The Role of International Environmental Agreements on the Extensive and Intensive Margins of International Trade

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Abstract

Environmental standards have remained controversial over the decades. This paper focuses on the specific role of international environmental agreements (IEAs) and accompanying regulations and standards on the bilateral extensive and intensive margins in international trade flows. We apply panel data estimation techniques to 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. Our results show that the tightening of environmental standards between a pair of countries reduces trade margins and their growth rates to a small extent only. To identify the specific deterring effects of different environmental agreements, we divide all IEAs into three categories: (i) pollution, (ii) resource, and (iii) other. We find small effects for specific type of IEAs as well. Our empirical finding of the small magnitude of negative IEA impact remains consistent with various robustness checks.

Keywords international environmental agreements, intensive margins, extensive margins

JEL Classification: F14; F18; F64; Q56

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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. Our study follows the 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), and 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.

Our 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) and 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), and Keller and Levinson (2002)). Others suggest no supporting evidence of a deterring effect of pollution regulation on foreign direct investment inflows, for example.[1] Due to data constraint, Kellenberg and Levinson (2014) study one particular IEA[2] 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.

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

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

Aiming to reconcile such mixed results in previous literature, our paper takes a first step to estimate the general impact of IEAs on trade margins using panel data methods. To begin with, we 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, we then apply a five-year first-differencing approach following Baier and Bergstrand (2007). The first set of our first-differencing 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, we find the initial negative IEA impact on the intensive margin eventually becomes smaller within a 10–15 year time frame. We find no effects on the extensive margin. To provide a detailed investigation of the differential effects of each type of environmental agreements, we divide IEAs into three categories: resource, pollution, and others. To see whether the number of IEAs two countries share has any influence, we count the total number of IEAs between each country pair by year, and the numbers of IEAs belonging to each distinct type as well. Our results are consistent irrespective of how we 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 our study is threefold. First, this paper is the first one to our 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 international environmental agreements. The unique IEA data we use enable us to take a large number of IEAs into account and test the general relationship between the variety and volume of trading goods and environmental regulation. Our finding that the intensive margin is more sensitive to changes in trade barriers than corresponding extensive margin is consistent with Chaney (2008).

Second, looking into different IEA types, we find evidence that both the pollution and resource type of IEAs have a negative effect on the intensive margin as well as overall trade. Previous literature on the role of intensive versus extensive margins has 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, we confirm 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 margins). 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 2 presents a detailed description of our 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 discusses our three data sources and related work. Section 4 explains the empirical findings of a deterring impact of IEAs on trade margins, from which we confirm a deterring impact of IEAs on trade margins. Section 5 provides several robustness checks by switching between different estimation models and sample periods, followed by concluding remarks in Section 6.

2 Methodology

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:

$$EM_{ijt} = \frac{\sum_{m \in M_{ijt}} X^m_{Wjt}}{\sum_{m \in M_{Wjt}} X^m_{Wjt}} \tag{1}$$

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:

$$IM_{ijt} = \frac{\sum_{m \in M_{ijt}} X^m_{ijt}}{\sum_{m \in M_{ijt}} X^m_{Wjt}} \tag{2}$$

where X_{ijt}^{m} 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 Eq.(1) is equal to the denominator of Eq.(2). 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:

$$EM_{ijt}IM_{ijt} = \frac{\sum_{m \in M_{ijt}} X_{ijmt}}{\sum_{m \in M_{Wjt}} X_{Wjmt}} = \frac{X_{ijt}}{X_{jt}} \tag{3}$$

where X_{jt} denotes j 's imports from the world. Taking the natural logarithms of Eq.(3) along with some algebra yields:

$$\ln EM_{ijt} + \ln IM_{ijt} = \ln \frac{X_{ijt}}{X_{jt}} = \ln OVER_{ijt} \tag{4}$$

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.

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) we use a set of five-year first differenced equations as below.

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

$$\Delta_5 \ln EM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 IEA_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{6}$$

$$\Delta_5 \ln IM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 IEA_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt} \tag{7}$$

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 our sample), the FD approach would be increasing estimation efficiency than using the FE method. To avoid potential over-rejection problems, we use clustered standard errors at country-pair levels in each set of FD estimation.

