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**International Cooperation in Environmental Policy: A Theoretical Model
Involving Competition for Foreign Direct Investment and an Empirical
Estimation Using Spatial Econometrics**

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Abstract: This study considers participation in international multilateral environmental treaties both theoretically and empirically. A model of emissions tax competition for foreign direct investment (FDI) with transboundary pollution results in two theoretical hypotheses. First, as is standard, one country's emissions tax is a positive function of the other country's emissions tax; that is, the slope of the best response function is positive. Second, the slope of the best response function increases with higher transboundary pollution rates and decreases with larger distances between countries. This implies that countries located close to each other respond more to the each other's tax changes than countries located far away. If emissions tax competition results in an inefficient race to the bottom in taxes, countries can join treaties to prevent the deleterious impacts of pollution. In particular, the value to committing to higher environmental standards is likely to be greater for those countries that are involved in stiffer race to the bottom competition. Therefore, a country's treaty participation may be more influenced by neighbors' treaty participation than by that of distant countries. Thus, empirically, a positive spatial lag in treaty participation may indicate such strategic interaction in environmental policies. Using a data set on forty countries participation in eleven treaties over the period 1980-2000, I find evidence consistent with the theory. In particular, the results suggest that strategic interaction takes place in treaty participation decisions across countries and that the extent of this interaction is a declining function of distance. Another important empirical finding is that, after instrumenting for FDI, FDI does not seem to impact treaty participation.

Keywords: environmental regulation, strategic interaction, tax competition

JEL Classification Numbers: D70, H23, H77, H87, Q20

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I. Introduction

Over the last two decades environmental issues have garnered a lot of attention. Issues ranging from pollution level to loss of species may be controlled or impacted by local regulations while they are in fact part of the global economy's social welfare function. Thus, declining environmental quality in the past has at least in part been blamed on environmental policies set by governments that do not internalize the externalities associated with environmental goods. What is worse is that countries may engage in competition, driving down already-low environmental policies. International environmental treaties have been established to encourage policies that should prevent such competition and benefit the global economy.

Participation in multilateral environmental treaties is in many respects a complex spatial process. A country's incentives to participate in environmental treaties are affected by the country's location relative to big polluters, how much transboundary pollution it emits to its major trading partners, and its political standing with nearby countries. These interactions work both ways—from a country to its neighbors and from the neighbors to the country. Further, there is a type of multiplicative effect of one country's impact on others. For example, Germany's impact on France echoes onto France's neighbors—Italy, Spain, and others. All of this can result in strategic interactions between countries when they make decisions to join environmental treaties that set environmental standards. With increasing globalization, this type of cooperation may be coming more prevalent. There has been some controversy about excluding environmental regulation from international trade agreements

(ITAs). Theoretically, countries bound by ITAs without environmental clauses can still compete in their environmental regulation bringing about inefficiently low environmental regulation across countries. Copeland and Taylor (2004) provide an excellent review of the literature and theory relating environmental regulation and international trade.

This study adds to the theoretical and empirical literature examining the competition in environmental regulation. The main focus is to empirically test for spatial interactions in international cooperation in environmental regulation with a theoretical model providing a possible reasoning behind such cooperation.

The theoretical model involves emissions tax competition for foreign direct investment (FDI) with transboundary pollution. Lower environmental regulation can be used to attract new investment. In my model, the governments are able to tax emissions that are produced in their own country but unable to tax emissions that come across borders from other nations. Therefore, not all the emission costs are fully internalized even by governments. In the two-country setting I find that if country 1 decreases their emissions taxes, then country 2 will decrease their taxes as well. Increasing the transboundary pollution effect (reducing the distance between countries) increases this effect. Thus, the functional form chosen in the model resolves the ambiguous sign of the slope of the best response function as presented by Fredriksson and Millimet (2002).¹

