 \approx 0.2173$) after 15 years. My finding of the lagged IEA effect is consistent with the empirical evidence found in Rose and Spiegel (2009).

In Panel 14.B when I replace the binary IEA variable with the count of the number of IEAs between each country pair, I find that the effects of five-year and 10-year lagged change in IEA numbers are insignificant on either extensive or intensive margins. However, when I allow for a longer time effect by adding 15-year lagged changes of IEA numbers, the growth rate of IEA numbers reduces the growth on trade margins as well. Specifically, increasing IEA numbers by one percent would decrease the country members' bilateral intensive margin by 7.45% ($e^{-(0.0374+0.0400)} - 1 \approx 0.0745$) after 15 years.

After taking the first step to estimate the general IEA effect, I then turn to look at the differing IEA effect in each sub-category. With the rationale explained in the previous section, I divide all IEAs into three types to see if there are any significant differences across the three types of agreements. Table 15 presents the results. In Panel 15.A, where I use a binary variables for each IEA type, I find evidence that both the pollution and resource type of IEAs have to some extent a deterring effect on the intensive and overall margins. Pollution agreements seem to have a short run effect only, while resource agreements tend to have an effect in over the long run.

Panel 15.B presents the estimated coefficients when looking at the effects of the changing number of IEAs in each category. The negative estimates on both intensive and overall margins are consistent with what I have in the upper panel when focusing on IEA dummy variables. One interesting finding is the time effects for the resource type. When only allowing five-year change in IEA size, the increase in IEA has no effect on trade margins. However, when I relax the timing by adding 10-year and 15-year lagged terms, the deterring effect of IEA growth shows up in intensive margins first and then in overall margins as well. Specifically, increasing the resource type of IEA by one percent would decrease the country members' bilateral intensive margin by 3.67% ($e^{-0.0374} - 1 \approx -0.0367$) after 10 years, and lead to an even larger reduction after 15 years at 8.92% ($e^{-(0.0477+0.0457)} - 1 \approx -0.892$).

My finding of the negative IEA impact on intensive margin and no impact on extensive margin is consistent with the prediction in Chaney (2008), of which the main idea is that in the presence of firm heterogeneity, the elasticity of substitution has opposite effects on the extensive and intensive margin. Building on the identical-firm model in Krugman (1980), Chaney adds firm heterogeneity in productivity and fixed cost of exporting to prove that, while a higher elasticity causes the intensive margin to be more sensitive to changes in trade barriers, it makes the extensive margin less sensitive.

Table 15: FD Estimation: IEAs separated into different categories

	Panel A: Using dummy variables of IEAs in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-0.0462*	0.0065	-0.0526*	-0.0488*	0.0023	-0.0511*	-0.0506*	-0.0023	-0.0483*
	(0.0267)	(0.0138)	(0.0272)	(0.0262)	(0.0139)	(0.0267)	(0.0265)	(0.0140)	(0.0270)
$dPOL_{(t-1)-(t-2)}$				-0.0091	-0.0152	0.0061	-0.0112	-0.0216	0.0105
				(0.0247)	(0.0141)	(0.0252)	(0.0246)	(0.0142)	(0.0251)
$dPOL_{(t-2)-(t-3)}$							-0.0152	-0.0275*	0.0122
							(0.0249)	(0.0151)	(0.0254)
$dRES_{t-(t-1)}$	-0.0228	0.0392	-0.0620	-0.0173	0.0463*	-0.0636	-0.0298	0.0446*	-0.0744
	(0.0465)	(0.0239)	(0.0484)	(0.0458)	(0.0240)	(0.0477)	(0.0462)	(0.0243)	(0.0483)
$dRES_{(t-1)-(t-2)}$				0.0277	0.0296	-0.0019	0.0122	0.0305	-0.0183
				(0.0463)	(0.0218)	(0.0463)	(0.0458)	(0.0221)	(0.0458)
$dRES_{(t-2)-(t-3)}$							-0.105**	0.0241	-0.130**
							(0.0510)	(0.0251)	(0.0518)
$dOTH_{t-(t-1)}$	-0.0406	-0.0147	-0.0259	-0.0392	-0.0101	-0.0291	-0.0375	-0.0129	-0.0247

Continued on next page

Table 15 (continued)

	(0.0280)	(0.0174)	(0.0290)	(0.0276)	(0.0174)	(0.0285)	(0.0278)	(0.0175)	(0.0286)
$dOTH_{(t-1)-(t-2)}$				0.0087	0.0283*	-0.0196	0.0075	0.0213	-0.0137
				(0.0285)	(0.0172)	(0.0286)	(0.0281)	(0.0172)	(0.0282)
$dOTH_{(t-2)-(t-3)}$							-0.0129	-0.0435**	0.0305
							(0.0351)	(0.0196)	(0.0341)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731
R-squared	0.169	0.337	0.205	0.169	0.337	0.205	0.169	0.337	0.205

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0349*	-0.0146	-0.0203	-0.0314*	-0.0158	-0.0156	-0.0279	-0.0175*	-0.0104
	(0.0188)	(0.0098)	(0.0192)	(0.0186)	(0.0098)	(0.0190)	(0.0190)	(0.0100)	(0.0193)
$sPOL_{(t-1)-(t-2)}$				0.0127	4.14e-05	0.0126	0.0188	-0.0026	0.0214
				(0.0175)	(0.0105)	(0.0178)	(0.0174)	(0.0106)	(0.0177)
$sPOL_{(t-2)-(t-3)}$							0.0210	-0.0161	0.0371*
							(0.0207)	(0.0130)	(0.0210)
$sRES_{t-(t-1)}$	0.0282	0.0051	0.0231	0.0221	0.0076	0.0146	0.0175	0.0078	0.0097

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Table 15 (continued)

	(0.0229)	(0.0110)	(0.0233)	(0.0225)	(0.0110)	(0.0228)	(0.0226)	(0.0111)	(0.0230)
$sRES_{(t-1)-(t-2)}$				-0.0273	0.0100	-0.0374*	-0.0366*	0.0110	-0.0477**
				(0.0203)	(0.0107)	(0.0204)	(0.0196)	(0.0107)	(0.0196)
$sRES_{(t-2)-(t-3)}$							-0.0415*	0.0042	-0.0457**
							(0.0218)	(0.0114)	(0.0224)
$sOTH_{t-(t-1)}$	0.0120	-0.0121	0.0242	0.0185	-0.0024	0.0209	0.0232	-0.0034	0.0266
	(0.0281)	(0.0182)	(0.0293)	(0.0278)	(0.0183)	(0.0291)	(0.0281)	(0.0185)	(0.0293)
$sOTH_{(t-1)-(t-2)}$				0.0376	0.0609***	-0.0233	0.0443	0.0563***	-0.0120
				(0.0277)	(0.0178)	(0.0279)	(0.0276)	(0.0179)	(0.0277)
$sOTH_{(t-2)-(t-3)}$							0.0345	-0.0281	0.0626*
							(0.0352)	(0.0210)	(0.0343)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731	42,731
R-squared	0.169	0.337	0.205	0.169	0.337	0.205	0.169	0.337	0.205

t statistics in parentheses.

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

3.4.2 Adding Trade Agreements

Table 16 presents the estimated coefficients when I consider both the effect of environmental and trade agreements. The estimated effects of IEA terms are consistently negative, although at a lower significance level and smaller magnitudes than those in Table 15 when ignoring the effects from all trade agreements. My estimated coefficients on the different types of trade agreements are similar to the results in Baier, Bergstrand, and Feng (2014) that "deeper" levels of EIA terms (COM) generally have larger stimulating effects than FTA on both the intensive and extensive margins, and the latter have larger effects than those preferential EIA terms (NRP and PTA). Specifically, in Panel 16.A I find that FTA membership generally increases two trading countries' bilateral intensive margin by 44.20% ($e^{0.196+0.170} - 1 \approx 0.4420$) after 15 years. The interesting finding is about the prediction of negotiating FTA and a particular IEA type such as pollution. The combined effect of FTA and POL membership after 10 years would be an 35.83% ($e^{0.200+0.170-0.0638} - 1 \approx 0.3583$) increase in the bilateral overall margin of two trading partners, and an 22.07% ($e^{0.171+0.0949-0.0665} - 1 \approx 0.2207$) increase in the intensive margin as well. Comparing to such predictions, the combined effect of COM and POL membership after 10 years would be of the same sign but yielding an even higher magnitude, at about an 50.86% ($e^{0.310+0.165-0.0638} - 1 \approx 0.5086$) increase in the overall margin, and an 22.69% ($e^{0.271-0.0665} - 1 \approx 0.2269$) increase in the intensive margin. In other words, the negative impact from environmental agreements are quite small in magnitude when comparing to the stimulating effect of non-partial trade agreements.

Panel 16.B presents the estimation results when I substitute the IEA dummies with number of IEAs in each category. I find small and negative coefficients on the overall and intensive margin for the pollution type, and there's no significant impact for the resource or other type. When a country pair has a free trade agreement sealed off, increasing the pollution type of IEA by one percent would decrease the country members' bilateral overall margin by 4.23% ($e^{-0.0432} - 1 \approx -0.0423$) after 5 years. However, when I take into account the positive impact of free trade agreements, the combined effect on the overall margin would be an 16.04% ($e^{0.192-0.0432} - 1 \approx 0.1604$) increase after 5 years, and yield an even larger increase at 17.29% ($e^{0.200-0.0405} - 1 \approx 0.1729$) after 10 years. Therefore the policy implication from such prediction is that, although environmental agreements have a deterring impact on trade margins, that effect is relatively small and is more than offset by the positive effect of trade agreements, if the two countries have a trade agreement.

3.5 Sensitivity Analysis

In this section, I provide the supplementary results using 3-year first differencing and fixed-effects approach. The main results presented in Tables 14 and 15 in section 3.4.1 use the 5-year FD specification following Baier, Bergstrand, and Feng (2014) approach. In a robustness analysis, I use 3-year level data following some previous studies (see Cheng and Wall, 1999). As shown, My Set 1 FD estimation and Set 2 FE results do not differ substantively from the corresponding 5-year analysis in the baseline results.

Table 16: FD Estimation: IEAs by category with trade effects being controlled (1965-2000)

	Panel A: Using dummy variables of IEAs in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0382	-0.0437	0.0055	-0.0244	-0.0321	0.0077	-0.0408	-0.0469	0.0061
	(0.0467)	(0.0281)	(0.0476)	(0.0465)	(0.0285)	(0.0473)	(0.0467)	(0.0288)	(0.0475)
$dNRP_{(t-1)-(t-2)}$				0.0754*	0.0654***	0.0101	0.0571	0.0496**	0.0076
				(0.0432)	(0.0243)	(0.0439)	(0.0423)	(0.0241)	(0.0430)
$dNRP_{(t-2)-(t-3)}$							-0.169***	-0.116***	-0.0533
							(0.0439)	(0.0246)	(0.0452)
$dPTA_{t-(t-1)}$	-0.0305	-0.0465	0.0160	-0.0242	-0.0428	0.0186	-0.0300	-0.0465	0.0165
	(0.0746)	(0.0371)	(0.0691)	(0.0742)	(0.0369)	(0.0686)	(0.0745)	(0.0370)	(0.0690)
$dPTA_{(t-1)-(t-2)}$				0.0086	-0.0155	0.0241	0.0018	-0.0180	0.0198
				(0.0637)	(0.0421)	(0.0602)	(0.0636)	(0.0420)	(0.0600)
$dPTA_{(t-2)-(t-3)}$							-0.199***	-0.0677**	-0.132*
							(0.0746)	(0.0292)	(0.0731)
$dFTA_{t-(t-1)}$	0.188***	0.0228	0.166***	0.200***	0.0291	0.171***	0.196***	0.0258	0.170***
	(0.0455)	(0.0268)	(0.0454)	(0.0458)	(0.0270)	(0.0456)	(0.0460)	(0.0271)	(0.0457)

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Table 16 (continued)

$dFTA_{(t-1)-(t-2)}$				0.170***	0.0748***	0.0949**	0.170***	0.0808***	0.0892**
				(0.0392)	(0.0252)	(0.0370)	(0.0392)	(0.0253)	(0.0370)
$dFTA_{(t-2)-(t-3)}$							0.0397	0.167***	-0.127**
							(0.0531)	(0.0300)	(0.0511)
$dCOM_{t-(t-1)}$	0.308***	0.0339	0.274***	0.310***	0.0389	0.271***	0.304***	0.0311	0.273***
	(0.0530)	(0.0304)	(0.0526)	(0.0528)	(0.0305)	(0.0525)	(0.0529)	(0.0307)	(0.0527)
$dCOM_{(t-1)-(t-2)}$				0.165***	0.114***	0.0511	0.152***	0.0993***	0.0525
				(0.0445)	(0.0295)	(0.0438)	(0.0445)	(0.0293)	(0.0439)
$dCOM_{(t-2)-(t-3)}$							0.0579	0.169***	-0.111**
							(0.0562)	(0.0375)	(0.0561)
$dPOL_{t-(t-1)}$	-0.0604*	0.0050	-0.0654**	-0.0638**	0.0027	-0.0665**	-0.0611*	0.0024	-0.0635**
	(0.0318)	(0.0161)	(0.0324)	(0.0313)	(0.0161)	(0.0317)	(0.0315)	(0.0162)	(0.0320)
$dPOL_{(t-1)-(t-2)}$				-0.0150	-0.0068	-0.0083	-0.0101	-0.0083	-0.0018
				(0.0280)	(0.0161)	(0.0287)	(0.0279)	(0.0162)	(0.0284)
$dPOL_{(t-2)-(t-3)}$							-0.0071	-0.0272	0.0201
							(0.0279)	(0.0170)	(0.0288)
$dRES_{t-(t-1)}$	-0.0350	0.0393	-0.0743	-0.0282	0.0522	-0.0804	-0.0438	0.0483	-0.0921

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Table 16 (continued)

	(0.0692)	(0.0356)	(0.0730)	(0.0684)	(0.0356)	(0.0719)	(0.0691)	(0.0357)	(0.0727)
$dRES_{(t-1)-(t-2)}$				0.0315	0.0621*	-0.0306	0.0023	0.0566*	-0.0543
				(0.0728)	(0.0336)	(0.0720)	(0.0723)	(0.0343)	(0.0713)
$dRES_{(t-2)-(t-3)}$							-0.201**	0.0056	-0.206**
							(0.0883)	(0.0478)	(0.0927)
$dOTH_{t-(t-1)}$	-0.0483	-0.0171	-0.0313	-0.0424	-0.0111	-0.0313	-0.0384	-0.0115	-0.0269
	(0.0346)	(0.0217)	(0.0360)	(0.0342)	(0.0218)	(0.0355)	(0.0345)	(0.0218)	(0.0358)
$dOTH_{(t-1)-(t-2)}$				0.0324	0.0312	0.0012	0.0360	0.0250	0.0110
				(0.0354)	(0.0210)	(0.0354)	(0.0350)	(0.0210)	(0.0349)
$dOTH_{(t-2)-(t-3)}$							0.0097	-0.0396*	0.0493
							(0.0420)	(0.0231)	(0.0408)
$Country - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	34,825	34,825	34,825	34,825	34,825	34,825	34,825	34,825	34,825
R-squared	0.168	0.330	0.205	0.168	0.330	0.205	0.169	0.331	0.205

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Table 16 (continued)

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0425	-0.0442	0.0017	-0.0276	-0.0313	0.0037	-0.0452	-0.0470	0.0018
	(0.0467)	(0.0281)	(0.0476)	(0.0465)	(0.0285)	(0.0473)	(0.0468)	(0.0289)	(0.0476)
$dNRP_{(t-1)-(t-2)}$				0.0759*	0.0661***	0.0098	0.0587	0.0477**	0.0111
				(0.0432)	(0.0244)	(0.0439)	(0.0424)	(0.0243)	(0.0431)
$dNRP_{(t-2)-(t-3)}$							-0.171***	-0.117***	-0.0532
							(0.0441)	(0.0247)	(0.0455)
$dPTA_{t-(t-1)}$	-0.0257	-0.0469	0.0211	-0.0203	-0.0436	0.0233	-0.0308	-0.0463	0.0155
	(0.0747)	(0.0371)	(0.0692)	(0.0744)	(0.0370)	(0.0688)	(0.0748)	(0.0371)	(0.0692)
$dPTA_{(t-1)-(t-2)}$				0.0107	-0.0151	0.0259	0.0041	-0.0141	0.0181
				(0.0637)	(0.0421)	(0.0602)	(0.0636)	(0.0421)	(0.0600)
$dPTA_{(t-2)-(t-3)}$							-0.199***	-0.0664**	-0.133*
							(0.0750)	(0.0294)	(0.0734)
$dFTA_{t-(t-1)}$	0.192***	0.0232	0.168***	0.200***	0.0282	0.172***	0.193***	0.0276	0.165***
	(0.0455)	(0.0268)	(0.0454)	(0.0458)	(0.0269)	(0.0455)	(0.0460)	(0.0270)	(0.0456)
$dFTA_{(t-1)-(t-2)}$				0.170***	0.0743***	0.0959***	0.167***	0.0839***	0.0828**

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Table 16 (continued)

				(0.0393)	(0.0252)	(0.0371)	(0.0393)	(0.0253)	(0.0372)
$dFTA_{(t-2)-(t-3)}$							0.0360	0.167***	-0.131**
							(0.0532)	(0.0301)	(0.0513)
$dCOM_{t-(t-1)}$	0.316***	0.0351	0.281***	0.313***	0.0396	0.274***	0.299***	0.0387	0.261***
	(0.0529)	(0.0304)	(0.0524)	(0.0527)	(0.0304)	(0.0523)	(0.0528)	(0.0307)	(0.0525)
$dCOM_{(t-1)-(t-2)}$				0.167***	0.109***	0.0582	0.149***	0.102***	0.0471
				(0.0443)	(0.0293)	(0.0437)	(0.0443)	(0.0292)	(0.0438)
$dCOM_{(t-2)-(t-3)}$							0.0430	0.178***	-0.135**
							(0.0560)	(0.0378)	(0.0559)
$sPOL_{t-(t-1)}$	-0.0432*	-0.0134	-0.0298	-0.0405*	-0.0129	-0.0276	-0.0398*	-0.0171	-0.0227
	(0.0228)	(0.0119)	(0.0231)	(0.0225)	(0.0119)	(0.0229)	(0.0230)	(0.0121)	(0.0234)
$sPOL_{(t-1)-(t-2)}$				0.0107	0.0053	0.0054	0.0140	-0.0026	0.0166
				(0.0203)	(0.0122)	(0.0207)	(0.0202)	(0.0125)	(0.0208)
$sPOL_{(t-2)-(t-3)}$							0.0146	-0.0266*	0.0413*
							(0.0234)	(0.0147)	(0.0240)
$sRES_{t-(t-1)}$	0.0287	0.0012	0.0274	0.0226	0.0039	0.0188	0.0218	0.0060	0.0158
	(0.0288)	(0.0133)	(0.0290)	(0.0283)	(0.0133)	(0.0285)	(0.0286)	(0.0134)	(0.0287)

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Table 16 (continued)

$sRES_{(t-1)-(t-2)}$				-0.0310	0.0073	-0.0382	-0.0369	0.0109	-0.0478*
				(0.0250)	(0.0132)	(0.0254)	(0.0242)	(0.0131)	(0.0245)
$sRES_{(t-2)-(t-3)}$							-0.0259	0.0062	-0.0321
							(0.0254)	(0.0137)	(0.0262)
$sOTH_{t-(t-1)}$	0.0242	-0.0158	0.0400	0.0271	-0.0069	0.0340	0.0263	-0.0135	0.0397
	(0.0328)	(0.0212)	(0.0346)	(0.0327)	(0.0214)	(0.0347)	(0.0331)	(0.0216)	(0.0350)
$sOTH_{(t-1)-(t-2)}$				0.0390	0.0487**	-0.0097	0.0370	0.0323	0.0047
				(0.0326)	(0.0206)	(0.0326)	(0.0326)	(0.0207)	(0.0326)
$sOTH_{(t-2)-(t-3)}$							0.0452	-0.0328	0.0780**
							(0.0397)	(0.0233)	(0.0389)
$Country - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	34,825	34,825	34,825	34,825	34,825	34,825	34,825	34,825	34,825
R-squared	0.168	0.330	0.205	0.168	0.330	0.205	0.169	0.331	0.205

t statistics in parentheses.