After testing the general effect of all environmental agreements, we 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 estimating equations for each IEA type on the trade margins are:

$$\begin{aligned}\Delta_5 \ln OVER_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) \\ + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{8}$$

$$\begin{aligned}\Delta_5 \ln EM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) \\ + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{9}$$

$$\begin{aligned}\Delta_5 \ln IM_{ijt} = \beta_0 + \beta_1 \left(\Delta_5 POL_{ijt}\right) + \beta_2 \left(\Delta_5 RES_{ijt}\right) + \beta_3 \left(\Delta_5 OTH_{ijt}\right) \\ + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{10}$$

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. One might be wondering whether ignoring the effect of trade agreements would potentially bias our findings of negative IEA impact on trade margins. Given this concern, we add controls of trade agreements into our regressions to see whether and how the estimated impact of IEA will be influenced by taking them into account. Our regression equations after adding all trade agreements broadly defined as economic integration agreement (EIA) variables are as below:

$$\begin{aligned}\Delta_5 \ln OVER_{ijt} = \beta_0 &+ \beta_1 \left(\Delta_5 NRPTA_{ijt}\right) + \beta_2 \left(\Delta_5 PTA_{ijt}\right) + \beta_3 \left(\Delta_5 FTA_{ijt}\right) \\ &+ \beta_4 \left(\Delta_5 COM_{ijt}\right) + \beta_5 \left(\Delta_5 POL_{ijt}\right) + \beta_6 \left(\Delta_5 RES_{ijt}\right) \\ &+ \beta_7 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{11}$$

$$\begin{aligned}\Delta_5 \ln EM_{ijt} = \beta_0 &+ \beta_1 \left(\Delta_5 NRPTA_{ijt}\right) + \beta_2 \left(\Delta_5 PTA_{ijt}\right) + \beta_3 \left(\Delta_5 FTA_{ijt}\right) \\ &+ \beta_4 \left(\Delta_5 COM_{ijt}\right) + \beta_5 \left(\Delta_5 POL_{ijt}\right) + \beta_6 \left(\Delta_5 RES_{ijt}\right) \\ &+ \beta_7 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{12}$$

$$\begin{aligned}\Delta_5 \ln IM_{ijt} = \beta_0 &+ \beta_1 \left(\Delta_5 NRPTA_{ijt}\right) + \beta_2 \left(\Delta_5 PTA_{ijt}\right) + \beta_3 \left(\Delta_5 FTA_{ijt}\right) \\ &+ \beta_4 \left(\Delta_5 COM_{ijt}\right) + \beta_5 \left(\Delta_5 POL_{ijt}\right) + \beta_6 \left(\Delta_5 RES_{ijt}\right) \\ &+ \beta_7 \left(\Delta_5 OTH_{ijt}\right) + \delta_{5,it} + \psi_{5,jt} + \upsilon_{5,ijt}\end{aligned} \tag{13}$$

where $NRPTA_{ijt}$ 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) we combine custom unions, common markets, and economic unions into one dummy COM_{ijt}, denoting the status of "deeper EIA."

Besides utilizing a set of binary variables to represent the control of IEA membership, we 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, we 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, we take a second step to capture the IEA effect by counting the number of IEAs per year between country i and j.

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.[3] 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.

Our economic integration agreements data including 198 countries are obtained from Baier and Bergstrand (2007) who compiled the Database on Economic Integration Agreements. They classified integration agreements following Lawrence (2000) and Frankel, Stein, and Wei (1997).[4] We use the most recently updated version (September 2015) of the database which coverd 23,201

[3] Available at `www.nber.org/data` and documented in Feenstra et al. (2005).
[4] The original data resource is at `www3.nd.edu/~jbergstr`.

country-pairs over 56 years and generate dummy variables for all types of free trade agreements according to their indexes. Baier and Bergstrand (2007) chooses 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.

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

[Insert Table 1 about here]

Table 1 shows the multilateral environmental agreements data collected from the IEA database. As we only use the multilateral environmental agreements we use the IEA and MEA designations interchangeably. The variable "$sum(IEA)$" counts the number of agreements recorded between

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

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

each country pair by year. After merging the IEA dataset together with the trade flow data and trade agreements data, we create a dummy variable indicating whether there exist at least one environmental agreement for each country pair. Since our IEA dataset covers almost all environmental agreements in the sample period, we recode those missing observations as zero IEAs in the combined data.

In the empirical analysis, we 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, we separate IEAs according to the categories listed in the IEA database: (i) pollution, (ii) resource, and (iii) others. 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 our 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.