¹ In the three-country model the sign of the slope of the best-response function is ambiguous. Country 1's best-response function to country 2's change in taxes depends on all other countries' environmental taxes, capital, and emissions, as well as the distances of all other countries from country 1. That is, the interactions between countries become quite complicated with the addition of one more country. A primary reason for this is that a higher tax by 1 affects the relative investment in 2 and 3. If the distance between 1 and 2 differs from that between 1 and 3, this causes ambiguous effects on transboundary emissions and, thus, ambiguous effects on country 2's and 3's tax rates. While the theoretical outcome is ambiguous, the empirical results involving more

Unlike Fredriksson and Millimet (2002), and Levinson (2003) the environmental policy variable employed in this study is not abatement costs or taxes on environmental bads (such as hazardous waste or emissions). Instead, I use treaty participation by countries as the environmental policy variable. While it is theoretically possible to observe a race to the top in environmental policies, the type of competition more commonly perceived is the race the bottom. This is especially likely for treaties today since to be Pareto improving they must be alleviating the race to the bottom, otherwise they would promote lowering environmental stringency. According to the theoretical model, countries located closer to each other would compete more in their policies than far away ones, but then also, if a bundle of countries involved in competition would decide to forgo the competition and enter into an international environmental agreement, then also treaty participation decisions must be spatially correlated.

For my empirical test, I use an unbalanced panel of data that includes forty countries between 1980 and 2000 to estimate participation in environmental treaties. I find positive strategic interactions, or spatial lags, in treaty participation for the full sample and for the Organization for Economic Cooperation and Development (OECD) countries. This may be evidence of countries responding to the race to the bottom in environmental regulation. The positive spatial lag in treaty participation implies that if a country's neighbors on average increase their treaty participation, then the country itself is also going to increase its treaty participation.

than two countries may reveal information about competition in environmental policies across countries. The nature of the theoretical outcome suggests that the empirical form most appropriate for this problem uses spatial econometrics.

Theory predicts that governments may keep their environmental regulations low to attract FDI. I include FDI in the treaty participation equation and instrument for it because FDI in turn is likely to be impacted by environmental regulation. I do not find that FDI affects treaty participation. It still may be that FDI influences other environmental policy variables.

The remainder of the paper proceeds as follows. The next section discusses previous literature. Section 3 provides an overview and the main results of the theoretical model. In section 4 I provide an overview of the empirical approach and discuss the data. Section 5 discusses the empirical results and section 6 concludes.

II. Previous Literature

A handful of papers have estimated the level of environmental regulation without allowing for competition in environmental regulation. For example, Dasgupta et al. (1995) estimate environmental stringency across countries finding that secure property rights, effective legal and judicial systems, and efficient public administration all increase environmental stringency. List and Gerking (2000) found that decentralization of environmental policy from the federal level to state level in 1981 did not result in deterioration of environmental quality. Eliste and Fredriksson (2002) explore the relationship between environmental stringency and transfers to agricultural producers/polluters. They claim that it is the positive relationship between stringency and transfers that may have resulted in weak or even counterintuitive findings related to environmental stringency and trade flows. I go beyond these studies by allowing for

strategic interaction across countries in environmental regulation through spatial autoregression.

Beron et al. (2003) and Murdoch et al. (2003) use spatial probit techniques to estimate strategic interactions in decisions of European countries to join the Montreal and the Helsinki protocols, respectively. These studies do not find robust results of strategic interactions between countries in their decisions to ratify² these protocols. One reason behind this may be that time series variation is not considered; instead all countries are treated as if they ratified the protocols at the same time. For example, the Montreal protocol was first ratified by 30 nations in 1988 and Beron et al. estimate the dummy variable indicating nations that ratified the treaty by 1990. By 1990, 65 countries had ratified this protocol, but 122 more countries have ratified it since then. Similarly, Murdoch et al. estimate the dummy variable that identifies countries that ratified the Helsinki Protocol by 1990. The earliest ratification of that protocol occurred in 1985 and nineteen countries ratified it by 1990. Since then three more countries have ratified the protocol. The time series variation for the Helsinki Protocol may not be very important because twelve countries—the bulk of its membership—ratified it in 1986. I will not only control for the time of treaty ratification but also involve more than one treaty in my study.