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

3.5.1 Fixed Effect Results as Robustness check

One may argue that using first differenced terms of the key variables might lead to bias estimates, because the variance of the IEAs and trade agreements might be minor in a 10-15 year time frame. Also, out of concern that many environmental standards, once signed might remain fixed for a longer time than trade agreements, I re-estimate the baseline first difference specification by replacing the first differenced terms with original variables and adding fixed effects. Table 17 presents the estimation results when using FE estimation at five-year intervals of the sample period 1965-2000. The FE specifications using five-year differenced data from 1962 to 2000 yield several negative coefficients for NRP and PTA, whereas the coefficient estimates for COM and FTA yield qualitatively similar coefficient estimates as using FD specification. Such negative estimates for NRP and PTA are consistent with the results in Baier, Bergstrand, and Feng (2014). They explained such relationship by the differing growth speed between intra-industry and inter-industry trade. Specifically, both NRP and PTA are typical integration status between developed and developing countries. Therefore when intra-industry growth over a particular period dominates interindustry trade growth, this trend over time will lead to a downward bias in the coefficient estimates for these partial integration agreements.

Table 17: FE Estimation: IEAs separated into different categories(1965-2000)

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
Panel A: Using dummy variables of IEAs in each category									
$dPOL_{t-(t-1)}$	-0.0230	0.0039	-0.0269	-0.0229	0.0102	-0.0331	-0.0197	0.0041	-0.0238
	(0.0259)	(0.0158)	(0.0257)	(0.0259)	(0.0152)	(0.0258)	(0.0260)	(0.0152)	(0.0259)
$dPOL_{(t-1)-(t-2)}$				0.0006	-0.0311**	0.0318	0.0017	-0.0259*	0.0277
				(0.0253)	(0.0148)	(0.0246)	(0.0246)	(0.0142)	(0.0242)
$dPOL_{(t-2)-(t-3)}$							0.0044	-0.0244	0.0288
							(0.0249)	(0.0160)	(0.0241)
$dRES_{t-(t-1)}$	0.0475	0.0434	0.0041	0.0541	0.0168	0.0373	0.0413	0.0236	0.0177
	(0.0444)	(0.0285)	(0.0440)	(0.0447)	(0.0265)	(0.0449)	(0.0446)	(0.0267)	(0.0450)
$dRES_{(t-1)-(t-2)}$				-0.0157	0.0736***	-0.0893**	0.0222	0.0469*	-0.0247
				(0.0451)	(0.0257)	(0.0437)	(0.0451)	(0.0254)	(0.0444)
$dRES_{(t-2)-(t-3)}$							-0.114**	0.0798***	-0.194***
							(0.0465)	(0.0247)	(0.0461)
$dOTH_{t-(t-1)}$	-0.0594**	-0.0283	-0.0312	-0.0652**	-0.0293	-0.0359	-0.0611**	-0.0318*	-0.0294
	(0.0283)	(0.0185)	(0.0275)	(0.0273)	(0.0179)	(0.0273)	(0.0275)	(0.0180)	(0.0274)

Continued on next page

Table 17 (continued)

$dOTH_{(t-1)-(t-2)}$				0.0149	0.0026	0.0123	0.0137	0.0074	0.0064
				(0.0287)	(0.0189)	(0.0283)	(0.0288)	(0.0183)	(0.0282)
$dOTH_{(t-2)-(t-3)}$							0.0068	-0.0168	0.0237
							(0.0341)	(0.0214)	(0.0325)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	54,778	54,778	54,778	54,778	54,778	54,778	54,778	54,778	54,778
R-squared	0.911	0.916	0.816	0.911	0.916	0.816	0.911	0.916	0.816

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0293	-0.0131	-0.0162	-0.0352*	-0.0138	-0.0214	-0.0301*	-0.0135	-0.0166
	(0.0184)	(0.0111)	(0.0180)	(0.0181)	(0.0109)	(0.0178)	(0.0182)	(0.0109)	(0.0180)
$sPOL_{(t-1)-(t-2)}$				0.0263	-0.0042	0.0305*	0.0144	-0.0077	0.0220
				(0.0185)	(0.0113)	(0.0178)	(0.0177)	(0.0109)	(0.0172)
$sPOL_{(t-2)-(t-3)}$							0.0380*	0.0048	0.0332*
							(0.0202)	(0.0137)	(0.0197)
$sRES_{t-(t-1)}$	-0.0031	0.0186	-0.0217	0.0119	0.0138	-0.0019	0.0117	0.0158	-0.0042

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Table 17 (continued)

	(0.0207)	(0.0121)	(0.0200)	(0.0209)	(0.0117)	(0.0204)	(0.0209)	(0.0117)	(0.0205)
$sRES_{(t-1)-(t-2)}$				-0.0480**	0.0184	-0.0664***	-0.0352*	0.0172	-0.0524***
				(0.0197)	(0.0117)	(0.0195)	(0.0196)	(0.0113)	(0.0195)
$sRES_{(t-2)-(t-3)}$							-0.0391*	0.0068	-0.0458**
							(0.0202)	(0.0126)	(0.0201)
$sOTH_{t-(t-1)}$	0.0122	0.0266	-0.0144	-0.0021	0.0057	-0.0078	0.0011	0.0062	-0.0051
	(0.0295)	(0.0194)	(0.0283)	(0.0283)	(0.0188)	(0.0277)	(0.0286)	(0.0190)	(0.0280)
$sOTH_{(t-1)-(t-2)}$				0.0431	0.0523***	-0.0092	0.0166	0.0367*	-0.0201
				(0.0295)	(0.0198)	(0.0284)	(0.0288)	(0.0191)	(0.0278)
$sOTH_{(t-2)-(t-3)}$							0.0808**	0.0486**	0.0323
							(0.0335)	(0.0219)	(0.0316)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	54,778	54,778	54,778	54,778	54,778	54,778	54,778	54,778	54,778
R-squared	0.911	0.916	0.816	0.911	0.916	0.816	0.911	0.916	0.816

t statistics in parentheses.

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

Panel 17.A uses dummy variables for IEA in each category. I find no significant deterring effects for pollution agreements. While for resource and other type, a decrease in both overall and intensive margins occurs in a 10-15 years time frame. Specifically, signing a resource type agreement would reduce the member countries' bilateral intensive margin by 17.63% ($e^{0.194} - 1 \approx 0.1763$) after 15 years. Such a finding is consistent with the main results when using five-year first difference estimation. When I look at the effect of a change in IEA size in Panel 17.B, the deterring effect of an increase in the number of resource related agreements is still significant: increasing the number of resource type agreements by 1 percent would actually reduce the member countries' bilateral intensive margin by 6.42% ($e^{-0.0664} - 1 \approx -0.0642$) after 10 years, and yield an even larger decrease by 9.35% ($e^{-0.0524-0.0498} - 1 \approx -0.0935$) after 15 years.

3.5.2 Using the Period 1965–1990

The sample period between 1965 and 2000 might lead to biased results, as by the year 1990 most of the trading country-pairs have been involved in some level of environmental agreement or protocols. In this section, I re-run all the first difference estimations using a shorter time window stopping at 1990, with the results shown in Table 18. The estimated IEA effects in the sub-sample of 1965-1990 are consistent with the previous prediction in Table 15 when all years are included. Specifically, for the resource type, the negative impact emerges immediately on the intensive margin, and becomes even larger within a 15-year time frame: getting involved in an resource type agreement would actually reduce the member countries' bilateral intensive margin by 31.06% ($e^{-0.221-0.151} - 1 \approx -0.3106$) after 15 years. Moreover, a positive impact of resource type agreements is detected here on the extensive margins, though it is insufficiently large to offset the negative effect on the intensive margin. The extensive margin increases by 16.3% ($e^{0.0788+0.0722} - 1 \approx 0.163$). There are few

Table 18: Sensitivity Analysis: FD Estimation by category (1965-1990)

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
Panel A: FD Estimation: IEA dummy by category									
$dPOL_{t-(t-1)}$	-0.0462	0.0036	-0.0498	-0.0496	-0.0042	-0.0454	-0.0586	-0.0066	-0.0520
	(0.0370)	(0.0175)	(0.0373)	(0.0362)	(0.0175)	(0.0366)	(0.0365)	(0.0176)	(0.0369)
$dPOL_{(t-1)-(t-2)}$				-0.0162	-0.0381**	0.0219	-0.0279	-0.0422**	0.0143
				(0.0382)	(0.0188)	(0.0383)	(0.0378)	(0.0185)	(0.0377)
$dPOL_{(t-2)-(t-3)}$							-0.0725**	-0.0197	-0.0528
							(0.0361)	(0.0193)	(0.0363)
$dRES_{t-(t-1)}$	-0.128*	0.0713**	-0.199***	-0.127*	0.0770**	-0.204***	-0.142**	0.0788**	-0.221***
	(0.0722)	(0.0325)	(0.0729)	(0.0716)	(0.0325)	(0.0724)	(0.0718)	(0.0325)	(0.0726)
$dRES_{(t-1)-(t-2)}$				0.0183	0.0678**	-0.0495	-0.0076	0.0722**	-0.0799
				(0.0785)	(0.0281)	(0.0761)	(0.0782)	(0.0281)	(0.0760)
$dRES_{(t-2)-(t-3)}$							-0.122*	0.0286	-0.151**
							(0.0638)	(0.0304)	(0.0650)
$dOTH_{t-(t-1)}$	0.0009	-0.0372	0.0381	-0.0005	-0.0349	0.0345	0.0023	-0.0343	0.0366
	(0.0393)	(0.0229)	(0.0411)	(0.0392)	(0.0229)	(0.0410)	(0.0392)	(0.0229)	(0.0409)

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Table 18 (continued)

$dOTH_{(t-1)-(t-2)}$				-0.0482	0.0709	-0.119	-0.0512	0.0701	-0.121
				(0.0914)	(0.0442)	(0.0892)	(0.0913)	(0.0442)	(0.0892)
$dOTH_{(t-2)-(t-3)}$							-0.0371	0.0138	-0.0508
							(0.0757)	(0.0348)	(0.0722)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	25,713	25,713	25,713	25,713	25,713	25,713	25,713	25,713	25,713
R-squared	0.156	0.381	0.209	0.156	0.381	0.209	0.156	0.381	0.209
Panel B: FD Estimation: Using log(sum of IEA) by category									
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0295	-0.0226*	-0.0069	-0.0312	-0.0270**	-0.0042	-0.0320	-0.0302**	-0.0018
	(0.0274)	(0.0126)	(0.0276)	(0.0274)	(0.0127)	(0.0277)	(0.0275)	(0.0127)	(0.0277)
$sPOL_{(t-1)-(t-2)}$				0.0112	-0.0041	0.0153	0.0109	-0.0114	0.0223
				(0.0327)	(0.0161)	(0.0329)	(0.0326)	(0.0162)	(0.0328)
$sPOL_{(t-2)-(t-3)}$							-0.0291	-0.0395**	0.0103
							(0.0367)	(0.0195)	(0.0372)
$sRES_{t-(t-1)}$	0.0058	-0.0005	0.0063	0.0069	0.0038	0.0031	0.0056	0.0069	-0.0013
	(0.0301)	(0.0132)	(0.0299)	(0.0301)	(0.0133)	(0.0300)	(0.0303)	(0.0133)	(0.0302)

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Table 18 (continued)

$sRES_{(t-1)-(t-2)}$				2.00e-05	0.0122	-0.0121	-0.0043	0.0179	-0.0222
				(0.0273)	(0.0125)	(0.0277)	(0.0270)	(0.0124)	(0.0272)
$sRES_{(t-2)-(t-3)}$							-0.0239	0.0282*	-0.0520
							(0.0339)	(0.0165)	(0.0349)
$sOTH_{t-(t-1)}$	-0.0114	-0.0478*	0.0364	-0.0109	-0.0474*	0.0366	-0.0077	-0.0462*	0.0385
	(0.0409)	(0.0244)	(0.0433)	(0.0409)	(0.0245)	(0.0434)	(0.0409)	(0.0244)	(0.0434)
$sOTH_{(t-1)-(t-2)}$				0.127*	0.137***	-0.0100	0.130*	0.144***	-0.0134
				(0.0673)	(0.0352)	(0.0663)	(0.0679)	(0.0354)	(0.0669)
$sOTH_{(t-2)-(t-3)}$							0.0509	0.0411	0.0099
							(0.0686)	(0.0319)	(0.0653)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	25,713	25,713	25,713	25,713	25,713	25,713	25,713	25,713	25,713
R-squared	0.156	0.381	0.208	0.156	0.381	0.208	0.156	0.381	0.209

t statistics in parentheses.

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

significant results for pollution and other types of agreements.

3.5.3 A Subset of Developing Countries

While there has been much work on the effects of environmental regulations on trade competitiveness, very little work uses data from developing countries, of which many are notorious for their severe pollution problems along with rapid economic development in recent years. As I am interested in whether there would be a difference in the impact of IEA between the developing countries and the rest of world, I constructed a subset of developing countries from the whole sample. Table 19 presents a list of the 107 developing countries specified by the World Bank in 2013. Countries with a Gross National Income per capita of US$ 11,905 and less are defined as developing. The re-estimated results from the subset of developing countries are shown in Table 20. The estimated effects in the developing country sub-sample does not differ much from the main results: the resource type of IEA has a significant negative impact on both bilateral intensive and overall margins after 10 years. For the pollution type, one percent increase in the number of IEAs would increase the overall margins between the trading country pair by 3.32% ($e^{0.0327} - 1 \approx 0.0332$) after 10 years.

Table 19: List of Developing Countries (Source: the World Bank, 2013)

Afghanistan	Albania	Algeria	American Samoa
Angola	Argentina	Armenia	Bangladesh
Belize	Benin	Bhutan	Bolivia
Bosnia and Herzegovina	Burkina Faso	Burundi	Cambodia
Cameroon	Cape Verde	Central African Republic	Chad
Comoros	Congo, Dem. Rep.	Congo, Rep.	Côte d'Ivoire
Cuba	Djibouti	Dominican Republic	Ecuador
Egypt, Arab Republic	El Salvador	Eritrea	Ethiopia
Fiji	Gambia, The	Georgia	Ghana
Guatemala	Guinea	Guinea-Bissau	Guyana
Haiti	Honduras	India	Indonesia
Iran, Islamic Rep.	Jamaica	Jordan	Kenya
Kiribati	Korea, Dem. Rep. (North)	Kosovo	Kyrgyz Republic
Lao PDR	Lesotho	Liberia	Libya
Macedonia, FYR	Madagascar	Malawi	Maldives
Mali	Marshall Islands	Mauritania	Micronesia, Fed. Sts.
Moldova	Mongolia	Morocco	Mozambique
Myanmar	Namibia	Nepal	Nicaragua
Niger	Nigeria	Pakistan	Papua New Guinea
Paraguay	Philippines	Rwanda	Samoa
Sao Tome and Principe	Senegal	Serbia	Sierra Leone
Solomon Islands	Somalia	South Sudan	Sri Lanka
Sudan	Swaziland	Syrian Arab Republic	Tajikistan
Tanzania	Thailand	Timor-Leste	Togo
Tonga	Tunisia	Uganda	Ukraine
Uzbekistan	Vanuatu	Vietnam	West Bank and Gaza
Yemen, Rep.	Zambia	Zimbabwe	

Table 20: Sensitivity Analysis: FD Estimation by category (Developing Countries)

	Panel A: FD Estimation: IEA dummy by category until 2000								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-0.0247	0.0035	-0.0281	-0.0264	0.0012	-0.0276	-0.0297	-0.0028	-0.0269
	(0.0302)	(0.0143)	(0.0303)	(0.0300)	(0.0143)	(0.0298)	(0.0301)	(0.0144)	(0.0300)
$dPOL_{(t-1)-(t-2)}$				0.0028	-0.0060	0.0088	-0.0019	-0.0119	0.0010
				(0.0277)	(0.0152)	(0.0282)	(0.0278)	(0.0152)	(0.0280)
$dPOL_{(t-2)-(t-3)}$							-0.0258	-0.0230	-0.0029
							(0.0277)	(0.0159)	(0.0276)
$dRES_{t-(t-1)}$	-0.0318	0.0138	-0.0456	-0.0173	0.0206	-0.0379	-0.0284	0.0197	-0.0481
	(0.0498)	(0.0246)	(0.0522)	(0.0493)	(0.0245)	(0.0515)	(0.0497)	(0.0247)	(0.0519)
$dRES_{(t-1)-(t-2)}$				0.0824	0.0251	0.0573	0.0709	0.0267	0.0442
				(0.0528)	(0.0235)	(0.0511)	(0.0518)	(0.0238)	(0.0502)
$dRES_{(t-2)-(t-3)}$							-0.0986*	0.0208	-0.119**
							(0.0566)	(0.0259)	(0.0554)
$dOTH_{t-(t-1)}$	-0.0285	-0.0256	-0.0029	-0.0250	-0.0180	-0.0071	-0.0202	-0.0196	-0.0006
	(0.0319)	(0.0168)	(0.0318)	(0.0311)	(0.0170)	(0.0311)	(0.0315)	(0.0170)	(0.0314)