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) and Copeland and Taylor (2009)) have argued for the need to clarify the differing impact of environmental regulations across categories. Our data set allows us to alleviate the aggregation bias to some extent because of the precise disaggregated categories of IEAs. Under such circumstance we are able to control for unobserved heterogeneity caused by category-specific effects.

4 Empirical Results

Table 2 provides a list of variables used in our 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. We 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 1 and 2. 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 3 and 4, 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 would be equal to the variation in overall margins. From which we would be able to infer the relative elasticities of trade margins to environmental agreements. The dummy variable of IEA ($dIEA$) takes the value of 1 when $sum(IEA)$ is equal to or greater than one in a specific year t and 0 otherwise.

[Insert Table 2 about here]

4.1 FD Results without and with Specific IEA Agreement Types

Table 3 presents our main empirical results from Eqs. (5) to (7). Panel 3.A gives a first set of estimates using $dIEA$ and their lagged terms. Within our 15-year time frame, we 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.

[Insert Table 3 about here]

The first three columns show the results allowing only a five-year change of IEAs. To see if there are any time effects, we 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. We 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. Our finding of the lagged IEA effect is consistent with the empirical evidence found in Rose and Spiegel (2009).

In Panel 3.B when we replace our binary IEA variable with the count of the number of IEAs between each country pair, we 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 we 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.

[Insert Table 4 about here]

After taking the first step to estimate the general IEA effect, we then turn to look at the differing IEA effect in each sub-category. With the rationale explained in the previous section, we divide all IEAs into three types to see if there are any significant differences across the three types of agreements. Table 4 presents the results. In Panel 4.A, where we use a binary variables for each IEA type, we 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 4.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 we 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 we 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% ($e^{-(0.0477+0.0457)} - 1 \approx -0.892$).

4.2 Adding Trade Agreements

Table 5 presents the estimated coefficients when we 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 4 when ignoring the effects from all trade agreements. Our 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 (FTA and COM) generally have larger stimulating effects on both the intensive and extensive margins. Specifically, we find that FTA membership generally increases two trading countries' bilateral intensive margin by 46.96% ($e^{0.199+0.186} - 1 \approx 0.4696$) 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 41.14% ($e^{0.205+0.186-0.0464} - 1 \approx 0.4114$) increase in the bilateral overall margin of two trading partners, and an 27.14% ($e^{0.181+0.108-0.0489} - 1 \approx 0.2714$) increase in the intensive margin as well. In other words, the negative impact from IEAs are quite small in magnitude when comparing to the stimulating effect of trade agreements. 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.

[Insert Table 5 about here]

5 Sensitivity Analysis

5.1 Fixed Effect Results as Robustness check

One may argue that using first differenced terms of our key variables might lead to bias estimates, because the variance of our 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, we re-estimate the baseline first difference specification by replacing the first differenced terms with original variables and adding fixed effects. Table 6 presents the estimation results when using FE estimation at five-year intervals of our 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 our coefficient estimates for these partial integration agreements.

[Insert Table 6 about here]

Panel 6.A uses dummy variables for IEA in each category. We find no significant deterring effects for pollution agreements. While for resource and other type, a decrease in both overall and intensive margins is 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 finding is consistent with our main results when using five-year first difference estimation. When we look at the effect of a change in IEA size in Panel 6.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.

5.2 Using the Period 1965–1990

Our 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, we re-run all our first difference estimations using a shorter time window stopping at 1990, with the results shown in Table 7. The estimated IEA effects are consistent with the previous prediction in Table 4 when all years are included. The deterring impact in the subsample of 1965-1990 shows up 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 32.29% ($e^{-0.227-0.163} - 1 \approx -0.3229$) after 15 years. Moreover, a positive impact of IEAs 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 17.59% ($e^{0.100+0.0651} - 1 \approx 0.1795$). There are few significant results for pollution and other types of agreements.

[Insert Table 7 about here]

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 we are interested in whether there would be a difference in the impact of IEA between the developing countries and the rest of world, we constructed a subset of developing countries from our whole sample. Table 8 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 9. The estimated effects in the developing country sub-sample does not differ much from our 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.

[Insert Table 8 about here]

[Insert Table 9 about here]

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. Our 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 we 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 we 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 a pair of countries has both a pollution and a trade agreement in place, the combined effect on the intensive margin is an increase of 27.14%. Our results confirm the mutual supportiveness between environmental agreements and trade growth.