This study is most related in methodology to Fredriksson and Millimet (2002) and Levinson (2003) which estimate different environmental regulation variables for US states and allow for strategic interaction between states. Both these studies find that states compete

² Ratification in this study stands for ratification, acceptance, approval, or accession.

in environmental stringency, as measured by the Levinson Index.³ Levinson (2003) also finds competition across states in the hazardous waste disposal tax rates. Both these studies use the spatial lag model as estimated by the instrumental variable (IV) approach instead of the spatial maximum likelihood approach because the IV method provides consistent results even in the presence of spatially correlated error terms. Fredriksson et al. (2004) also considered competition in environmental stringency. Moreover, they allow for competition across different policy variables. For a review of other empirical tax competition studies see Brueckner (2003). Instead of working with US state level data I will use country level data.

In the political science arena Roberts et al. (2004) estimate a model determining treaty participation in 22 multilateral environmental treaties by 98 countries in 1999. They provide an excellent review of the political theories associated with treaty participation and their regression involves primarily political variables. Of the variables they include in their model I will use the narrowness of export base measured by the United Nations Conference on Trade and Development (UNCTAD) export diversification index. Their study, though, does not control for a potential spatial lag in treaty participation.

My study not only allows for strategic interaction in environmental regulation across countries through spatial autoregression, but also involves more than one treaty and includes time series variation in data. This is the first such study using international data.⁴

³ The Levinson index for a state is greater than one if the state in a given period spent more on pollution abatement than the average state with the same industry mix (Levinson, 2003).

⁴ Fredriksson and Millimet (2002) and Levinson (2003) use US state-level data and find strategic interactions in emissions abatement costs and solid waste disposal taxes.

III. Theoretical Model

The theoretical tax competition literature is somewhat mixed in determining if the race to the top or the race to the bottom would result from emissions tax competition between countries in their attempt to attract mobile factors. For example, McAusland (2002) and Eerola (2004) find that the race to the top is likely the outcome of emissions tax competition because foreign capital owners are not represented by the tax-setting governments. In a two-country setting, McAusland (2002) finds that in the presence of mobile capital, the pollution host has higher environmental regulations than in the absence of mobile capital, and higher than that which maximizes global welfare given fixed capital investments in each jurisdiction. This inefficiently high environmental stringency is caused by the exclusion of foreign firm's profits from the local government's objective function. In another two-country model with an imperfectly competitive (Cournot or Bertrand) polluting industry, Eerola (2004) finds that non-cooperative policy leads to emissions taxes that are inefficiently high. The inefficiently high taxes are caused by two factors: first, foreign multinationals do not lose market share due to higher taxes but simply shift production from one country to the other, and second, because multinationals export their profits, the governments tend to overtax these profits. His model does not consider transboundary pollution.

In Cremer and Gahvari's (2004) tax competition model with transboundary pollution two types of taxes are considered—commodity taxes and emissions taxes. In their model, when moving from closed to open economies, tax competition occurs in commodity taxes but not in emissions taxes. This is because competition in emissions taxes distorts production decisions. Therefore, in their model competition in emissions taxes are ruled out. The

authors find that harmonization of emissions taxes above the Nash equilibrium level across countries reduces aggregate emissions and increases overall welfare.

Barrett (1994) finds that whether a race to the top or to the bottom occurs is determined by the market structure. Similarly, in Rauscher's (1995) model the countries may choose too high of emissions taxes so that investment does not occur (a discrete choice) even though it would be optimal if countries were able to cooperate. This is the result of a desire to have the polluter produce elsewhere and import, the so-called "Not In My Back Yard" result. They also find that the opposite may be true; countries may set tax rates too low resulting in investment that would be suboptimal if the countries were able to cooperate. Markusen et al. (1995), and Hoel (1997) also find that both the race to the top and the race to the bottom are likely outcomes. Further, Hoel finds that just because competition in emissions taxes is inefficient, does not mean that coordinating and setting uniform taxes across all countries is not necessarily any better than non-cooperative outcomes. Empirically it is difficult to impossible to determine if the competition in environmental regulation is a race to the top or a race to the bottom. The studies above and Rauscher (1997) find that whether race to the top or race to the bottom is observed, non-cooperative outcomes are not Pareto optimal.