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Table 20 (continued)

$dOTH_{(t-1)-(t-2)}$				0.0292	0.0482***	-0.0190	0.0342	0.0433**	-0.0090
				(0.0338)	(0.0176)	(0.0328)	(0.0330)	(0.0177)	(0.0323)
$dOTH_{(t-2)-(t-3)}$							0.0166	-0.0288	0.0454
							(0.0374)	(0.0198)	(0.0362)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	30,604	30,604	30,604	30,604	30,604	30,604	30,604	30,604	30,604
R-squared	0.165	0.386	0.212	0.165	0.386	0.212	0.165	0.386	0.213

Panel B: FD Estimation: Using log(sum of IEA) by category until 2000

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0306	-0.0191*	-0.0115	-0.0237	-0.0172*	-0.0066	-0.0200	-0.0188*	-0.0012
	(0.0216)	(0.0104)	(0.0217)	(0.0214)	(0.0104)	(0.0215)	(0.0218)	(0.0105)	(0.0218)
$sPOL_{(t-1)-(t-2)}$				0.0270	0.0159	0.0111	0.0327*	0.0134	0.0193
				(0.0200)	(0.0113)	(0.0199)	(0.0198)	(0.0115)	(0.0198)
$sPOL_{(t-2)-(t-3)}$							0.0223	-0.0113	0.0336
							(0.0233)	(0.0139)	(0.0232)
$sRES_{t-(t-1)}$	0.0192	0.0152	0.0040	0.0102	0.0149	-0.0047	0.0062	0.0157	-0.0095
	(0.0261)	(0.0114)	(0.0261)	(0.0254)	(0.0114)	(0.0254)	(0.0257)	(0.0115)	(0.0257)

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Table 20 (continued)

$sRES_{(t-1)-(t-2)}$				-0.0414*	-0.0011	-0.0404*	-0.0490**	0.0006	-0.0496**
				(0.0224)	(0.0115)	(0.0220)	(0.0216)	(0.0112)	(0.0212)
$sRES_{(t-2)-(t-3)}$							-0.0369	0.0069	-0.0438*
							(0.0243)	(0.0122)	(0.0247)
$sOTH_{t-(t-1)}$	0.0140	-0.0075	0.0215	0.0225	0.0048	0.0177	0.0268	0.0051	0.0217
	(0.0315)	(0.0180)	(0.0318)	(0.0311)	(0.0182)	(0.0316)	(0.0315)	(0.0184)	(0.0320)
$sOTH_{(t-1)-(t-2)}$				0.0550*	0.0826***	-0.0276	0.0630**	0.0823***	-0.0193
				(0.0320)	(0.0187)	(0.0313)	(0.0316)	(0.0189)	(0.0310)
$sOTH_{(t-2)-(t-3)}$							0.0456	-0.0052	0.0508
							(0.0369)	(0.0211)	(0.0361)
$Country - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	30,604	30,604	30,604	30,604	30,604	30,604	30,604	30,604	30,604
R-squared	0.165	0.386	0.212	0.165	0.387	0.212	0.165	0.387	0.213

t statistics in parentheses.

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

3.5.4 Excluding-China Analysis

Previous studies such as Feenstra et al. (1998) and Feenstra et al. (1999) show that one main factor leading to the U.S. trade deficiency in the last two decades of the 20th century is the accelerated relocation of US imports from East Asian countries to China. Also, Maasoumi, Racine, and Stengos (2007) use non-parametric approach to find some divergence and convergence in the big difference China makes to the world and international movements in GDP, trade growth, and poverty movements. To further guard against the possibility that country selection might be affecting my conclusions of the negative IEA impact on trade margins, I re-estimate the previous regression with China excluded in the country list. Estimation results are presented in Table 21. The estimated IEA categorical impact is consistent with the previous predictions. For both the pollution-type and resource-type agreements, a negative IEA impact appears in a 10-15 year time frame. Comparing to the previous results in Table 15, the estimation coefficients here is quite close although marginally smaller on the extensive and overall margin. Therefore I confirm the findings in the baseline estimation.

Table 21: Sensitivity Analysis: FD Estimation by category (Excluding China)

	Panel A: FD Estimation: IEA dummy by category until 2000								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-0.0424	0.0090	-0.0514*	-0.0452*	0.0055	-0.0507*	-0.0473*	0.0003	-0.0476*
	(0.0269)	(0.0138)	(0.0273)	(0.0264)	(0.0140)	(0.0269)	(0.0266)	(0.0141)	(0.0271)
$dPOL_{(t-1)-(t-2)}$				-0.0098	-0.0125	0.0027	-0.0124	-0.0198	0.0075
				(0.0249)	(0.0140)	(0.0251)	(0.0249)	(0.0141)	(0.0250)
$dPOL_{(t-2)-(t-3)}$							-0.0175	-0.0318**	0.0143
							(0.0253)	(0.0151)	(0.0257)
$dRES_{t-(t-1)}$	-0.0283	0.0377	-0.0660	-0.0226	0.0443*	-0.0669	-0.0351	0.0425*	-0.0776
	(0.0469)	(0.0241)	(0.0488)	(0.0462)	(0.0242)	(0.0481)	(0.0466)	(0.0245)	(0.0487)
$dRES_{(t-1)-(t-2)}$				0.0292	0.0275	0.0017	0.0139	0.0284	-0.0145
				(0.0467)	(0.0220)	(0.0467)	(0.0461)	(0.0222)	(0.0462)
$dRES_{(t-2)-(t-3)}$							-0.106**	0.0241	-0.130**
							(0.0511)	(0.0252)	(0.0519)
$dOTH_{t-(t-1)}$	-0.0431	-0.0134	-0.0297	-0.0419	-0.0090	-0.0329	-0.0398	-0.0115	-0.0282
	(0.0285)	(0.0169)	(0.0289)	(0.0280)	(0.0168)	(0.0282)	(0.0282)	(0.0169)	(0.0284)

Continued on next page

Table 21 (continued)

$dOTH_{(t-1)-(t-2)}$				0.0079	0.0282	-0.0202	0.0075	0.0216	-0.0140
				(0.0290)	(0.0175)	(0.0290)	(0.0286)	(0.0175)	(0.0286)
$dOTH_{(t-2)-(t-3)}$							-0.0093	-0.0430**	0.0338
							(0.0356)	(0.0199)	(0.0346)
$Country - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,283	42,283	42,283	42,283	42,283	42,283	42,283	42,283	42,283
R-squared	0.169	0.338	0.206	0.169	0.338	0.206	0.169	0.338	0.206

Panel B: FD Estimation: Using log(sum of IEA) by category until 2000

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0347*	-0.0119	-0.0228	-0.0314*	-0.0138	-0.0176	-0.0281	-0.0157	-0.0124
	(0.0190)	(0.0097)	(0.0192)	(0.0188)	(0.0098)	(0.0191)	(0.0191)	(0.0099)	(0.0194)
$sPOL_{(t-1)-(t-2)}$				0.0125	-0.0030	0.0155	0.0182	-0.0059	0.0241
				(0.0177)	(0.0105)	(0.0179)	(0.0175)	(0.0106)	(0.0178)
$sPOL_{(t-2)-(t-3)}$							0.0212	-0.0178	0.0389*
							(0.0209)	(0.0131)	(0.0211)
$sRES_{t-(t-1)}$	0.0286	0.0048	0.0238	0.0225	0.0077	0.0148	0.0180	0.0077	0.0103
	(0.0232)	(0.0110)	(0.0234)	(0.0228)	(0.0110)	(0.0229)	(0.0229)	(0.0111)	(0.0231)

Continued on next page

Table 21 (continued)

$sRES_{(t-1)-(t-2)}$				-0.0279	0.0115	-0.0393*	-0.0371*	0.0119	-0.0490**
				(0.0205)	(0.0105)	(0.0203)	(0.0197)	(0.0105)	(0.0196)
$sRES_{(t-2)-(t-3)}$							-0.0420*	0.0012	-0.0432*
							(0.0223)	(0.0114)	(0.0227)
$sOTH_{t-(t-1)}$	0.0091	-0.0115	0.0206	0.0156	-0.0019	0.0175	0.0205	-0.0021	0.0226
	(0.0285)	(0.0177)	(0.0292)	(0.0283)	(0.0177)	(0.0288)	(0.0285)	(0.0179)	(0.0290)
$sOTH_{(t-1)-(t-2)}$				0.0377	0.0609***	-0.0232	0.0455	0.0572***	-0.0118
				(0.0282)	(0.0181)	(0.0282)	(0.0280)	(0.0182)	(0.0280)
$sOTH_{(t-2)-(t-3)}$							0.0404	-0.0242	0.0647*
							(0.0357)	(0.0213)	(0.0348)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	42,283	42,283	42,283	42,283	42,283	42,283	42,283	42,283	42,283
R-squared	0.169	0.338	0.206	0.169	0.338	0.206	0.169	0.338	0.206

t statistics in parentheses.

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

3.5.5 3-year FD analysis

The 3-year FD results are reported in Tables 22, 23, and 24. The negative IEA impact is not statistically significant in Table 22, when categorical difference is not taken into account. However, in Table 23 I can see that when IEAs are separated into three different types, the pollution-type agreements show a small and negative impact on the bilateral intensive margins, and a positive impact on the extensive margins with or without lagged terms being added. When trade agreements are being added in Table 24, I find the deterring impact of IEAs becomes even smaller. Such results confirm the findings from the 5-year FD analysis: environmental agreements have little or no impact on the extensive margins. The negotiation of trade and environmental agreements will actually be beneficial for trading countries' growth in trade varieties.

3.5.6 3-year FE analysis

For further investigation I also use a set of 3-year FE estimations as an alternative approach. Tables 25, 26, and 27 report the robustness check results. I find that in Table 25 when all type of IEAs are treated as one group, the negative IEA impact is statistically significant on the bilateral intensive and overall margins. Using IEA dummies and numbers of IEAs, both results are comparable and consistent. Furthermore, when I separate IEAs into sub-groups in 26 and 27, both the pollution and resource type agreements show a significant negative impact on the intensive margins as well. Hence I conclude that the supplementary results using a 3-year approach are consistent with the 5-year baseline findings in section 3.4.1 and 3.4.2.

Table 22: 3-yr FD Estimation: All IEAs regardless of category differences

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
Panel A: Using IEA dummy variables in all categories									
$dIEA_{t-(t-1)}$	-0.0357	0.0099	-0.0455	-0.0350	0.0116	-0.0465	-0.0346	0.0103	-0.0449
	(0.0302)	(0.0155)	(0.0312)	(0.0298)	(0.0155)	(0.0308)	(0.0298)	(0.0156)	(0.0309)
$dIEA_{(t-1)-(t-2)}$				0.0062	0.0150	-0.0088	0.0067	0.0133	-0.0067
				(0.0312)	(0.0149)	(0.0311)	(0.0306)	(0.0149)	(0.0304)
$dIEA_{(t-2)-(t-3)}$							0.0034	-0.0137	0.0170
							(0.0327)	(0.0158)	(0.0324)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137
Panel B: Using log(sum(IEA)) in all categories									
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sIEA_{t-(t-1)}$	0.0058	-0.0032	0.009	0.0074	-0.002	0.0094	0.0051	-0.0025	0.0076
	(0.0166)	(0.0078)	(0.0170)	(0.0163)	(0.0077)	(0.0168)	(0.0164)	(0.0078)	(0.0168)
$sIEA_{(t-1)-(t-2)}$				0.0169	0.0126	0.0042	0.0148	0.0122	0.0025
				(0.0162)	(0.0081)	(0.0161)	(0.0158)	(0.008)	(0.0156)
$sIEA_{(t-2)-(t-3)}$							-0.0189	-0.0037	-0.0153
							(0.0162)	(0.0091)	(0.0167)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137

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

Table 23: 3-year FD Estimation: IEA impacts by category (1962-1998)

	Panel A: Using IEA dummies in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-0.0200	0.0192*	-0.0392*	-0.0157	0.0191*	-0.0348	-0.0176	0.0183*	-0.0359
	(0.0228)	(0.0107)	(0.0230)	(0.0224)	(0.0106)	(0.0226)	(0.0226)	(0.0107)	(0.0227)
$dPOL_{(t-1)-(t-2)}$				0.0299	0.0017	0.0282	0.0277	0.001	0.0267
				(0.0213)	(0.0103)	(0.0214)	(0.0208)	(0.0103)	(0.0209)
$dPOL_{(t-2)-(t-3)}$							-0.0158	-0.0063	-0.0096
							(0.0216)	(0.0108)	(0.0216)
$dRES_{t-(t-1)}$	-0.0303	0.0164	-0.0467	-0.030	0.0191	-0.0490	-0.0310	0.0180	-0.0491
	(0.0328)	(0.0173)	(0.0343)	(0.0324)	(0.0173)	(0.0339)	(0.0324)	(0.0174)	(0.0339)
$dRES_{(t-1)-(t-2)}$				-0.0026	0.0198	-0.0224	-0.003	0.0182	-0.0212
				(0.0335)	(0.0160)	(0.0335)	(0.0330)	(0.0160)	(0.0327)
$dRES_{(t-2)-(t-3)}$							0.0048	-0.0190	0.0238
							(0.0355)	(0.0170)	(0.0350)
$dOTH_{t-(t-1)}$	-0.0232	-0.0289*	0.0057	-0.0193	-0.0286*	0.0093	-0.0211	-0.0273*	0.0062
	(0.0263)	(0.0148)	(0.0269)	(0.0260)	(0.0148)	(0.0266)	(0.0261)	(0.0148)	(0.0267)

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Table 23 (continued)

$dOTH_{(t-1)-(t-2)}$				0.0594**	0.0047	0.0546**	0.0564**	0.0068	0.0496**
				(0.0242)	(0.0125)	(0.0246)	(0.0238)	(0.0125)	(0.0241)
$dOTH_{(t-2)-(t-3)}$							-0.0226	0.0136	-0.0362
							(0.0251)	(0.0117)	(0.0250)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0056	-0.0120	0.0063	-0.0062	-0.0137*	0.0075	-0.0043	-0.0120	0.0078
	(0.0155)	(0.0079)	(0.0158)	(0.0153)	(0.0079)	(0.0156)	(0.0154)	(0.0079)	(0.0157)
$sPOL_{(t-1)-(t-2)}$				-0.002	-0.0108	0.0088	0.0005	-0.0086	0.0091
				(0.0149)	(0.0078)	(0.0151)	(0.0147)	(0.0078)	(0.0149)
$sPOL_{(t-2)-(t-3)}$							0.0114	0.0127	-0.0014
							(0.0160)	(0.0089)	(0.0161)
$sRES_{t-(t-1)}$	0.0025	0.0008	0.0017	0.004	0.003	0.0006	0.0004	0.0013	-0.0008
	(0.0179)	(0.008)	(0.0183)	(0.0177)	(0.008)	(0.0180)	(0.0177)	(0.008)	(0.0181)

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Table 23 (continued)

$sRES_{(t-1)-(t-2)}$				0.0084	0.0166*	-0.0083	0.0053	0.0149*	-0.0097
				(0.0178)	(0.0087)	(0.0174)	(0.0173)	(0.0086)	(0.0170)
$sRES_{(t-2)-(t-3)}$							-0.0231	-0.0123	-0.0109
							(0.0174)	(0.0094)	(0.0177)
$sOTH_{t-(t-1)}$	0.0238	-0.0138	0.0375	0.0278	-0.0141	0.0419*	0.0277	-0.0133	0.0410*
	(0.0244)	(0.0141)	(0.0248)	(0.0240)	(0.0141)	(0.0245)	(0.0242)	(0.0142)	(0.0246)
$sOTH_{(t-1)-(t-2)}$				0.0421*	-0.0018	0.0439*	0.0412*	-0.0006	0.0418*
				(0.0237)	(0.0128)	(0.0241)	(0.0233)	(0.0128)	(0.0237)
$sOTH_{(t-2)-(t-3)}$							-0.0035	0.0103	-0.0138
							(0.0257)	(0.0129)	(0.0253)
$Country - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137

t statistics in parentheses.