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Table 1: 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 2: Summary Statistics of Trade Margins and Agreements(1965-2000)

Variable	**Observations**	**Mean**	**Std. Dev.**	**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

Table 3: **FD Estimation: All IEAs regardless of category differences**

Panel 3.A: Using IEA dummy variables in all categories

	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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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 3.B: Using log(sum(IEA)) in all categories

	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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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.

Table 4: **FD Estimation: IEAs separated into different categories**

	Panel 4.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
	(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)
Fixed effects									
$Importer-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter-year$	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

Continued on next page

Table 4 – continued from previous page

Panel 4.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)	(0.0010)	(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
	(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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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.

Table 5: **FD Estimation: IEAs by category with trade effects being controlled (1965-2000)**

	Panel 5.A: Using dummy variables of IEAs in each category								
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0377	-0.0279	-0.0098	-0.0247	-0.0148	-0.0099	-0.0400	-0.0270	-0.0129
	(0.0448)	(0.0282)	(0.0471)	(0.0446)	(0.0285)	(0.0469)	(0.0447)	(0.0288)	(0.0470)
$dNRP_{(t-1)-(t-2)}$				0.0766*	0.0771***	-0.0005	0.0598	0.0643***	-0.0045
				(0.0409)	(0.0224)	(0.0415)	(0.0400)	(0.0222)	(0.0407)
$dNRP_{(t-2)-(t-3)}$							-0.155***	-0.0979***	-0.0573
							(0.0411)	(0.0228)	(0.0424)
$dPTA_{t-(t-1)}$	-0.0359	-0.0549	0.0190	-0.0304	-0.0514	0.0209	-0.0379	-0.0551	0.0172
	(0.0720)	(0.0362)	(0.0668)	(0.0716)	(0.0360)	(0.0664)	(0.0719)	(0.0361)	(0.0668)
$dPTA_{(t-1)-(t-2)}$				0.0063	-0.0129	0.0192	-0.0007	-0.0143	0.0136
				(0.0619)	(0.0406)	(0.0585)	(0.0618)	(0.0405)	(0.0583)
$dPTA_{(t-2)-(t-3)}$							-0.212***	-0.0603**	-0.151**
							(0.0730)	(0.0282)	(0.0711)
$dFTA_{t-(t-1)}$	0.192***	0.0172	0.175***	0.205***	0.0248	0.181***	0.199***	0.0213	0.178***
	(0.0426)	(0.0255)	(0.0431)	(0.0429)	(0.0258)	(0.0433)	(0.0431)	(0.0259)	(0.0434)
$dFTA_{(t-1)-(t-2)}$				0.186***	0.0779***	0.108***	0.186***	0.0830***	0.103***
				(0.0362)	(0.0241)	(0.0346)	(0.0362)	(0.0242)	(0.0346)
$dFTA_{(t-2)-(t-3)}$							0.0301	0.162***	-0.132***
							(0.0512)	(0.0284)	(0.0494)
$dCOM_{t-(t-1)}$	0.302***	0.0449	0.257***	0.301***	0.0509*	0.250***	0.293***	0.0431	0.250***
	(0.0503)	(0.0290)	(0.0502)	(0.0502)	(0.0291)	(0.0503)	(0.0503)	(0.0293)	(0.0504)
$dCOM_{(t-1)-(t-2)}$				0.186***	0.121***	0.0656	0.171***	0.105***	0.0653
				(0.0424)	(0.0283)	(0.0421)	(0.0424)	(0.0282)	(0.0422)
$dCOM_{(t-2)-(t-3)}$							0.0491	0.173***	-0.124**
							(0.0532)	(0.0352)	(0.0535)
$dPOL_{t-(t-1)}$	-0.0451*	0.0063	-0.0514*	-0.0464*	0.0025	-0.0489*	-0.0456*	0.0016	-0.0472*
	(0.0267)	(0.0138)	(0.0272)	(0.0262)	(0.0139)	(0.0267)	(0.0265)	(0.0140)	(0.0270)
$dPOL_{(t-1)-(t-2)}$				-0.0078	-0.0147	0.0069	-0.0052	-0.0171	0.0120
				(0.0247)	(0.0141)	(0.0252)	(0.0246)	(0.0142)	(0.0251)
$dPOL_{(t-2)-(t-3)}$							-0.0131	-0.0246	0.0115
							(0.0249)	(0.0151)	(0.0255)
$dRES_{t-(t-1)}$	-0.0230	0.0395*	-0.0625	-0.0180	0.0466*	-0.0646	-0.0311	0.0446*	-0.0757
	(0.0465)	(0.0239)	(0.0484)	(0.0458)	(0.0240)	(0.0477)	(0.0462)	(0.0242)	(0.0483)
$dRES_{(t-1)-(t-2)}$				0.0265	0.0279	-0.0015	0.0095	0.0281	-0.0186
				(0.0463)	(0.0219)	(0.0463)	(0.0458)	(0.0221)	(0.0458)
$dRES_{(t-2)-(t-3)}$							-0.103**	0.0253	-0.129**
							(0.0510)	(0.0251)	(0.0518)
$dOTH_{t-(t-1)}$	-0.0377	-0.0137	-0.0240	-0.0354	-0.0086	-0.0267	-0.0326	-0.0093	-0.0232
	(0.0281)	(0.0175)	(0.0291)	(0.0276)	(0.0175)	(0.0286)	(0.0279)	(0.0175)	(0.0288)
$dOTH_{(t-1)-(t-2)}$				0.0116	0.0285*	-0.0169	0.0132	0.0237	-0.0105
				(0.0286)	(0.0172)	(0.0287)	(0.0282)	(0.0173)	(0.0284)
$dOTH_{(t-2)-(t-3)}$							-0.0013	-0.0364*	0.0351
							(0.0350)	(0.0196)	(0.0341)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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	0.170	0.338	0.205

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Table 5 – continued from previous page

Panel 5.B: Using log(sum of IEA) in each category									
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dNRP_{t-(t-1)}$	-0.0421	-0.0281	-0.0140	-0.0278	-0.0140	-0.0138	-0.0433	-0.0268	-0.0165
	(0.0449)	(0.0283)	(0.0472)	(0.0446)	(0.0286)	(0.0469)	(0.0448)	(0.0289)	(0.0471)
$dNRP_{(t-1)-(t-2)}$				0.0768*	0.0773***	-0.0005	0.0621	0.0629***	-0.0008
				(0.0409)	(0.0224)	(0.0416)	(0.0402)	(0.0223)	(0.0408)
$dNRP_{(t-2)-(t-3)}$							-0.156***	-0.0990***	-0.0572
							(0.0412)	(0.0229)	(0.0426)
$dPTA_{t-(t-1)}$	-0.0332	-0.0549	0.0218	-0.0281	-0.0512	0.0231	-0.0381	-0.0538	0.0157
	(0.0720)	(0.0362)	(0.0668)	(0.0717)	(0.0361)	(0.0665)	(0.0721)	(0.0362)	(0.0669)
$dPTA_{(t-1)-(t-2)}$				0.0084	-0.0126	0.0210	0.0022	-0.0117	0.0139
				(0.0619)	(0.0406)	(0.0585)	(0.0618)	(0.0406)	(0.0583)
$dPTA_{(t-2)-(t-3)}$							-0.211***	-0.0598**	-0.151**
							(0.0733)	(0.0283)	(0.0714)
$dFTA_{(t-1)-(t-2)}$	0.194***	0.0186	0.175***	0.205***	0.0240	0.181***	0.197***	0.0231	0.174***
	(0.0426)	(0.0255)	(0.0431)	(0.0429)	(0.0257)	(0.0432)	(0.0430)	(0.0258)	(0.0433)
$dFTA_{(t-1)-(t-2)}$				0.187***	0.0751***	0.112***	0.184***	0.0831***	0.101***
				(0.0364)	(0.0242)	(0.0348)	(0.0364)	(0.0242)	(0.0349)
$dFTA_{(t-2)-(t-3)}$							0.0280	0.162***	-0.134***
							(0.0512)	(0.0285)	(0.0494)
$dCOM_{t-(t-1)}$	0.308***	0.0466	0.261***	0.304***	0.0529*	0.251***	0.291***	0.0523*	0.238***
	(0.0503)	(0.0289)	(0.0501)	(0.0502)	(0.0291)	(0.0501)	(0.0503)	(0.0294)	(0.0502)
$dCOM_{(t-1)-(t-2)}$				0.189***	0.115***	0.0743*	0.169***	0.107***	0.0624
				(0.0424)	(0.0282)	(0.0422)	(0.0425)	(0.0282)	(0.0424)
$dCOM_{(t-2)-(t-3)}$							0.0431	0.182***	-0.139***
							(0.0530)	(0.0354)	(0.0532)
$sPOL_{t-(t-1)}$	-0.0364*	-0.0149	-0.0215	-0.0338*	-0.0156	-0.0182	-0.0318*	-0.0182*	-0.0136
	(0.0189)	(0.00982)	(0.0192)	(0.0187)	(0.0099)	(0.0190)	(0.0190)	(0.0100)	(0.0194)
$sPOL_{(t-1)-(t-2)}$				0.0100	0.0005	0.0095	0.0151	-0.0048	0.0198
				(0.0176)	(0.0105)	(0.0179)	(0.0175)	(0.0107)	(0.0178)
$sPOL_{(t-2)-(t-3)}$							0.0162	-0.0187	0.0349*
							(0.0208)	(0.0131)	(0.0211)
$sRES_{t-(t-1)}$	0.0291	0.0054	0.0237	0.0246	0.0083	0.0163	0.0221	0.0101	0.0120
	(0.0229)	(0.0110)	(0.0233)	(0.0225)	(0.0110)	(0.0228)	(0.0226)	(0.0111)	(0.0230)
$sRES_{(t-1)-(t-2)}$				-0.0244	0.0101	-0.0346*	-0.0320	0.0136	-0.0456**
				(0.0203)	(0.0107)	(0.0204)	(0.0196)	(0.0107)	(0.0197)
$sRES_{(t-2)-(t-3)}$							-0.0357	0.0068	-0.0425*
							(0.0219)	(0.0115)	(0.0225)
$sOTH_{t-(t-1)}$	0.0093	-0.0125	0.0218	0.0096	-0.0037	0.0133	0.0097	-0.0084	0.0180
	(0.0281)	(0.0182)	(0.0293)	(0.0279)	(0.0183)	(0.0292)	(0.0281)	(0.0185)	(0.0294)
$sOTH_{(t-1)-(t-2)}$				0.0295	0.0583***	-0.0288	0.0281	0.0457**	-0.0176
				(0.0278)	(0.0179)	(0.0280)	(0.0277)	(0.0180)	(0.0279)
$sOTH_{(t-2)-(t-3)}$							0.0302	-0.0311	0.0613*
							(0.0352)	(0.0210)	(0.0345)
Fixed effects									
$Importer-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter-year$	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	0.170	0.338	0.205