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

Table 24: 3-yr FD Estimation: IEAs by category with trade effects being controlled

Panel A: Using dummy variables of IEAs in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0414	2.48e-05	-0.0414	-0.0349	-6.17e-05	-0.0349	-0.0335	0.0009	-0.0343
	(0.0343)	(0.0163)	(0.0349)	(0.0336)	(0.0160)	(0.0341)	(0.0337)	(0.0161)	(0.0342)
$dNRP_{(t-1)-(t-2)}$				0.0631*	0.0023	0.0608*	0.0646*	0.0044	0.0602*
				(0.0347)	(0.0171)	(0.0351)	(0.0340)	(0.0168)	(0.0342)
$dNRP_{(t-2)-(t-3)}$							0.0228	0.0220	0.0008
							(0.0354)	(0.0182)	(0.0371)
$dPTA_{t-(t-1)}$	0.0065	-0.0489*	0.0554	0.007	-0.0504**	0.0574	0.0091	-0.0505**	0.0596
	(0.0576)	(0.0256)	(0.0566)	(0.0574)	(0.0255)	(0.0563)	(0.0574)	(0.0255)	(0.0563)
$dPTA_{(t-1)-(t-2)}$				0.0302	-0.0530*	0.0831	0.0321	-0.0533*	0.0854
				(0.0586)	(0.0273)	(0.0582)	(0.0584)	(0.0273)	(0.0580)
$dPTA_{(t-2)-(t-3)}$							0.110	0.0066	0.103
							(0.0687)	(0.0257)	(0.0694)
$dFTA_{t-(t-1)}$	0.157***	-0.0195	0.176***	0.165***	-0.0183	0.183***	0.166***	-0.0179	0.184***
	(0.0328)	(0.0171)	(0.0339)	(0.0328)	(0.0171)	(0.0339)	(0.0329)	(0.0171)	(0.0339)

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Table 24 (continued)

$dFTA_{(t-1)-(t-2)}$				0.196***	0.0039	0.193***	0.196***	0.0041	0.192***
				(0.0336)	(0.0179)	(0.0350)	(0.0336)	(0.0180)	(0.0349)
$dFTA_{(t-2)-(t-3)}$							0.0581	0.0357*	0.0224
							(0.0438)	(0.0200)	(0.0438)
$dCOM_{t-(t-1)}$	0.151***	-0.0642***	0.215***	0.158***	-0.0633***	0.222***	0.158***	-0.0626***	0.221***
	(0.0393)	(0.0227)	(0.0402)	(0.0393)	(0.0227)	(0.0401)	(0.0394)	(0.0227)	(0.0402)
$dCOM_{(t-1)-(t-2)}$				0.229***	0.0434**	0.185***	0.230***	0.0430**	0.187***
				(0.0405)	(0.0205)	(0.0406)	(0.0403)	(0.0205)	(0.0404)
$dCOM_{(t-2)-(t-3)}$							0.0889*	0.0218	0.0670
							(0.0508)	(0.0255)	(0.0505)
$dPOL_{t-(t-1)}$	-0.0189	0.0189*	-0.0378	-0.0135	0.0190*	-0.0325	-0.0158	0.0181*	-0.0339
	(0.0228)	(0.0107)	(0.0230)	(0.0225)	(0.0106)	(0.0226)	(0.0226)	(0.0107)	(0.0227)
$dPOL_{(t-1)-(t-2)}$				0.0310	0.0015	0.0295	0.0289	0.0007	0.0283
				(0.0212)	(0.0103)	(0.0214)	(0.0208)	(0.0103)	(0.0209)
$dPOL_{(t-2)-(t-3)}$							-0.0136	-0.0062	-0.0074
							(0.0216)	(0.0108)	(0.0217)
$dRES_{t-(t-1)}$	-0.0301	0.0164	-0.0465	-0.0304	0.0189	-0.0492	-0.0312	0.0179	-0.0491

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Table 24 (continued)

	(0.0328)	(0.0173)	(0.0343)	(0.0324)	(0.0173)	(0.0339)	(0.0324)	(0.0174)	(0.0340)
$dRES_{(t-1)-(t-2)}$				-0.0032	0.0196	-0.0228	-0.003	0.0181	-0.0211
				(0.0335)	(0.0160)	(0.0335)	(0.0330)	(0.0160)	(0.0327)
$dRES_{(t-2)-(t-3)}$							0.0058	-0.0194	0.0252
							(0.0355)	(0.0170)	(0.0350)
$dOTH_{t-(t-1)}$	-0.0238	-0.0294**	0.0056	-0.0197	-0.0285*	0.0089	-0.0211	-0.0271*	0.0061
	(0.0263)	(0.0148)	(0.0269)	(0.0260)	(0.0148)	(0.0266)	(0.0261)	(0.0148)	(0.0267)
$dOTH_{(t-1)-(t-2)}$				0.0575**	0.005	0.0525**	0.0545**	0.007	0.0475**
				(0.0242)	(0.0125)	(0.0246)	(0.0238)	(0.0125)	(0.0242)
$dOTH_{(t-2)-(t-3)}$							-0.0209	0.0139	-0.0348
							(0.0251)	(0.0117)	(0.0250)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137

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Table 24 (continued)

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0421	0.0001	-0.0422	-0.0367	-0.0009	-0.0359	-0.0347	0.0006	-0.0354
	(0.0343)	(0.0163)	(0.0349)	(0.0336)	(0.0161)	(0.0341)	(0.0338)	(0.0161)	(0.0342)
$dNRP_{(t-1)-(t-2)}$				0.0651*	0.0014	0.0637*	0.0683**	0.0045	0.0638*
				(0.0347)	(0.0171)	(0.0351)	(0.0340)	(0.0167)	(0.0343)
$dNRP_{(t-2)-(t-3)}$							0.0247	0.0224	0.0023
							(0.0354)	(0.0183)	(0.0372)
$dPTA_{t-(t-1)}$	0.007	-0.0481*	0.0551	0.0074	-0.0498*	0.0572	0.0089	-0.0506**	0.0594
	(0.0576)	(0.0256)	(0.0565)	(0.0574)	(0.0255)	(0.0562)	(0.0574)	(0.0255)	(0.0562)
$dPTA_{(t-1)-(t-2)}$				0.0277	-0.0527*	0.0804	0.0314	-0.0517*	0.0831
				(0.0587)	(0.0273)	(0.0583)	(0.0585)	(0.0272)	(0.0581)
$dPTA_{(t-2)-(t-3)}$							0.112	0.0096	0.103
							(0.0688)	(0.0256)	(0.0695)
$dFTA_{t-(t-1)}$	0.156***	-0.0192	0.175***	0.164***	-0.0175	0.182***	0.166***	-0.0177	0.183***
	(0.0328)	(0.0171)	(0.0338)	(0.0328)	(0.0171)	(0.0338)	(0.0329)	(0.0171)	(0.0338)
$dFTA_{(t-1)-(t-2)}$				0.194***	0.0053	0.188***	0.193***	0.005	0.188***

Continued on next page

Table 24 (continued)

				(0.0337)	(0.0181)	(0.0352)	(0.0337)	(0.0181)	(0.0351)
$dFTA_{(t-2)-(t-3)}$							0.0538	0.0378*	0.0160
							(0.0437)	(0.0201)	(0.0438)
$dCOM_{t-(t-1)}$	0.153***	-0.0622***	0.215***	0.157***	-0.0602***	0.218***	0.158***	-0.0614***	0.220***
	(0.0393)	(0.0227)	(0.0402)	(0.0392)	(0.0227)	(0.0400)	(0.0392)	(0.0227)	(0.0401)
$dCOM_{(t-1)-(t-2)}$				0.225***	0.0447**	0.181***	0.226***	0.0428**	0.184***
				(0.0405)	(0.0206)	(0.0406)	(0.0403)	(0.0205)	(0.0404)
$dCOM_{(t-2)-(t-3)}$							0.0814	0.0247	0.0567
							(0.0510)	(0.0258)	(0.0507)
$sPOL_{t-(t-1)}$	-0.0068	-0.0116	0.0048	-0.0075	-0.0132*	0.0056	-0.0071	-0.0115	0.0044
	(0.0155)	(0.0079)	(0.0158)	(0.0153)	(0.0079)	(0.0156)	(0.0155)	(0.0079)	(0.0157)
$sPOL_{(t-1)-(t-2)}$				-0.0036	-0.0108	0.0072	-0.0021	-0.0085	0.0064
				(0.0149)	(0.0078)	(0.0152)	(0.0147)	(0.0078)	(0.0149)
$sPOL_{(t-2)-(t-3)}$							0.0084	0.0132	-0.0049
							(0.0161)	(0.0089)	(0.0162)
$sRES_{t-(t-1)}$	0.0027	0.0008	0.0019	0.0043	0.0031	0.0012	0.0019	0.0016	0.0003
	(0.0179)	(0.008)	(0.0183)	(0.0177)	(0.008)	(0.0180)	(0.0177)	(0.008)	(0.0181)

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Table 24 (continued)

$sRES_{(t-1)-(t-2)}$				0.009	0.0164*	-0.0075	0.0063	0.0149*	-0.0086
				(0.0178)	(0.0087)	(0.0174)	(0.0173)	(0.0086)	(0.0170)
$sRES_{(t-2)-(t-3)}$							-0.0219	-0.0119	-0.0100
							(0.0174)	(0.0094)	(0.0177)
$sOTH_{t-(t-1)}$	0.0211	-0.0136	0.0348	0.0185	-0.0141	0.0327	0.0185	-0.0131	0.0316
	(0.0244)	(0.0141)	(0.0249)	(0.0241)	(0.0142)	(0.0246)	(0.0243)	(0.0142)	(0.0247)
$sOTH_{(t-1)-(t-2)}$				0.0395*	-0.0011	0.0406*	0.0372	-9.16e-06	0.0372
				(0.0237)	(0.0128)	(0.0242)	(0.0234)	(0.0129)	(0.0238)
$sOTH_{(t-2)-(t-3)}$							-0.0057	0.0112	-0.0169
							(0.0257)	(0.0129)	(0.0254)
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381	89,381
R-squared	0.132	0.253	0.137	0.132	0.253	0.137	0.132	0.253	0.137

t statistics in parentheses.

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

Table 25: 3-yr FE Estimation: All IEAs regardless of category differences

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
	Panel A: Using IEA dummy variables in all categories								
$IEA_{t-(t-1)}$	-0.0662*	0.0280	-0.0942***	-0.0420	0.0025	-0.0444	-0.0462	0.0045	-0.0507
	(0.0346)	(0.0209)	(0.0336)	(0.0350)	(0.0203)	(0.0331)	(0.0348)	(0.0202)	(0.0331)
$IEA_{(t-1)-(t-2)}$				-0.0427	0.0451**	-0.0878***	-0.0138	0.0311*	-0.0449
				(0.0341)	(0.0184)	(0.0321)	(0.0334)	(0.0165)	(0.0319)
$IEA_{(t-2)-(t-3)}$							-0.0483	0.0233	-0.0716**
							(0.0323)	(0.0175)	(0.0302)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785
	Panel B: Using log(sum(IEA)) in all categories								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sIEA_{t-(t-1)}$	-0.0308**	0.009	-0.0398***	-0.0242	-0.007	-0.0172	-0.0258	-0.0059	-0.0199
	(0.0157)	(0.0094)	(0.0153)	(0.0162)	(0.009)	(0.0157)	(0.0162)	(0.009)	(0.0158)
$sIEA_{(t-1)-(t-2)}$				-0.0114	0.0280***	-0.0394**	0.0013	0.0188**	-0.0175
				(0.0163)	(0.0096)	(0.0159)	(0.0168)	(0.0093)	(0.0164)
$sIEA_{(t-2)-(t-3)}$							-0.0209	0.0151	-0.0360**
							(0.0165)	(0.0098)	(0.0161)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785

t statistics in parentheses.

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

Table 26: 3-year FE Estimation: IEA impacts by category (1962-1998))

	Panel A: Using IEA dummies in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$POL_{t-(t-1)}$	-0.0378	0.0137	-0.0515**	-0.0378	0.0142	-0.0520**	-0.0395*	0.0125	-0.0520**
	(0.0232)	(0.0129)	(0.0222)	(0.0233)	(0.0126)	(0.0225)	(0.0232)	(0.0125)	(0.0225)
$POL_{(t-1)-(t-2)}$				0.0006	-0.0033	0.0038	0.0131	0.0042	0.009
				(0.0224)	(0.0117)	(0.0216)	(0.0213)	(0.0108)	(0.0211)
$POL_{(t-2)-(t-3)}$							-0.0226	-0.0144	-0.0082
							(0.0221)	(0.0125)	(0.0211)
$RES_{t-(t-1)}$	-0.0375	0.0533**	-0.0907**	-0.0244	0.0215	-0.0459	-0.0288	0.0218	-0.0506
	(0.0374)	(0.0228)	(0.0364)	(0.0382)	(0.0225)	(0.0363)	(0.0380)	(0.0224)	(0.0364)
$RES_{(t-1)-(t-2)}$				-0.0201	0.0551***	-0.0752**	-0.0005	0.0428**	-0.0434
				(0.0372)	(0.0192)	(0.0346)	(0.0362)	(0.0176)	(0.0344)
$RES_{(t-2)-(t-3)}$							-0.0347	0.0211	-0.0558*
							(0.0348)	(0.0187)	(0.0325)
$OTH_{t-(t-1)}$	-0.0255	-0.0017	-0.0238	-0.0481*	-0.0079	-0.0402	-0.0473*	-0.0082	-0.0390
	(0.0270)	(0.0166)	(0.0261)	(0.0278)	(0.0167)	(0.0275)	(0.0278)	(0.0167)	(0.0274)

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Table 26 (continued)

$OTH_{(t-1)-(t-2)}$				0.0383	0.0082	0.0301	0.0480*	0.0071	0.0409
				(0.0265)	(0.0151)	(0.0263)	(0.0254)	(0.0137)	(0.0252)
$OTH_{(t-2)-(t-3)}$							-0.0179	0.0028	-0.0208
							(0.0251)	(0.0144)	(0.0246)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$sPOL_{t-(t-1)}$	-0.0174	-0.0222**	0.0048	-0.0254	-0.0243**	-0.0011	-0.0229	-0.0239**	0.001
	(0.0167)	(0.0097)	(0.0161)	(0.0164)	(0.0095)	(0.0160)	(0.0164)	(0.0094)	(0.0160)
$sPOL_{(t-1)-(t-2)}$				0.0140	0.002	0.0120	-0.0098	-0.0087	-0.0011
				(0.0168)	(0.0095)	(0.0162)	(0.0152)	(0.0086)	(0.0152)
$sPOL_{(t-2)-(t-3)}$							0.0439**	0.0185*	0.0255
							(0.0174)	(0.0106)	(0.0166)
$sRES_{t-(t-1)}$	-0.0311*	0.0127	-0.0438***	-0.0205	0.0041	-0.0246	-0.0214	0.0049	-0.0263

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Table 26 (continued)

	(0.0169)	(0.0103)	(0.0164)	(0.0172)	(0.0096)	(0.0167)	(0.0172)	(0.0096)	(0.0167)
$sRES_{(t-1)-(t-2)}$				-0.0182	0.0160	-0.0342**	0.0074	0.0194**	-0.0120
				(0.0175)	(0.0101)	(0.0170)	(0.0180)	(0.0098)	(0.0175)
$sRES_{(t-2)-(t-3)}$							-0.0435**	-0.005	-0.0385**
							(0.0176)	(0.0103)	(0.0171)
$sOTH_{t-(t-1)}$	0.0677**	0.0240	0.0437*	0.0299	0.0099	0.0200	0.0298	0.009	0.0209
	(0.0279)	(0.0167)	(0.0264)	(0.0272)	(0.0163)	(0.0262)	(0.0273)	(0.0164)	(0.0263)
$sOTH_{(t-1)-(t-2)}$				0.0637**	0.0211	0.0427	0.0228	-0.0067	0.0295
				(0.0271)	(0.0156)	(0.0262)	(0.0254)	(0.0144)	(0.0252)
$sOTH_{(t-2)-(t-3)}$							0.0717***	0.0500***	0.0216
							(0.0269)	(0.0158)	(0.0256)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785

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

Table 27: 3-yr FE Estimation: IEAs by category with trade effects being controlled

	Panel A: Using dummy variables of IEAs in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$NRP_{t-(t-1)}$	-0.120***	-0.0329*	-0.0866**	-0.0755**	0.0044	-0.0799**	-0.0850**	-0.0012	-0.0838**
	(0.0360)	(0.0190)	(0.0340)	(0.0358)	(0.0182)	(0.0347)	(0.0357)	(0.0180)	(0.0345)
$NRP_{(t-1)-(t-2)}$				-0.0635*	-0.0566***	-0.0069	0.0460	-0.0068	0.0528
				(0.0366)	(0.0190)	(0.0352)	(0.0354)	(0.0176)	(0.0351)
$NRP_{(t-2)-(t-3)}$							-0.164***	-0.0742***	-0.0897**
							(0.0382)	(0.0205)	(0.0378)
$PTA_{t-(t-1)}$	-0.007	-0.0940***	0.0869*	-0.0063	-0.0702**	0.0639	-0.0077	-0.0693**	0.0616
	(0.0562)	(0.0321)	(0.0514)	(0.0656)	(0.0336)	(0.0609)	(0.0652)	(0.0332)	(0.0606)
$PTA_{(t-1)-(t-2)}$				-0.0078	-0.0415	0.0337	-0.0106	-0.0566*	0.0460
				(0.0610)	(0.0312)	(0.0556)	(0.0602)	(0.0300)	(0.0583)
$PTA_{(t-2)-(t-3)}$							0.0018	0.0233	-0.0215
							(0.0706)	(0.0362)	(0.0633)
$FTA_{t-(t-1)}$	0.313***	0.0934***	0.220***	0.209***	0.0528**	0.156***	0.199***	0.0561**	0.143***
	(0.0425)	(0.0226)	(0.0400)	(0.0418)	(0.0230)	(0.0391)	(0.0413)	(0.0226)	(0.0389)

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Table 27 (continued)

$FTA_{(t-1)-(t-2)}$				0.192***	0.0759***	0.116***	0.216***	0.0276	0.189***
				(0.0417)	(0.0212)	(0.0397)	(0.0371)	(0.0206)	(0.0372)
$FTA_{(t-2)-(t-3)}$							-0.0449	0.0843***	-0.129***
							(0.0489)	(0.0258)	(0.0464)
$COM_{t-(t-1)}$	0.522***	0.189***	0.333***	0.290***	0.0772**	0.212***	0.278***	0.0647**	0.214***
	(0.0529)	(0.0304)	(0.0473)	(0.0520)	(0.0317)	(0.0463)	(0.0518)	(0.0313)	(0.0461)
$COM_{(t-1)-(t-2)}$				0.350***	0.168***	0.181***	0.325***	0.144***	0.181***
				(0.0503)	(0.0265)	(0.0484)	(0.0457)	(0.0265)	(0.0442)
$COM_{(t-2)-(t-3)}$							0.0574	0.0145	0.0430
							(0.0610)	(0.0324)	(0.0568)
$POL_{t-(t-1)}$	-0.0192	0.0195	-0.0387*	-0.0186	0.0210*	-0.0396*	-0.0173	0.0213*	-0.0386*
	(0.0232)	(0.0129)	(0.0222)	(0.0234)	(0.0126)	(0.0226)	(0.0233)	(0.0125)	(0.0225)
$POL_{(t-1)-(t-2)}$				0.0099	0.001	0.0089	0.0183	0.0067	0.0116
				(0.0223)	(0.0117)	(0.0216)	(0.0212)	(0.0108)	(0.0211)
$POL_{(t-2)-(t-3)}$							-0.0107	-0.0086	-0.0021
							(0.0221)	(0.0125)	(0.0211)
$RES_{t-(t-1)}$	-0.0374	0.0530**	-0.0903**	-0.0276	0.0195	-0.0471	-0.0324	0.0200	-0.0524

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Table 27 (continued)

	(0.0375)	(0.0228)	(0.0365)	(0.0382)	(0.0225)	(0.0364)	(0.0381)	(0.0225)	(0.0364)
$RES_{(t-1)-(t-2)}$				-0.0151	0.0569***	-0.0720**	-0.0012	0.0428**	-0.0440
				(0.0372)	(0.0192)	(0.0347)	(0.0362)	(0.0176)	(0.0344)
$RES_{(t-2)-(t-3)}$							-0.0275	0.0231	-0.0506
							(0.0349)	(0.0187)	(0.0325)
$OTH_{t-(t-1)}$	-0.0047	0.0058	-0.0105	-0.0253	0.001	-0.0262	-0.0226	0.0019	-0.0245
	(0.0270)	(0.0166)	(0.0262)	(0.0278)	(0.0167)	(0.0275)	(0.0278)	(0.0167)	(0.0274)
$OTH_{(t-1)-(t-2)}$				0.0403	0.0091	0.0312	0.0495*	0.008	0.0415
				(0.0265)	(0.0151)	(0.0263)	(0.0253)	(0.0137)	(0.0252)
$OTH_{(t-2)-(t-3)}$							-0.0168	0.0027	-0.0194
							(0.0251)	(0.0144)	(0.0246)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785

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Table 27 (continued)

Panel B: Using log(sum of IEA) in each category

	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$NRP_{t-(t-1)}$	-0.119***	-0.0323*	-0.0865**	-0.0767**	0.0038	-0.0805**	-0.0865**	-0.0014	-0.0850**
	(0.0361)	(0.0192)	(0.0341)	(0.0359)	(0.0183)	(0.0348)	(0.0358)	(0.0181)	(0.0346)
$NRP_{(t-1)-(t-2)}$				-0.0603*	-0.0559***	-0.0044	0.0492	-0.0056	0.0547
				(0.0366)	(0.0190)	(0.0352)	(0.0354)	(0.0176)	(0.0351)
$NRP_{(t-2)-(t-3)}$							-0.159***	-0.0732***	-0.0854**
							(0.0384)	(0.0206)	(0.0380)
$PTA_{t-(t-1)}$	-0.0009	-0.0914***	0.0904*	-0.0026	-0.0696**	0.0669	-0.0048	-0.0691**	0.0643
	(0.0563)	(0.0322)	(0.0515)	(0.0657)	(0.0336)	(0.0609)	(0.0654)	(0.0331)	(0.0606)
$PTA_{(t-1)-(t-2)}$				-0.0029	-0.0394	0.0364	-0.009	-0.0571*	0.0481
				(0.0610)	(0.0311)	(0.0556)	(0.0603)	(0.0301)	(0.0584)
$PTA_{(t-2)-(t-3)}$							0.0071	0.0250	-0.0179
							(0.0710)	(0.0363)	(0.0636)
$FTA_{t-(t-1)}$	0.316***	0.0945***	0.221***	0.210***	0.0552**	0.155***	0.200***	0.0572**	0.143***
	(0.0425)	(0.0226)	(0.0400)	(0.0418)	(0.0230)	(0.0391)	(0.0413)	(0.0227)	(0.0388)
$FTA_{(t-1)-(t-2)}$				0.193***	0.0745***	0.118***	0.217***	0.0283	0.189***

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Table 27 (continued)

				(0.0420)	(0.0213)	(0.0400)	(0.0372)	(0.0207)	(0.0374)
$FTA_{(t-2)-(t-3)}$							-0.0477	0.0796***	-0.127***
							(0.0487)	(0.0259)	(0.0462)
$COM_{t-(t-1)}$	0.524***	0.189***	0.334***	0.287***	0.0796**	0.207***	0.270***	0.0622**	0.208***
	(0.0524)	(0.0303)	(0.0472)	(0.0516)	(0.0316)	(0.0460)	(0.0513)	(0.0312)	(0.0458)
$COM_{(t-1)-(t-2)}$				0.348***	0.166***	0.183***	0.323***	0.142***	0.181***
				(0.0507)	(0.0267)	(0.0488)	(0.0459)	(0.0266)	(0.0442)
$COM_{(t-2)-(t-3)}$							0.0474	0.0066	0.0408
							(0.0612)	(0.0330)	(0.0571)
$POL_{t-(t-1)}$	-0.0303*	-0.0252***	-0.0051	-0.0311*	-0.0249***	-0.0062	-0.0293*	-0.0248***	-0.0045
	(0.0168)	(0.0097)	(0.0161)	(0.0164)	(0.0095)	(0.0160)	(0.0164)	(0.0095)	(0.0160)
$POL_{(t-1)-(t-2)}$				-0.0027	-0.0036	0.0009	-0.0169	-0.0111	-0.0058
				(0.0167)	(0.0095)	(0.0162)	(0.0152)	(0.0087)	(0.0153)
$POL_{(t-2)-(t-3)}$							0.0247	0.0114	0.0133
							(0.0174)	(0.0106)	(0.0166)
$RES_{t-(t-1)}$	-0.0166	0.0173*	-0.0339**	-0.0109	0.0069	-0.0178	-0.0103	0.0084	-0.0187
	(0.0169)	(0.0103)	(0.0164)	(0.0172)	(0.0096)	(0.0167)	(0.0172)	(0.0097)	(0.0168)

Continued on next page

Table 27 (continued)

$RES_{(t-1)-(t-2)}$				-0.0051	0.0214**	-0.0266	0.0103	0.0206**	-0.0103
				(0.0175)	(0.0101)	(0.0170)	(0.0180)	(0.0098)	(0.0175)
$RES_{(t-2)-(t-3)}$							-0.0265	0.0025	-0.0290*
							(0.0176)	(0.0104)	(0.0172)
$OTH_{t-(t-1)}$	0.0375	0.0133	0.0242	0.0083	0.0017	0.0066	0.0093	0.0019	0.0074
	(0.0279)	(0.0168)	(0.0265)	(0.0273)	(0.0164)	(0.0264)	(0.0274)	(0.0164)	(0.0265)
$OTH_{(t-1)-(t-2)}$				0.0346	0.0081	0.0265	0.0132	-0.0122	0.0254
				(0.0270)	(0.0157)	(0.0262)	(0.0254)	(0.0145)	(0.0253)
$OTH_{(t-2)-(t-3)}$							0.0285	0.0314**	-0.0029
							(0.0270)	(0.0160)	(0.0258)
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Country-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783	105,783
R-squared	0.893	0.911	0.785	0.893	0.911	0.785	0.893	0.911	0.785

t statistics in parentheses.

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

3.6 Concluding Remarks

Previous studies on the role of international environmental policies are quite rare due to data restrictions and the endogenity problem, which exists commonly in most assessments of the effect of environmental regulation. The paper uses panel data estimation methods and a large number of international environmental and trade agreements to explore whether signing environmental agreements would be reducing a country's growth of trade. Using five-year FD estimation methods I find that IEA membership generally decreases two trading countries' bilateral intensive margin by 10.68% within a 5-10 year time period, and leads to an even larger reduction at 21.73% after 15 years.

While I find the existence of a negative effect from environmental agreements, it is more than offset by the positive effect of trade agreements should one be in place. When two countries have both a pollution and a trade agreement in place, the combined effect on the intensive margin is an increase of 27.14%. The results confirm that environmental agreements and trade growth are reinforcing each other. Alongside with the globalized economy and free trade development, there is a lot of concern with environmental agreements that they are unfavorable to firms since most binding commitments fundamentally increase costs of production. This can have a negative effect on employment and many firm outcomes. In the sphere of international trade, binding commitments may reduce a country's comparative advantage and reduce its export potential, as their firms have higher costs of production and are less able to compete on world markets. I find that environmental agreements have little effect on the extensive margin, so even if the costs of firms are increasing, it does not drive them out of exporting. I do find more consistent negative effects on the intensive margin, but they are relatively small and not always present. So while environmental agreements do decrease the volume of trade, the effect is small. And it is always more than offset if the two countries have a trade agreement as well.

CHAPTER IV

POLLUTION REGULATION AND FOREIGN DIRECT INVESTMENT INFLOWS: EVIDENCE FROM CHINA

4.1 Introduction

Recent years have witnessed one of the most contentious debates regarding international trade, foreign direct investment (FDI), and the environment: the existence, the benefits, and the drawbacks of the pollution haven effect, the result of firms' choosing particular areas that are not restricted by pollution-control laws because they wish to reduce their cost of production. Although several studies document the impact of pollution regulations on domestic production, the question of whether firms increase FDI in response to a new domestic regulation has remained unanswered. As the central government of China has instituted an environmental policy, referred to as the Two Control Zones (TCZ) policy, to regulate pollution in its provinces, the country is an ideal place to study the impact of pollution regulations on FDI.

Since it adopted the open and reform policy in 1978, the Chinese government has been aggressively attracting FDI. Thus, since 1992, it has been the largest recipient of FDI among developing countries, and in 2003, it surpassed the United States as the world's largest recipient of global FDI.[1] On the other hand, China's rapid economic growth in recent decades has been accompanied by severe environmental degradation such as over-exploitation and mass industrial pollution, typical problems in developing countries. Meanwhile, China is a large country with substantial differences in the distribution of FDI and the environmental quality of its regions, which provides us with enough variation to identify the pollution haven effect.

[1]Based on the statistics from *The CIA World Factbook* on 2013

In a 2007 report, the World Bank estimated that pollution resulted in a 5.78% decline of China's GDP caused by premature deaths of the labor force, health care costs, and material damages.[2] Moreover, with the level of annual average particulate matter of less than 10 μm in diameter (PM_{10}) concentrations being higher than 100 Ig/m^3 in several selected cities, China has overtaken the United States as the world's largest producer of carbon dioxide, the chief greenhouse gas. To control sulfur dioxide (SO_2) emissions, the Chinese government in 1998 implemented a new regulatory policy, "Acid Rain and Sulfur Dioxide Emission Zones," namely, the TCZ policy. The policy package covers a total of 1.09 million square kilometers, comprising 175 cities and districts in 27 provinces, which account for about 11.4% of the entire territory of China.

To shed light on the effect of the pollution haven effect, this paper compiles detailed Chinese provincial-level data to assess the impact of environmental stringency on the location choice of FDI inflows by province. The study employs a difference-in-differences (DID) approach by exploring time and cross-sectional variation. As FDI into a host region may depend on the FDI in neighboring regions, it also uses the spatial error model to account for third-region effects in FDI inflows.

The rest of the paper is organized as follows. Section 4.2 briefly summarizes related studies in the existing pollution haven literature and introduces the contribution of this paper. Section 4.3 presents a brief description of the institutional background of environmental regulations in China. Section 4.4 discusses the empirical methodology of estimating the pollution haven effect. Data sources and summary statistics are also provided. Section 4.5 explains the empirical findings of the DID estimators and several robustness checks, followed by concluding remarks in Section 4.6.

[2]World Bank. 2007. Cost of pollution in China : economic estimates of physical damages. Washington, DC: World Bank.

4.2 Literature Review

The possibility that polluting multinational enterprises (MNEs) outsource production activities to developing countries with less stringent environmental regulation has been labeled as the "Pollution Haven Hypothesis" (PHH), for which empirical support is weak. After all, trade theory suggests that many other factors in addition to pollution regulations, affect trade flows (Copeland and Taylor, 2004). Although the PHH cannot be easily proven, we can address the pollution haven effect: a tightening up of pollution regulation will have an effect on plant location decisions and trade flows (Taylor, 2004). Most empirical studies attempting to address the pollution haven effect have yielded, at best, mixed results. Until quite recently, PHH studies have reached a consensus that differences in the stringency of environmental regulations have little or no effect on trade and investment flows. By using a conditional logit model to analyze the site selection of all MNEs, Friedman, Gerlowski, and Silberman (1992) show that nearness to markets is the dominant factor influencing the location decision of foreign manufacturing branch plants. List (1999) presents evidence that air pollution emissions in the U.S. converged during the 1929-1994 period, suggesting that states in the U.S. do not compete for industries by loosening environmental regulations. Dean, Lovely, and Wang (2009) examine the pattern of FDI inflows across Chinese provinces to test whether foreign firms embodying less efficient abatement technologies are more responsive to inter-provincial differences in environmental regulations. Their finding confirms that only ethnically Chinese investors are significantly sensitive to the provincial differences while non-ethnically Chinese investors transferring relatively advanced technologies show no significant response.

The early literature typically provides no supporting evidence for the pollution haven effect, yet later studies tend to find a statistically significant, but economically mild effect of environmental regulations on industry composition. For example, Becker and Henderson (2000) use panel data from 1963 to 1992 and find that air-quality regulations cause the firm birth rate in polluting industries to drop by 26-45%. Industries with bigger plants are affected the most, shifting the industrial structure toward less-regulated single-plant firms. To assess the impact of environmental stringency on capital flows, Keller and Lenvinson (2002), List and Co (2000), and List et. al (2003) explore regulatory costs that deter investment in U.S. states with relatively more stringent environmental regulations. These U.S. studies argue that lack of evidence for PHH in earlier studies may arise from a failure to account for endogeneity problems and measurement error. The empirical challenge to addressing the pollution haven effect is how to deal with the potential endogeneity of environmental regulations. Recent studies started to explore the potential endogeneity of environmental regulations. Using instrumental variable (IV) estimation, Millimet and Roy (2011) find (i) evidence of such endogenous regulations, (ii) a negative impact of local environmental regulations on inbound FDI in pollution-intensive sectors, particularly when measured by employment, and (iii) larger effects of environmental regulations once endogeneity is addressed.

Using the change in environmental regulations, specifically, the 1998 TCZ environmental policy in China, my study is similar to and complements the empirical work. For example, Tanaka (2010) proves that by imposing stringent regulations on pollutant emissions from power plants, the TCZ policy has led to significant reductions in air pollution and infant mortality rate. Recent work by Lu, Wu, and Yu (2012) uses a DID approach to find that being listed as a TCZ city in China causes the amount of FDI to drop by 25.6%. To explore the effect of TCZ policy on a firm's export activity, Hering and Poncet (2014) show that state-owned firms are less intensively affected and thus able to export relatively more. However, a relative decline has existed in exports of both foreign and private firms: If a sector uses more energy, its exports tend to decline more profoundly.

This paper builds on the existing literature in several ways. As empirical work allowing for third-region effects is sparse, it extends Lu, Wu, and Yu (2012) by assuming a spatial correlation of FDI inflow across provinces when estimating the environmental stringency effect. By combining the DID estimation of the TCZ policy effect and spatial autocorrelations among regions, I find that previous DID analysis has, to some extent, overestimated the effect of the TCZ policy. In addition, using province-level data enables us to obtain a unique TCZ Index (area percentage of TCZ cities) for each province and helps me improve the level of accuracy in my estimation of the policy effect. Specifically, for each province, there is a distinct TCZ index, so the estimated policy effect differs across regions.

4.3 Environmental Policies and FDI in China

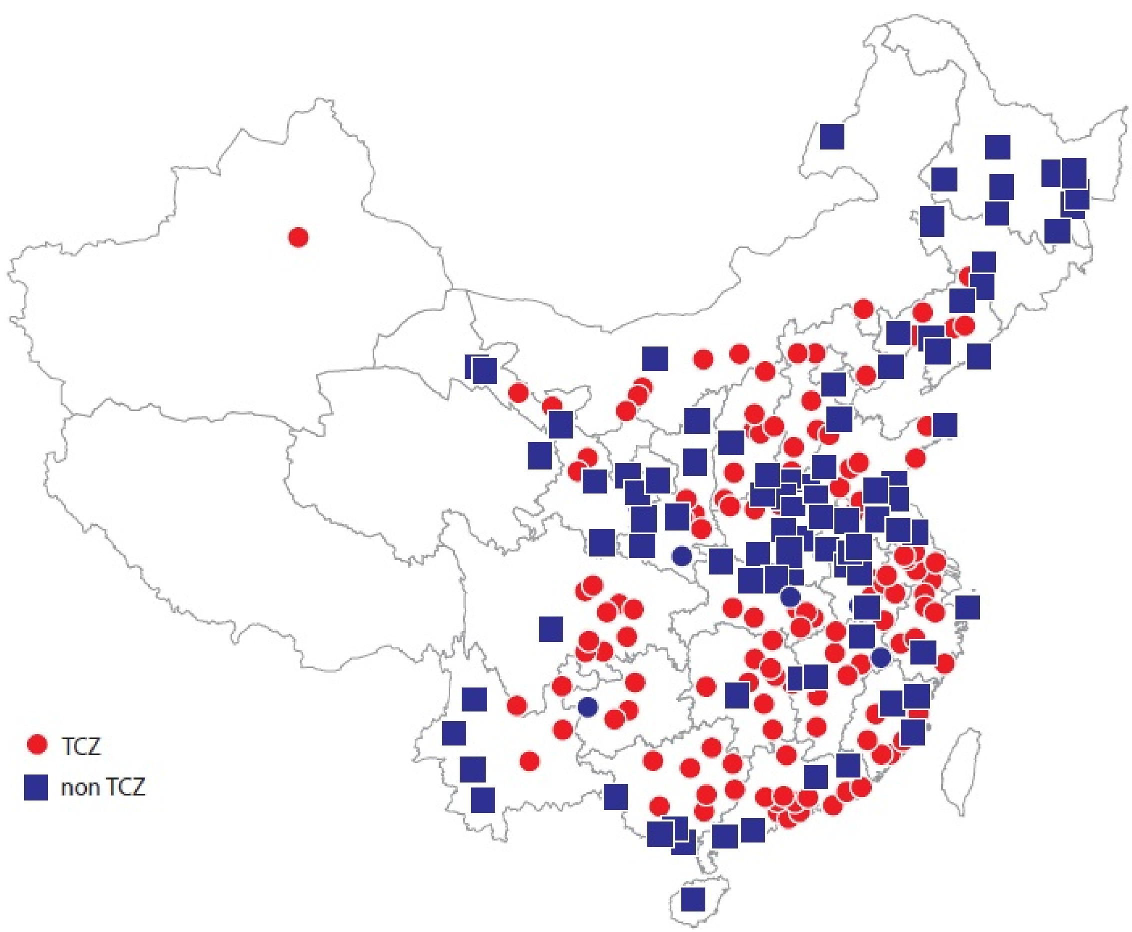
4.3.1 Two Control Zones policy

Deeply concerned by the effects of increasing air pollution on the environment, human health, and life, the Chinese government adopted a series of environmental regulations. Known as the Air Pollution Prevention and Control Law (APPCL), the first version of the environmental legislation in China was enacted in 1987 and executed in 1988. This environmental law did not yield the expected outcomes. Because it did not present any concrete policies on how to control SO_2 emissions and specify which government body should be responsible for enforcing the policies (Lu, Wu, and Yu, 2012), SO_2 emissions were still increasing, and areas affected by acid rain expanded. In 1995, the Chinese government amended the 1987 APPCL. The major part of the amendment includes a section that regulates pollutant emissions and coal combustion, particularly by high sulfur-content coal at power plants (Hao et. al, 2001).