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

Table 6: **FE Estimation: IEAs separated into different categories(1965-2000)**

Panel 6.A: Using dummy variables of IEAs in each category	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-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)
$dOTH_{(t-1)-(t-2)}$				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)
Fixed effects									
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Importer-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter-year$	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

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Table 6 – continued from previous page

Panel 6.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
	(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)
Fixed effects									
$Country-pair$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Importer-year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter-year$	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.

Table 7: **Sensitivity Analysis: FD Estimation by category (1965-1990)**

Panel 7.A: FD Estimation: IEA dummy by category									
	Overall	Extensive	Intensive	Overall	Extensive	Intensive	Overall	Extensive	Intensive
$dPOL_{t-(t-1)}$	-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)
$dRES_{t-(t-1)}$	-0.112	0.0930***	-0.205***	-0.111	0.0981***	-0.209***	-0.127*	0.100***	-0.227***
	(0.0728)	(0.0354)	(0.0746)	(0.0722)	(0.0353)	(0.0740)	(0.0723)	(0.0353)	(0.0742)
$dRES_{(t-1)-(t-2)}$				0.0199	0.0607*	-0.0408	-0.0074	0.0651*	-0.0725
				(0.0783)	(0.0356)	(0.0794)	(0.0781)	(0.0358)	(0.0794)
$dRES_{(t-2)-(t-3)}$							-0.133**	0.0297	-0.163**
							(0.0649)	(0.0316)	(0.0670)
$dOTH_{t-(t-1)}$	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)
$dOTH_{(t-1)-(t-2)}$				-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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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

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Table 7 – continued from previous page

Panel 7.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)
$sRES_{(t-1)-(t-2)}$				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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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.

Table 8: **List of Developing Countries**

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	

(Source: the World Bank, 2013)

Table 9: **Sensitivity Analysis: Developing countries only: IEAs by category**

	Panel 9.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)
$dOTH_{(t-1)-(t-2)}$				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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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

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Table 9 – continued from previous page

Panel 9.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)
$sRES_{(t-1)-(t-2)}$				-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)
Fixed effects									
$Importer - year$	Y	Y	Y	Y	Y	Y	Y	Y	Y
$Exporter - year$	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.