After the enforcement of 1995 APPCL, pollution regulations that control SO_2 emissions became substantially more stringent. In January 1998, with the approval of the document "The Official Reply of the State Council Concerning Acid Rain Control

Areas and SO_2 Pollution Control Areas," the Chinese State Council implemented a new policy entitled "Acid Rain and Sulfur Dioxide Emission Zones," namely the Two Control Zones (TCZ) policy. Based on records from preceding years, prefectures were designated as Acid Rain Control Zones if they had average annual pH values for precipitation of less than or equal to 4.5, sulfur deposition above the critical load, and a high recorded level of SO_2 emission. The SO_2 Pollution Control Zones included cities with high levels of SO_2 emissions and annual average ambient SO_2 concentrations above the second level defined by the National Ambient Air Quality Standard (NAAQS) or daily concentrations exceeding the third level of the NAAQS.

Figure 1: Distribution of Two Control Zones cities



Source: Hering and Poncet (2014)

Figure 1 shows the geographic distribution of TCZ cities in China. The policy covers a total of 1.09 million square kilometers, comprising 175 cities in 27 provinces that account for about 11.4% of the entire territory of China. Other characteristics of the Two Control Zones are shown in Table 28. SO_2 emissions in the TCZ areas accounted for 58.9% of the national total, which implies that acid rain and SO_2 pollution in China would not deteriorate if SO_2 emission could be well controlled in the treatment areas (Hao et. al, 2001). Generally, whereas SO_2 pollution control zones are located in northern China because of its heating system, acid rain control zones are located in southern China, where the climate is relatively more humid. Air quality in the TCZ area is measured by ambient SO_2 and NO_2 concentrations as well as the level of total suspended particles (TSP).

Table 28: Characteristics of the Two Control Zones in 1995

Items	**SO2 Control**	**Acid Rain Control**	**Two Control Zones**
Area%	3.0	8.4	11.4
Population%	9.7	30.9	40.6
GDP%	18.2	44.2	62.4
SO2 emission%	25.4	33.5	58.9

Specifically, the provisions included in the TCZ policy are as follows:

1. Any new coal mines with a sulfur content greater than 3.0% cannot be established, and the existing mines are gradually shut down or required to limit output.

2. Construction of any new coal-burning thermal power plant will not be approved in cities or suburbs of large and medium-size cities; for newly built or rebuilt thermal power plants, if the sulfur content in burning coal exceeds 1.0%, desulfurization facilities must be installed.

3. Existing plants should take measures to reduce SO_2 emissions and install flue gas desulfurization (FGD) facilities.

The effectiveness of these regulatory actions are documented in various studies. Table 29 presents a list of all Chinese mainland provinces, their geographical locations, their TCZ Indexes, and total volume of SO_2 emissions in the year 1998 and 2000. The numbers in parentheses represent the volume of discharge in the TCZ area of each province in the year 2000. A comparison of the last two columns shows that SO_2 emissions decreased in most provinces after the cut-off year of 1998. For example, in Beijing, the total volume of emissions dropped from 305.1 to 224 thousand tons in 2000, and the percentage of SO_2 pollution emitted by TCZ area accounted for more than 95% of the total. In some provinces(e.g., Tianjing, Fujian, Jiangxi, and Jilin), SO_2 emission increased from 1998 to 2000.

4.3.2 FDI trends and determinants

Empirical researchers on FDI have engaged in a heated debate on what the determinants of the location of FDI are. By estimating the effects of the determinants of FDI in 29 Chinese regions from 1985 to 1995, Cheng and Kwan (2000) find that a large regional market, good infrastructure, and preferential policy affect FDI inflows positively, but wage cost affect them negatively. The effect of education is positive, but it is not statistically significant. In addition, FDI also has a strong self-reinforcing effect. Consistent with the theoretical considerations and empirical observations mentioned above, the existing literature has pointed out the importance of five sets of variables: (a) access to national and regional markets; (b) wage costs adjusted for the quality and the productivity of the labor force and other labor market conditions such as unemployment and the degree of unionization; (c) policies toward FDI, including tax

Table 29: List of Chinese mainland provinces and volume of SO2 discharge (10,000 tons)

Code	**Province**	**Location**	**TCZ %**	**1998SO2**	**2000SO2**
1	Beijing	North	0.4816	30.51	22.40(21.59)
2	Tianjing	North-Coastal	0.3637	22.99	32.99(25.64)
3	Hebei	North-Coastal	0.8533	140.29	132.13(80.32)
4	Shanxi	North	0.6136	141.99	120.16(73.71)
5	Inner-Mongolia	North	0.1163	72.8	66.38(35.80)
6	Liaoning	North-Coastal	0.6143	99.19	93.24(55.00)
7	Jilin	North	0.3009	28.39	28.57(9.00)
8	Heilongjiang	North	0	30.01	29.66(N/A)
9	Shanghai	Coastal	1	48.89	46.50(46.50)
10	Jiangsu	Coastal	0.5868	125.46	120.18(100.00)
11	Zhejiang	Coastal	0.8201	65.98	59.28(56.25)
12	Anhui	Interior	0.2391	42.36	39.53(14.30)
13	Fujian	Coastal	0.6411	16.49	22.50(19.37)
14	Jiangxi	Interior	0.435	30.46	32.31(16.60)
15	Shandong	North-Coastal	0.4861	225.89	179.59(116.30)
16	Henan	North	0.2662	100.29	87.69(46.33)
17	Hubei	Interior	0.2974	56.88	56.04(40.21)
18	Hunan	Interior	0.7248	72.21	77.25(67.30)
19	Guangdong	Coastal	0.7126	67.88	90.47(81.83)
20	Guangxi	Coastal	0.6302	70.09	83.03(63.75)
21	Hainan	Coastal	0	2.04	2.04(N/A)
22	Chongqing	West	0.3237	68.05	83.94(69.20)
23	Sichuan	West	0.2576	140.77	122.30(99.30)
24	Guizhou	West	0.2728	192.79	145.01(84.92)
25	Yunnan	West	0.2239	36	38.59(27.24)
26	Tibet	Interior-West	0	0.14	0.08(N/A)
27	Shaanxi	North-West	0.2249	66.02	62.33(23.41)
28	Gansu	North-West	0.1812	38.35	36.85(25.58)
29	Qinghai	North-West	0	3.14	3.2(N/A)
30	Ningxia	North-West	0.2229	21.52	20.58(7.77)
31	Xinjiang	North-West	0.0084	33.56	31.05(9.18)

Source: Chinese Environment Yearbook

rates; (d) the availability and quality of the infrastructure, and (e) the economies of agglomeration.

To experiment with an appropriate choice of each set of variables and following Cheng and Kwan (2000), I include several proxies. The proxies for infrastructure variables are the value of foreign capital by contracts, the retail sales of social consumption goods, the area of paved roads per capita, and number of buses each year. For labor productivity, they are the total number of employees of all industries, the average annual wages of employees, the annual output of all industries, and the number of high school students. For the economies of agglomeration, I use the value and the growth rate of the province-level GDP , and the value of province-specific retail consumption goods. For access to national and regional markets, I use a location dummy variable North, spatial FDI and its lagged terms, and the surrounding GDPs. The policy variable used here refers to the coastal dummy. In China, Special Economic Zones (SEZs) [3] and Open Coastal Cities (OCCs) [4] are the two most important policy designations for attracting inflows of FDI. Additionally, they are, to a certain extent, confined to a small subset of regions along the coast.

4.4 Empirical Methods

4.4.1 Empirical Strategy

Following the baseline DID estimation framework in Lu, Wu, and Yu (2012), my analysis exploits the TCZ environmental policy, implemented in 1998 as a quasi-natural experiment. Specifically, whereas the treatment group comprises the cities designated as TCZ areas in 1998, the control group includes those not receiving TCZ policy intervention in 1998. From a comparison of the outcome variable for TCZ

[3] As part of China's economic reforms and openness policy, SEZs were established to attract and utilize foreign capital investments. In 1980, the first four SEZs were Shantou, Shenzhen, and Zhuhai in Guangdong Province and Xiamen in Fujian Province.

[4] In the early 1980s, 14 coastal cities were granted the status of OCCs. The special policies granted these cities loose regulations from the central government and brought rapid development along the coast.

regions with that for non-TCZ regions before and after the policy change, I identify the pollution haven effect from the following DID regression:

$$\ln FDI_{it} = \alpha_i + \lambda_t + \gamma TCZ_i \times Post_t + X_{it}'\beta + \varepsilon_{it} \tag{27}$$

where i denotes the region in year t; α_i is the region fixed effect capturing all time-invariant characteristics; λ_t is the year fixed effect and X_{it} controls for other potential determinants of FDI inflows as discussed in the previous section so as to isolate the effect of environmental policy. The DID estimator in this equation is the interaction between the indicator of the treatment status TCZ_i and that of the post-treatment period $Post_t$.

For the interaction term, TCZ_i is the index calculating the area percentage of TCZ cities in each region. Hence, for each province, it is a unique number between 0 and 1 . The closer it is to 1, the larger the area that is receiving TCZ treatment. $Post_t$ indicates the post-treatment period,

$$Post_t = \begin{cases} 1 & \forall t \geq 1998 \\ 0 & otherwise \end{cases} \tag{28}$$

and ε_{it} is the error term. Consequently, the identification assumption requires that the regressor of interest, $TCZ_i \times Post_t$, which is conditional on a complete list of control variables (α_i, λ_t, X_{it}), be uncorrelated with the error term, ε_{it}, i.e.,

$$E\left[\varepsilon_{it} | TCZ_i \times Post_t, \alpha_i, \lambda_t, X_{it}\right] = E\left[\varepsilon_{it} | \alpha_i, \lambda_t, X_{it}\right] \tag{29}$$

According to previous quantitative analysis, the TCZ designation is not determined by past economic performance and political considerations, in particular, the growth prospect of FDI (Lu, Wu, and Yu, 2012). However, several concerns might be raised before my identification assumption is satisfied. One potential concern is the existence of some unidentified pre-existing trends that may affect both the TCZ status and ex-post- FDI inflows between the treatment and control groups. To alleviate the common serial correlation issue in my DID analysis, I remove the time series dimension by aggregating the data into two periods: pre- and post-intervention. According to Bertrand, Duflo, and Mullainathan (2004), collapsing the data into pre- and post-periods produces consistent standard errors in a DID approach, even when the number of states is small (although the power of this test declines fast). Moreover, to identify the difference between the DID estimator of the TCZ and that of the non-TCZ group, I use the TCZ Index of each province to replace the province dummy to see if the result changes. In addition, to avoid the over-rejection problem, I cluster standard errors by province.

Another potential concern in satisfying the identification assumption regards the timing of the change in the environmental policy. Specifically, because of the two-year gap between compilation of the TCZ list in late 1995 and the date it took effect, one may be concerned about whether any expectation effect, that is, the effect of environmental regulation on FDI, occurred before the effective date of the policy. As a robustness check, I conduct a placebo test by using 1995 instead of 1998 as the time of treatment. Given that the TCZ became policy only after 1998, the use of 1995 as the beginning of treatment should not produce a significant treatment effect. For additional checks on the identification assumption, I include average wages of employees to identify a negative wage effect. Considering that the economic effect of FDI inflows is continuous, I then add cumulative FDI. Moreover, to identify a large-scale effect of China's open policy, I include only non-coastal regions as a robustness check.

4.4.2 Data

To determine the impact of the TCZ policy, the empirical analysis includes three major data sources that trace the yearly evolution of FDI inflows, air quality, and various economic characteristics across provinces. The first data source is the *Chinese City Statistical Yearbook (2012)*[5], which aggregates yearly data about the outcome variable of the real amount of FDI used for each region from 1988 to 2012. I also use this data source to compile data on the control variables X_{it}, such as the values of FDI contracts, the number of industrial enterprises, and employment as the entire labor supply; and potential determinants used in the investigation on the designation of the TCZ status, such as the number of high school students each year, the area of paved roads per capita, the gross value of yearly industrial output, and the total sales of retail consumption goods. The second data source is the *China Environment Yearbook (2012)*, which covers all basic data related to the environment at the national level and at the provincial level (i.e., provinces, autonomous regions, and municipalities directly under the control of the central government), and main statistical data on the environment in relevant years of China. As an annual statistics publication, it is complied jointly by the National Bureau of Statistics, the Ministry of Environmental Protection, and other ministries, reflecting basic situation of all aspects of environment in China. I obtain information about the annual discharge of SO_2 at the industrial level and the household level from 1988 to 2012.

The third data source is the 1998 State Council's official document "The Official Reply of the State Council Concerning Acid Rain Control Areas and Sulfur Dioxide Pollution Control Areas." It provides a detailed list of cities assigned as the Acid Rain Control Zone, and the ones assigned as the SO2 Control Zone. Among the 280 cities for which the *Chinese City Statistical Yearbook* has information 158 are TCZ cities. During the sample period (1988-2012), the composition of this list remained unchanged, and all TCZ designations are reported in the document. As these three sources of data had missing values, I complemented the data from these sources by downloading several economic variables from city statistics collected by the National

[5]China Statistics Press, National Bureau of Statistics of China http://csp.stats.gov.cn/

Bureau of Statistics of China at *China Data Online* [6] from the Michigan China Data Center. These included yearly indices of the GDP, the number of industrial enterprises, and the gross industrial output.

4.4.3 Descriptive Statistics

Table 30 presents the details of the summary statistics and the description of the key variables in estimating the effect of the TCZ policy. The data set covers the 31 contiguous Chinese provinces from 1988 to 2012. One point worth clarifying is that Chongqing Municipality lacks data for six of the years under study because it did not become an administrative district until it separated from Sichuan Province in 1997. To retain consistency and avoid omitting data, I chose to separate the data of Chongqing Province from that of Sichuan Province from 1988 to 1996, treating these two provinces as separate during the entire time frame.

The measures of FDI include the yearly amount of real FDI received for all manufacturers within a region and the amount of investment from foreign-owned affiliates each year according to signed contracts. Since the *Chinese City Statistical Yearbook* does not have information about FDI for each industry or sector, I have to examine the average effect across all industries instead of the differential impact of polluting and non-polluting industries. For all variables related to FDI, GDP, or wages, I compute real values using the Consumer Price Index (CPI) for each year. "Retail consumption," an economic indicator compiled and released by the Census Bureau and the Department of Commerce, serves as an aggregated measure of the sales of retail goods to the entire country. "Number of buses" refers to all publicly-owned buses under the operated transit system. "Coastal" refers to 11 provinces: Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and

[6] http://chinadataonline.org/

Table 30: Summary statistics and variable descriptions

Variable	Mean	Std. Dev.	N	Description
TCZ Index	0.236	0.284	806	Area percentage of cities receiving TCZ treatment
FDI(log)	10.544	2.442	765	Amount of real FDI receiving (10,000 USD)
Cum.FDI(log)	13.788	2.03	775	Amount of FDI stock each year (10,000 USD)
GDP(log)	16.658	1.524	754	GDP of each province (10,000 CNY)
GDP growth rate	1.112	0.037	775	Growth rate of GDP
Surr.GDP (log)	17.132	1.121	775	Weighted GDP of surrounding provinces (10,000 CNY)
Spatial FDI (log)	11.663	1.4	775	Amount of spatial lagged FDI (10,000 USD)
Contract value(log)	11.105	2.036	566	Value of foreign capital by contracts (10,000 USD)
Retail consumption(log)	15.863	1.444	775	Retail sales of social consumption goods (10,000 CNY)
Number of firms(log)	8.398	1.431	454	Total number of industrial firms
Industrial Output(log)	16.962	1.646	633	Output of the industrial sector (10,000 CNY)
Employment(log)	5.598	0.954	605	Total number of employees (10,000)
Wage(log)	9.406	0.789	573	Average annual wage of employees
Buses(log)	8.545	1.108	541	Number of Buses
Road area per capita(log)	1.796	0.689	539	Paved road area per capita
High school students(log)	2.713	1.363	775	Number of high school students
Industrial SO2(log)	3.534	1.391	644	Industrial discharge of SO2 by region
North	0.484	0.5	806	Northern regions of China
Coastal	0.355	0.479	806	Coastal regions of China

Hainan. "Northern" includes 15 provinces such as Beijing, Jilin, Shanxi, Inner Mongolia, Gansu, and another ten provinces located in northern China.

4.5 Results

4.5.1 Main Results

Table 31 reports the baseline regression results from estimating the DID estimation equation (1) over the 1988-2012 time period. From columns 1 to 4, the estimated DID coefficients are consistently negative. Three are statistically significant and comparable in magnitude. Such findings imply that regions with tougher environmental regulations attracted a smaller amount of FDI, confirming the pollution haven hypothesis. Specifically, by ignoring the time-series dimension and simply dividing the data into pre- and post-1998 periods, column 1 presents basic estimation results. Columns 2-3 show a comparison between using a dummy for each province and not using a dummy. Without region dummies a TCZ dummy replaces the region dummy; and in this case, because no region dummy is omitted, column 3 shows that the number of observations is larger. Column 4 shows baseline DID results with more accurate estimates when error terms are clustered at the provincial level.

The economic magnitude of the pollution haven effect is significant. On average, for a province with 10% of its area designated as TCZ cities, the implementation of the TCZ policy led to a drop in the amount of FDI by 30.67%. This decrease is comparable to the effects found in the literature. For instance, Becker and Henderson (2000) find that tougher environment regulations result in a decrease in the birth rates of companies in polluting industries by 26 to 45%. Kellenberg (2009) estimates that between 1999 and 2003, the environmental policy caused the value added of U.S. affiliates located in countries in the top 20th percentile to grow by approximately 8.6%, while the corresponding number for developing and transition economies in the top 20th percentile was 32%. Hanna (2010) finds that the Clean Air Act Amendments

Table 31: Baseline DID Results

	(1) No time-series	(2) w/ Regiond	(3) w/o Regiond	(4) w/ Cluster s.e
TCZ*post	-3.018***	-3.067***	-0.381	-3.067***
	(-5.12)	(-4.64)	(-1.19)	(-5.09)
GDP(log)	0.047	0.363	0.726***	0.363
	(0.13)	(1.01)	(3.20)	(0.53)
GDP growth	2.803*	2.887	7.643***	2.887
	(1.84)	(1.56)	(3.99)	(1.19)
Retail (log)	1.367***	1.162**	0.430*	1.162
	(3.24)	(2.29)	(1.75)	(1.46)
Contract(log)	0.219***	0.231***	0.641***	0.231**
	(2.84)	(3.10)	(9.62)	(2.43)
No.firms(log)	-0.162	-0.146	0.097	-0.146
	(-0.83)	(-0.81)	(0.75)	(-0.55)
Employment(log)	-0.318*	-0.795**	-0.029	-0.795
	(-1.69)	(-2.55)	(-0.18)	(-1.66)
Buses(log)	-0.266	-0.286	0.204***	-0.286
	(-1.25)	(-1.43)	(2.88)	(-1.06)
Highschool(log)	-0.325*	0.172	-0.050	0.172
	(-1.96)	(0.70)	(-0.37)	(0.46)
SO2 emission(log)	0.266*	0.281*	-0.087	0.281
	(1.86)	(1.74)	(-2.92)	(1.65)
Ind.Output(log)	0.065	-0.105	-0.805***	-0.105
	(0.57)	(-0.69)	(-5.94)	(-0.54)
Road(log)	0.154	0.214	0.256***	0.214
	(0.99)	(1.49)	(3.42)	(1.09)
North	1.049***	1.197***	-0.003	1.197***
	(5.55)	(6.11)	(-0.04)	(6.04)
Coastal	2.072***	1.948***	0.270**	1.948***
	(6.16)	(5.16)	(2.21)	(4.28)
Region dummy	Y	Y	N	Y
Year dummy	N	Y	Y	Y
TCZ Index	N	N	0.228	N
			(0.87)	
Constant	-14.29***	-13.07***	-12.15***	-13.07
	(-4.04)	(-2.60)	(-4.59)	(-1.55)
Observations	270	270	352	270

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

over the 1966-1999 period increased the foreign assets of U.S. multinationals by 5.3% and foreign output by 9%. The estimated coefficients of other economic determinants of FDI also make economic sense. Each year, larger aggregated values of signed contracts attracted more foreign investment by about 23.9%. In addition, FDI is clustered in regions with larger domestic consumption; and foreign firms are more likely to locate in coastal than in interior regions but are less likely to locate in northern than southern areas.

4.5.2 Robustness Checks

Table 32 presents the results of a number of robustness checks. After probing the robustness of the estimates to determine the sensitivity of the DID estimation results, I find little evidence contradicting the basic conclusions discussed above. Specifically, I first add the wage effect into the baseline DID equation to determine if the average wage of employees has a negative effect on FDI inflows as predicted by the previous FDI literature. According to the results in Column 1, the estimated decrease in FDI inflows is around 33% less when the wage effect is taken into account. The estimated coefficient of the average wage is negative, as expected, but not statistically significant. In the second column, I use 1995 as the cut-off year to check the existence of an expectation effect of the TCZ policy. The estimated coefficient of the interaction term TCZ*post is much smaller in magnitude and less significant. Provided that a trend break indeed existed around 1998 and considering the expectation effect, using 1995 is likely to understate the policy impact while still producing statistical significance at the conventional level. In addition, the results in Column 3 show that calculating cumulative FDI for each province still leads to a highly statistically significant DID estimator that changes very little. Column 4 shows the estimation results in the sub-group of non-coastal regions. Although the estimated magnitude is smaller, it is still negative and significant. In summary, although the identification

Table 32: Falsification Tests

	(1) Incl. wage	(2) Use year 1995	(3) w/ FDI Stock	(4) Non-coastal only
TCZ*post	-2.019***	-1.004**	-3.038***	-0.911***
	(-3.32)	(-2.67)	(-4.92)	(-3.07)
GDP(log)	0.363	0.036	0.365	0.419
	(0.80)	(0.08)	(0.53)	(0.65)
GDP growth	2.751	2.497	2.928	3.975
	(1.14)	(1.01)	(1.21)	(1.45)
Retail(log)	0.410**	0.563**	1.155	1.184*
	(2.41)	(2.47)	(1.50)	(1.95)
No.firms(log)	-0.140	-0.476	-0.145	-0.216*
	(-0.53)	(-1.60)	(-0.54)	(-1.78)
Employment(log)	-0.738	-0.428	-0.796	-1.031***
	(-1.56)	(-0.83)	(-1.67)	(-2.99)
Buses(log)	-0.313	-0.300	-0.285	0.148
	(-1.12)	(-1.06)	(-0.84)	(0.31)
Highschool(log)	0.164	0.172	0.170	0.288
	(0.45)	(0.46)	(0.46)	(1.07)
SO2 emission(log)	0.422**	0.146	0.277	-0.282*
	(2.03)	(0.77)	(1.60)	(-2.04)
Ind.Output(log)	-0.080	-0.105	-0.107	-0.739*
	(-0.41)	(-0.54)	(-0.57)	(-2.28)
Road(log)	0.222	0.214	0.156	-0.143
	(1.11)	(1.09)	(0.80)	(-0.60)
Contract(log)	0.605***	0.273***	0.232**	0.314***
	(6.84)	(3.26)	(2.47)	(3.93)
Avg.wage(log)	-0.225			
	(-0.19)			
North	-1.573***	-1.054**	1.187***	-0.0664
	(-4.57)	(-2.59)	(6.20)	(-0.34)
Coastal	1.101***	0.186	1.921***	
	(3.18)	(0.86)	(4.05)	
Region dummy	Y	Y	Y	Y
Year dummy	Y	Y	Y	Y
Cumulative FDI			0.007	
			(0.40)	
Constant	-13.92	-13.07	-13.39	-15.70**
	(-1.61)	(-1.55)	(-1.59)	(-3.07)
Observations	270	270	270	270

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

assumption of the DID estimation cannot be fully verified, the analysis conducted in this subsection increases the confidence that the baseline DID estimates may not suffer from severe estimation bias.

In addition to the baseline regression results and their robustness checks, Table 33 summarizes the results of a simple quantile regression. Although most of the empirical literature has used ordinary least squares (OLS) regressions to identify the linear effect of regressors, the OLS method has its own constraints, among which the most significant is that all the coefficients are estimated at the mean level. It is highly sensitive to outliers that lie far away from the average. To overcome such shortcomings of my OLS results, I use quantile estimation to capture the change in the policy effect at four quantiles of FDI inflows. Table 33 shows that the estimated regulation effect is larger at the median level of FDI than at the 25th and 75th quantiles. All of them are comparable to the baseline linear estimators.

4.5.3 Spatial analysis

In the empirical FDI literature, models with a third-party effect have been used to address the spatial interdependence of the FDI determinants. Drukker and Millimet (2007) provides the first theoretical and empirical analysis that merges the literature on environmental regulation and capital flows with that on third-country effects in the FDI location choice. Using U.S. state-level data, they find that, although state attributes rarely have statistically significant effects on their inbound U.S. FDI, many neighboring state attributes matter both economically and statistically. In addition, they find that using recently derived spatial-econometric methods produces results that better concur with the theoretical model than methods that ignore that spatial auto-correlation.

As pointed by Drukker and Millimet (2007), research into the validity of the PHH must account for spatial spillover, as third-country effects are present in analyses of

Table 33: Quantile Regression Results

	(1) OLS Results	(2) 25th quantile	(3) 50th quantile	(4) 75th quantile
TCZ*post	-3.067***	-2.727***	-3.292***	-2.896***
	(-5.09)	(-4.51)	(-6.68)	(-3.73)
GDP(log)	0.363	1.027***	0.815***	0.370
	(0.53)	(3.10)	(3.02)	(0.87)
GDP growth	2.887	1.960	1.103	1.029
	(1.19)	(0.91)	(0.63)	(0.37)
Retail(log)	1.162	-0.000	1.002***	0.977*
	(1.46)	(-0.00)	(3.15)	(1.95)
Contract(log)	0.231**	0.299***	0.270***	0.267***
	(2.43)	(5.65)	(6.26)	(3.92)
No.firms(log)	-0.146	-0.032	-0.206	-0.160
	(-0.55)	(-0.18)	(-1.44)	(-0.71)
Employment(log)	-0.795	-1.033***	-1.068***	-0.792*
	(-1.66)	(-3.14)	(-3.99)	(-1.88)
Buses(log)	-0.286	0.138	-0.227	-0.224
	(-1.06)	(0.65)	(-1.30)	(-0.82)
Highschool(log)	0.172	0.265	0.109	0.158
	(0.46)	(0.91)	(0.46)	(0.42)
SO2 emission(log)	0.281	0.188	0.371***	0.205
	(1.65)	(1.30)	(3.16)	(1.11)
Ind.Output(log)	-0.105	-0.103	-0.139	0.009
	(-0.54)	(-0.45)	(-0.75)	(0.03)
Road(log)	0.214	0.170	0.183	0.172
	(1.09)	(1.04)	(1.37)	(0.82)
North	1.197***	0.913***	1.076***	1.253***
	(6.04)	(4.71)	(6.82)	(5.03)
Coastal	1.948***	2.062***	1.920***	1.697***
	(4.28)	(5.92)	(6.77)	(3.80)
Region dummy	Y	Y	Y	Y
Year dummy	Y	Y	Y	Y
Constant	-13.07	-8.080	-13.89***	-9.720
	(-1.55)	(-1.69)	(-3.57)	(-1.58)
Observations	270	270	270	270

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the impact of environmental regulations on capital flows. Specifically, province-level environmental regulations are strongly related to the regulatory stringency of neighboring states. To account for such third-country effects, Coughlin and Segev (2000) find empirical evidence for a spatial error model, as shocks to FDI are correlated across provinces. However, Blonigen et. al (2007) choose the spatial lag model over the spatial error model. While the former allows the data to reveal patterns of substitution or complementarity as well as the strength of any such patterns through the estimated spatial coefficient, the spatial error model is silent with respect to evidence of the substitution or complementarity of FDI across countries; therefore, it does not inform theory.

My study follows the spatial approach in Blonigen et al. (2007) and uses the spatial weight matrix W to capture the proximity of a specific host to other host provinces by measuring the distances between host provinces. This matrix is used to construct the spatial lag term $W \cdot FDI$ and the surrounding-market potential measure, another spatial lag term $W \cdot GDP$. The standard literature of spatial analysis generally claims that regions with close geographical proximity tend to have a greater impact on each other than regions that are far apart. In other words, a short distance between two regions could indicate that they are closely interconnected in terms of economic activities while a long distance could indicate regions that may not influence each other significantly.

Following Blonigen et. al (2007),

$$FDI_{it} = \beta_0 + \beta_1 Host\,Var._{it} + \beta_2 Surrounding\,Mkt\,Potential_t + \rho \cdot W \cdot FDI_t + \varepsilon_{it}. \quad (30)$$

Here W denotes a full spatial weight matrix, s.t.

$$W = \begin{bmatrix} W_{1988} & 0 & 0 & \cdots & 0 \\ 0 & W_{1989} & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & W_{2012} \end{bmatrix} \tag{31}$$

Each block-diagonal matrix W_t represents a 31×31 matrix for year t,

$$W_t = \begin{bmatrix} 0 & w_t(d_{ij}) & w_t(d_{ik}) \\ w_t(d_{ji}) & 0 & w_t(d_{jk}) \\ w_t(d_{ki}) & w_t(d_{kj}) & 0 \end{bmatrix} \tag{32}$$

Table 34 summarizes the results of spatial regression. Column 2, which adds time-lagged FDI, shows that ignoring a region's own FDI inflows in the previous year leads to an over-estimated policy effect. Moreover, I add spatially-weighted GDP as the measure of the surrounding market in column 3 and spatially-weighted FDI in column 4. The estimated coefficients are consistently negative and increase in magnitude, confirming the finding of third-country effects in the FDI literature. Specifically, the spatial lag model results in Column 4 suggest that FDI inflow into neighboring regions has a negative effect on a region's own investment inflow. Without considering a third-region effect, previous DID estimations have overestimated the TCZ policy effect. A more precise prediction would be that, on average, a province with 10% of its area designated as a TCZ group has a 26.5% decrease in its FDI inflows annually.

4.6 Concluding Remarks

Understanding the relationships among environmental policies, capital flows, and trade flows is an important and timely topic. While the literature on capital flows has recognized the importance of third-country effects, the literature on the pollution haven effect has yet to do so. This paper contributes to the existing body of knowledge

Table 34: Spatial Lag Analysis

	(1) Baseline	(2) w/ lag FDI	(3) w/ weighted GDP	(4) w/ spatial FDI
TCZ*post	-3.067***	-2.990***	-2.809***	-2.650**
	(-5.09)	(-4.77)	(-4.69)	(-2.32)
GDP(log)	0.363	0.337	0.282	0.908*
	(0.53)	(0.52)	(0.42)	(1.90)
GDP growth	2.887	2.979	3.336	-3.996
	(1.19)	(1.20)	(1.40)	(-1.39)
Retail(log)	1.162	1.163	1.065	-0.708
	(1.46)	(1.45)	(1.28)	(-0.63)
No.firms(log)	-0.146	-0.157	-0.135	0.373
	(-0.55)	(-0.63)	(-0.53)	(1.13)
Employment(log)	-0.795	-0.793	-0.789	-0.384
	(-1.66)	(-1.67)	(-1.66)	(-0.59)
Buses(log)	-0.286	-0.283	-0.283	-0.175
	(-1.06)	(-1.05)	(-1.05)	(-0.48)
Highschool(log)	0.172	0.179	0.152	-0.203
	(0.46)	(0.49)	(0.42)	(-0.53)
SO2 emission(log)	0.281	0.270	0.255	0.514**
	(1.65)	(1.52)	(1.52)	(2.46)
Ind.Output(log)	-0.105	-0.094	-0.089	0.397
	(-0.54)	(-0.50)	(-0.47)	(0.71)
Road(log)	0.214	0.203	0.199	0.355
	(1.09)	(1.08)	(1.06)	(1.27)
Contract(log)	0.231**	0.227**	0.234**	0.586***
	(2.43)	(2.53)	(2.57)	(5.95)
North	1.197***	1.210***	1.584**	-0.592
	(6.04)	(6.73)	(2.56)	(-0.84)
Coastal	1.948***	1.883***	1.656***	1.933***
	(4.28)	(3.70)	(3.26)	(3.09)
Time lagged FDI		0.025	0.029	
		(0.42)	(0.49)	
Surrounding Mkt			1.636	0.400
			(0.69)	(0.13)
Spatial FDI				-0.517
				(-0.71)
Constant	-13.07	-13.08	-39.32	0.637
	(-1.55)	(-1.56)	(-1.08)	(0.01)
Observations	270	270	270	270

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

by merging them to investigate whether the existence of a pollution haven effect more precisely.

By using a change in environmental policy, namely the 1998 TCZ policy in China, to control for the potential endogeneity of environmental regulations, and tracing the change of FDI inflows for 31 provinces over the 1988-2012 period, I found that on average, provinces with 10% city areas designated as TCZ attract around 26.5% less FDI than their non-TCZ counterparts. My results were robust to a series of robustness checks on the identification assumption along with other economic concerns. Ignoring the spatial correlation of provincial FDI inflows led to an overestimated policy effect.

CHAPTER V

CONCLUSION AND OUTLOOK

The precise impact of environmental regulations on trade growth has been a central preoccupation of the international trade-environment debate in the recent decades. Due to limited data availability on global environmental agreements and policies, existing studies addressing the effect of IEAs/MEAs are rare. This dissertation is the first investigation on international trade flows with comprehensive IEA data rather than some particular multinational environmental regulations or standards. After introductory remarks of the first chapter, the second chapter takes a first step to analyse the general impacts of multi-lateral environmental agreements (MEAs) on international bilateral trade flows, following Baier and Bergstrand (2007). The results imply that environmental agreements have no deterring impact on member countries' trade growth. When the positive effect of trade agreements are also taken into account, the results show that country pairs signing a free trade agreement and an environmental agreement together have an even larger increase in trade volume than their non-member counterparts. The subsequent findings when MEAs are separated into groups of different categories/sizes are consistent with the baseline results: environmental agreements and trade growth are actually reinforcing each other. Additionally, it addresses an individual impact specific to every environmental agreement in the current dataset.

The third chapter examines the specific role of IEAs on member countries' bilateral intensive and extensive margins. Using five-year first differencing estimation methods I find that IEA membership generally decreases two trading countries' bilateral intensive margin by 10.68% within a 5-10 year time period, and leads to an even larger reduction at 21.73% after 15 years. While the existence of a negative effect from environmental agreements is addressed, it is more than offset by the positive effect of trade agreements should one be in place. When two countries have both a pollution and a trade agreement in place, the combined effect on the intensive margin is an increase of 27.14%. My results confirm that environmental agreements and trade growth are reinforcing each other.

The fourth chapter compiles detailed Chinese provincial-level data to assess the precise impact of environmental stringency on the location choice of FDI inflows by province. By focusing on a particular environmental policy, namely the 1998 TCZ policy in China, to control for the potential endogeneity of environmental regulations, and tracing the change of FDI inflows for 31 provinces over the 1988-2012 period, I find that on average, provinces with 10% city areas designated as TCZ attract around 26.5% less FDI than their non-TCZ counterparts. My results are robust to a series of robustness checks on the identification assumption along with other economic concerns. As FDI into a host region may depend on the FDI in neighboring regions, it also uses the spatial error model to account for third-region effects in FDI inflows. As results show, ignoring the spatial correlation of provincial FDI inflows led to an overestimated policy effect.

For future research, I wish to go broadly further in the following aspects. First, this thesis places more emphasis on investigating the aggregate effect of IEAs by considering the presence of environmental agreements rather than the number of IEAs between each country pair. It is possible that using the number of IEAs as indicators in the generalist approach could generate more detailed results of the overall IEA impact. Also, different IEAs have diversified characteristics such as the types, subjects, coverage, signature date, lineages, and number of signatories. All of which may have a differential impact on international trade. Conducting more detailed investigations on these heterogenous design of MEAs as well as their statuses of regulation implementation could provide more insights on the specialist approach. Additionally, the difference between the announcement and ratification date of every environmental agreement 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. There is also one more approach to be fulfilled. The environmental agreement dummies could be further separated to indicate whether the agreement in question is the first, second, third, and so on agreement between the two countries, so as to enable future studies to have a more detailed investigation of the differential timing impact for each IEA.

When it comes to the evaluation of trade impact, using a single dummy variable standing for environmental agreements provides me with a limited capacity to examine their effects in detail. For instance, MEAs dealing with pollution of air and oceans may have a larger effect on bilateral trade in energy-intensive sectors, while agreements on species and habitats will have relatively smaller effects on international competitiveness. Using highly aggregated data on either trade volume or numbers of environmental agreements provides us with limited results. I could either recode the data to associate industries with agreements, or use data disaggregated to the SITC 4-digit data level, which would address the data aggregation issue and lead to some new findings. Furthermore, existing studies are starting to place emphasis on how global trade policies are affecting the environment; therefore another direction to investigate the IEA dataset is to study how the trade flows and EIAs change the numbers of environmental agreements. All these above are challenging but worthwhile extensions for the subsequent work.

REFERENCES

[1] Aichele, R. and Felbermayr, G., "Kyoto and the carbon content of trade," tech. rep., FZID discussion papers, 2010.

[2] Aichele, R. and Felbermayr, G., "Kyoto and the carbon footprint of nations," *Journal of Environmental Economics and Management*, vol. 63, no. 3, pp. 336–354, 2012.

[3] Aichele, R. and Felbermayr, G., "Estimating the effects of kyoto on bilateral trade flows using matching econometrics," *The World Economy*, vol. 36, no. 3, pp. 303–330, 2013.

[4] Aichele, R. and Felbermayr, G., "Kyoto and carbon leakage: An empirical analysis of the carbon content of bilateral trade," *Review of Economics and Statistics*, vol. 97, no. 1, pp. 104–115, 2015.

[5] Anderson, J. E., "A theoretical foundation for the gravity equation," *The American Economic Review*, pp. 106–116, 1979.

[6] Anderson, J. E., "The gravity model," *Annual Review of Economics*, vol. 3, no. 1, pp. 133–160, 2011.

[7] Anderson, J. E. and van Wincoop, E., "Gravity with gravitas: A solution to the border puzzle," *American Economic Review*, vol. 93, no. 1, pp. 170–192, 2003.

[8] Anderson, J. E. and Yotov, Y. V., "The changing incidence of geography," tech. rep., National Bureau of Economic Research, 2008.

[9] Anderson, J. E. and Yotov, Y. V., "Terms of trade and global efficiency effects of free trade agreements, 1990-2002," tech. rep., National Bureau of Economic Research, 2011.

[10] Armington, P. S., "A theory of demand for products distinguished by place of production (une théorie de la demande de produits différenciés d'après leur origine)(una teoría de la demanda de productos distinguiéndolos según el lugar de producción)," *Staff Papers-International Monetary Fund*, pp. 159–178, 1969.

[11] Baier, S. L. and Bergstrand, J. H., "Economic determinants of free trade agreements," *Journal of international Economics*, vol. 64, no. 1, pp. 29–63, 2004.

[12] Baier, S. L. and Bergstrand, J. H., "Do free trade agreements actually increase members' international trade?," *Journal of international Economics*, vol. 71, no. 1, pp. 72–95, 2007.

[13] Baier, S. L., Bergstrand, J. H., and Feng, M., "Economic integration agreements and the margins of international trade," *Journal of International Economics*, vol. 93, no. 2, pp. 339–350, 2014.

[14] Baier, Scott L and Bergstrand, Jeffrey H, "Database on economic integration agreements (september 2015)," 2015. data retrieved from EIA database, `http://www3.nd.edu/~jbergstr/`.

[15] Barrett, S., "Self-enforcing international environmental agreements," *Oxford Economic Papers*, pp. 878–894, 1994.

[16] Becker, R. and Henderson, V., "Effects of air quality regulations on polluting industries," *Journal of political Economy*, vol. 108, no. 2, pp. 379–421, 2000.

[17] Bergstrand, J. H., Egger, P., and Larch, M., "Economic determinants of the timing of preferential trade agreement formations and enlargements," *Notre Dame, University of Notre Dame, Working Paper*, 2010.

[18] Bertrand, M., Duflo, E., and Mullainathan, S., "How much should we trust differences-in-differences estimates?," *The Quarterly Journal of Economics*, pp. 249–275, 2004.

[19] Besedeš, T., Johnson, E. P., and Tian, X., "Economic determinants of multilateral environmental agreements," 2016.

[20] Besedeš, T. and Prusa, T. J., "The role of extensive and intensive margins and export growth," *Journal of Development Economics*, vol. 96, no. 2, pp. 371–379, 2011.

[21] Blonigen, B. A., Davies, R. B., Waddell, G. R., and Naughton, H. T., "Fdi in space: Spatial autoregressive relationships in foreign direct investment," *European Economic Review*, vol. 51, no. 5, pp. 1303–1325, 2007.

[22] Central Intelligence Agency, "The world factbook," 2013. data retrieved from Washington, DC: Central Intelligence Agency, `https://www.cia.gov/library/publications/the-world-factbook/index.html`.

[23] Chaney, T., "Distorted gravity: the intensive and extensive margins of international trade," *The American Economic Review*, vol. 98, no. 4, pp. 1707–1721, 2008.

[24] Cheng, I.-H. and Wall, H. J., "Controlling for heterogeneity in gravity models of trade and integration," *Federal Reserve Bank of St. Louis Working Paper Series*, no. 1999-010, 1999.

[25] Cheng, L. K. and Kwan, Y. K., "What are the determinants of the location of foreign direct investment? the chinese experience," *Journal of international economics*, vol. 51, no. 2, pp. 379–400, 2000.

[26] China Data Online, "China yearly macro-economics statistics(provincial)," 2014. data retrieved from All China Data Center, `http://chinadataonline.org/member/macroyr/`.

[27] China Environment Yearbook Editing Committee and others, "China environment yearbook," *China Environment Yearbook Press, Beijing*, 2012.

[28] Copeland, B. R. and Taylor, M. S., "Trade, growth, and the environment," *Journal of Economic Literature*, vol. 42, pp. 7–71, 2004.

[29] Copeland, B. R. and Taylor, M. S., "Trade, tragedy, and the commons," *American Economic Review*, vol. 99, no. 3, pp. 725–49, 2009.

[30] Coughlin, C. C. and Segev, E., "Foreign direct investment in china: a spatial econometric study," *The world economy*, vol. 23, no. 1, pp. 1–23, 2000.

[31] Dean, J. M., Lovely, M. E., and Wang, H., "Are foreign investors attracted to weak environmental regulations? evaluating the evidence from china," *Journal of Development Economics*, vol. 90, no. 1, pp. 1–13, 2009.

[32] Drukker, D. and Millimet, D. L., "Assessing the pollution haven hypothesis in an interdependent world," tech. rep., 2007.

[33] Eaton, J., Eslava, M., Kugler, M., Tybout, J., Becker, S., Grossman, G., and Hausmann, R., "The margins of entry into exports markets: Evidence from columbia," 2008.

[34] Eaton, J., Kortum, S., and Kramarz, F., "Dissecting trade: Firms, industries, and export destinations," *American Economic Review*, vol. 94, no. 2, pp. 150–154, 2004.

[35] Ederington, J. and Minier, J., "Is environmental policy a secondary trade barrier? an empirical analysis," *Canadian Journal of Economics/Revue canadienne d'économique*, vol. 36, no. 1, pp. 137–154, 2003.

[36] Egger, H., Egger, P., and Greenaway, D., "The trade structure effects of endogenous regional trade agreements," *Journal of international Economics*, vol. 74, no. 2, pp. 278–298, 2008.

[37] Egger, P., "A note on the proper econometric specification of the gravity equation," *Economics Letters*, vol. 66, no. 1, pp. 25–31, 2000.

[38] Egger, P., Jessberger, C., and Larch, M., "Trade and investment liberalization as determinants of multilateral environmental agreement membership," *International Tax and Public Finance*, vol. 18, no. 6, pp. 605–633, 2011.

[39] Egger, P., Jessberger, C., and Larch, M., "Impacts of trade and the environment on clustered multilateral environmental agreements," *The World Economy*, vol. 36, no. 3, pp. 331–348, 2013.

[40] Eichengreen, B. and Irwin, D. A., "Trade blocs, currency blocs and the reorientation of world trade in the 1930s," *Journal of International economics*, vol. 38, no. 1, pp. 1–24, 1995.

[41] Esty, D. C., "Bridging the trade-environment divide," *Journal of Economic Perspectives*, pp. 113–130, 2001.

[42] Feenstra, R. C., "New product varieties and the measurement of international prices," *The American Economic Review*, pp. 157–177, 1994.

[43] Feenstra, R. C., Hai, W., Woo, W. T., and Yao, S., "The us-china bilateral trade balance: its size and determinants," tech. rep., National bureau of economic research, 1998.

[44] Feenstra, R. C., Hai, W., Woo, W. T., and Yao, S., "Discrepancies in international data: an application to china-hong kong entrepôt trade," *The American Economic Review*, vol. 89, no. 2, pp. 338–343, 1999.

[45] Feenstra, R. C., Lipsey, R. E., Deng, H., Ma, A. C., and Mo, H., "World trade flows: 1962-2000," tech. rep., National Bureau of Economic Research, 2005.

[46] Felbermayr, G. J. and Kohler, W., "Exploring the intensive and extensive margins of world trade," *Review of World Economics*, vol. 142, no. 4, pp. 642–674, 2006.

[47] Flam, H. and Helpman, E., "Vertical product differentiation and north-south trade," *The American Economic Review*, pp. 810–822, 1987.

[48] Foster, N., Poeschl, J., and Stehrer, R., "The impact of preferential trade agreements on the margins of international trade," *Economic Systems*, vol. 35, no. 1, pp. 84–97, 2011.

[49] Frankel, J. A., Stein, E., and Wei, S.-J., *Regional trading blocs in the world economic system*. Peterson Institute, 1997.

[50] Friedman, J., Gerlowski, D. A., and Silberman, J., "What attracts foreign multinational corporations? evidence from branch plant location in the united states," *Journal of Regional science*, vol. 32, no. 4, pp. 403–418, 1992.

[51] Goldberg, P., Khandelwal, A. K., Pavcnik, N., and Topalova, P. B., "Trade liberalization and new imported inputs," in *American Economic Review, Papers and Proceedings*, vol. 99, pp. 494–500, 2009.

[52] Grossman, G. M. and Helpman, E., *Innovation and growth in the global economy*. MIT press, 1993.

[53] Hanna, R., "Us environmental regulation and fdi: evidence from a panel of us-based multinational firms," *American Economic Journal: Applied Economics*, vol. 2, no. 3, pp. 158–189, 2010.

[54] Hao, J., Wang, S., Liu, B., and He, K., "Plotting of acid rain and sulfur dioxide pollution control zones and integrated control planning in china," *Water, Air, and Soil Pollution*, vol. 130, no. 1-4, pp. 259–264, 2001.

[55] Helpman, E., Melitz, M., and Rubinstein, Y., "Estimating trade flows: Trading partners and trading volumes," *The Quarterly Journal of Economics*, pp. 441–487, 2008.

[56] Henderson, D. J. and Millimet, D. L., "Pollution abatement costs and foreign direct investment inflows to us states: A nonparametric reassessment," *The Review of Economics and Statistics*, vol. 89, no. 1, pp. 178–183, 2007.

[57] Hering, L. and Poncet, S., "Environmental policy and exports: Evidence from chinese cities," *Journal of Environmental Economics and Management*, vol. 68, no. 2, pp. 296–318, 2014.

[58] Hillberry, R. H. and McDaniel, C. A., "A decomposition of north american trade growth since nafta," *US International Trade Commission Working Paper*, no. 2002-12, 2002.

[59] Hopenhayn, H. A., "Entry, exit, and firm dynamics in long run equilibrium," *Econometrica: Journal of the Econometric Society*, pp. 1127–1150, 1992.

[60] Hummels, D. and Klenow, P. J., "The variety and quality of a nation's exports," *American Economic Review*, pp. 704–723, 2005.

[61] Javorcik, B. S. and Wei, S.-J., "Pollution havens and foreign direct investment: dirty secret or popular myth?," *Contributions in Economic Analysis & Policy*, vol. 3, no. 2, 2004.

[62] Kehoe, T. J. and Ruhl, K. J., "How important is the new goods margin in international trade?," in *2006 Meeting Papers*, no. 733, Society for Economic Dynamics, 2006.

[63] Kellenberg, D. and Levinson, A., "Waste of effort? international environmental agreements," *Journal of the Association of Environmental and Resource Economists*, vol. 1, no. 1, pp. 135–169, 2014.

[64] Kellenberg, D. K., "An empirical investigation of the pollution haven effect with strategic environment and trade policy," *Journal of international economics*, vol. 78, no. 2, pp. 242–255, 2009.

[65] Keller, W. and Levinson, A., "Pollution abatement costs and foreign direct investment inflows to us states," *Review of Economics and Statistics*, vol. 84, no. 4, pp. 691–703, 2002.

[66] Kohl, T., "Do we really know that trade agreements increase trade?," *Review of World Economics*, vol. 150, no. 3, pp. 443–469, 2014.

[67] Kohl, T., Brakman, S., and Garretsen, H., "Do trade agreements stimulate international trade differently? evidence from 296 trade agreements," *The World Economy*, vol. 39, no. 1, pp. 97–131, 2016.

[68] Krugman, P., "Scale economies, product differentiation, and the pattern of trade," *The American Economic Review*, pp. 950–959, 1980.

[69] Lawrence, R. Z., *Regionalism, multilateralism, and deeper integration*. Brookings Institution Press, 2000.

[70] Leonard, H. J. and Duerksen, C. J., "Environmental-regulations and the location of industry-an international perspective," *Columbia Journal of World Business*, vol. 15, no. 2, pp. 52–68, 1980.

[71] Levinson, A. and Taylor, M. S., "Unmasking the pollution haven effect," *International Economic Review*, vol. 49, no. 1, pp. pp. 223–254, 2008.

[72] List, J. A., "Have air pollutant emissions converged among us regions? evidence from unit root tests," *Southern Economic Journal*, pp. 144–155, 1999.

[73] List, J. A. and Co, C. Y., "The effects of environmental regulations on foreign direct investment," *Journal of Environmental Economics and Management*, vol. 40, no. 1, pp. 1–20, 2000.

[74] List, J. A., Millimet, D. L., Fredriksson, P. G., and McHone, W. W., "Effects of environmental regulations on manufacturing plant births: evidence from a propensity score matching estimator," *Review of Economics and Statistics*, vol. 85, no. 4, pp. 944–952, 2003.

[75] Lu, Y., Wu, M., and Yu, L., "Is there a pollution haven effect? evidence from a natural experiment in china," *Evidence from a Natural Experiment in China (May 1, 2012)*, 2012.

[76] Maasoumi, E., Racine, J., and Stengos, T., "Growth and convergence: A profile of distribution dynamics and mobility," *Journal of Econometrics*, vol. 136, no. 2, pp. 483–508, 2007.

[77] Magee, C. S., "Endogenous preferential trade agreements: An empirical analysis," *Contributions in Economic Analysis & Policy*, vol. 2, no. 1, 2003.

[78] Markusen, J. R., "39 location choice, environmental quality and public policy," 1999.

[79] McGuire, M. C., "Regulation, factor rewards, and international trade," *Journal of public economics*, vol. 17, no. 3, pp. 335–354, 1982.

[80] Melitz, M. J., "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica*, vol. 71, no. 6, pp. 1695–1725, 2003.

[81] Millimet, D. L. and List, J. A., "The case of the missing pollution haven hypothesis," *Journal of Regulatory Economics*, vol. 26, no. 3, pp. 239–262, 2004.

[82] Millimet, D. L. and Roy, J., "Three new empirical tests of the pollution haven hypothesis when environmental regulation is endogenous," 2011.

[83] Mitchell, R. B., "International environmental agreements: a survey of their features, formation, and effects," *Annual Review of Environment and Resources*, vol. 28, no. 1, pp. 429–461, 2003.

[84] Murdoch, J. C., Sandler, T., and Vijverberg, W. P., "The participation decision versus the level of participation in an environmental treaty: a spatial probit analysis," *Journal of Public Economics*, vol. 87, no. 2, pp. 337–362, 2003.

[85] Pearson, C. S., "Down to business: multinational corporations the environment and development.," 1985.

[86] Pearson, C. S., "Multinational corporations, environment, and the third world: business matters," *Duke Press policy studies (USA)*, 1987.

[87] Pethig, R., "Pollution, welfare, and environmental policy in the theory of comparative advantage," *Journal of environmental economics and management*, vol. 2, no. 3, pp. 160–169, 1976.

[88] Ronald B. Mitchell, "International environmental agreements database project (version 2014.3)," 2014. data retrieved from IEA database, `http://iea.uoregon.edu/`.

[89] Rose, A. K. and others, "Do we really know that the wto increases trade?," *American Economic Review*, vol. 94, no. 1, pp. 98–114, 2004.

[90] Rose, A. K. and Spiegel, M. M., "Noneconomic engagement and international exchange: The case of environmental treaties," *Journal of Money, Credit and Banking*, vol. 41, no. 2-3, pp. 337–363, 2009.

[91] Siebert, H., "Environmental quality and the gains from trade," *Kyklos*, vol. 30, no. 4, pp. 657–673, 1977.

[92] Tanaka, S., "Environmental regulations in china and their impact on air pollution and infant mortality," 2010.

[93] Taylor, M. S., "Unbundling the pollution haven hypothesis," *Advances in Economic Analysis & Policy*, vol. 3, no. 2, 2004.

[94] The World Bank, "Cost of pollution in china : economic estimates of physical damages," 2007. data retrieved from World Development Indicators, `http://documents.worldbank.org/curated/en/2007/02/7503894/cost-pollution-china-economic-estimates-physical-damages`.

[95] The World Bank, "Country and lending groups," 2013. data retrieved from World Development Indicators, `http://data.worldbank.org/about/country-and-lending-groups`.

[96] Tinbergen, J. and others, "Shaping the world economy; suggestions for an international economic policy," *Books (Jan Tinbergen)*, 1962.

[97] Trefler, D., "Trade liberalization and the theory of endogenous protection: an econometric study of us import policy," *Journal of political Economy*, pp. 138–160, 1993.

[98] Trefler, D., "The long and short of the canada-us free trade agreement," *American Economic Review*, vol. 94, no. 4, pp. 870–895, 2004.

[99] Ulph, A. M. and others, "Trade and the environment," *Books*, 1999.

[100] Walter, I., "Environmentally induced industrial relocation to developing countries," *Environment and trade*, vol. 2, pp. 235–256, 1982.

[101] Williams, M.-A., "Regional environmental agreements and initiatives in the americas," *Yearbook of International Environmental Law*, vol. 18, no. 1, p. 65, 2008.

[102] Wooldridge, J. M., *Econometric analysis of cross section and panel data*. MIT press, 2010.

[103] Xing, Y. and Kolstad, C. D., "Do lax environmental regulations attract foreign investment?," *Environmental and Resource Economics*, vol. 21, no. 1, pp. 1–22, 2002.

[104] Yearbook, China Statistical and others, "China statistical yearbook," *National Bureau of statistics of China*, 2012. data retrieved from `http://csp.stats.gov.cn/`.