The focus of this study is to determine if competition actually occurs and since the studies above do not explicitly model the best response functions of different countries' emissions taxes, I present a new model of international tax competition involving emissions taxes on capital owners. This model will be somewhat related to that developed by Fredriksson and Millimet (2002), but instead of modeling strategic interaction in pollution

abatement costs I model competition in emissions tax rates across countries. Their model differs in three key ways. First, they assume that the pollution is ‘perfectly’ transboundary implying the same pollution level is faced by the two countries. Second, their model does not involve any competition for capital. In essence, in their model pollution abatement is too low because neither country can trust the neighbor to choose the higher, globally more efficient, level of pollution abatement. Third, because of their more general functional form Fredriksson and Millimet are unable to sign the slope of the best response function. I, however, find that the best response function has a positive slope as is implicitly predicted by emissions tax competition models discussed in the first part of this section.

In the theoretical model, if one country decreases (increases) its emissions taxes then the other country decreases (increases) its emissions taxes as well. A special aspect of the model is that it allows for transboundary pollution of different rates. This feature allows me to conclude that countries with higher rates of transboundary pollution (located closer together) react more to each others’ changes in taxes than the far away ones. The intuition behind this finding is that if country 1 lowers its taxes to attract more FDI then country 2 will lower its taxes as well because otherwise it would be getting a good deal of its neighbor’s pollution without any of the benefits of hosting the FDI.

To formalize this intuition, I present a two country model. Let there be two countries, 1 and 2, that compete to attract a portion of the fixed world FDI allocated to them, \bar{K} .⁵ The model is a two-stage game, where in the first stage the governments simultaneously set their

⁵ Endogenizing \bar{K} would complicate the analysis without removing the effects central to this study. It is therefore omitted for simplicity.

emissions tax rates and in the second stage the capital owner chooses the distribution of FDI allocations across the two countries. The solution technique is subgame perfection and therefore the game is solved backwards. Because the firm will not let any FDI sit idle, the fixed level of FDI is fully allocated between country 1 and 2; so that $\bar{K} = K_1 + K_2$, where K_1 is FDI flow into country 1 and K_2 is FDI flow into country 2. The firm's objective function takes the following form:

$$\text{Max}_{K_1} f(K_1) - t_1 E(K_1) + f^*(\bar{K} - K_1) - t_2 E^*(\bar{K} - K_1), \quad (1)$$

where $f(K)$ and $f^*(K)$ are increasing concave production functions for country 1 and 2, respectively, that satisfy the Inada conditions. The two countries are assumed to be small enough to not affect world prices, thus, price of the produced good is normalized to one. The two countries' emissions tax rates are given by t_1 and t_2 . $E(K)$ and $E^*(K)$ are the firm's emissions cost functions in country 1 and 2, respectively. The emissions cost functions are increasing convex functions with $E(0) = E^*(0) = 0$ and $E'(0) = E'^*(0) = 0$. These assumptions made for the production and emissions cost functions ensure that a positive amount of FDI flows to both countries. I am assuming that the firm is not taxed on its output but rather on its emissions, and further that country 1 cannot tax the firm on emissions produced in country 2.

The first order condition of the firm's problem is:

$$f'(K_1) - t_1 E'(K_1) - f'^*(\bar{K} - K_1) + t_2 E'^*(\bar{K} - K_1) = 0 \quad (2)$$

and the comparative statics that arise from this problem are:

$$\frac{dK_1}{dt_1} = \frac{E'(K_1)}{\gamma_1 + \gamma_2} < 0 \quad (3)$$

and

$$\frac{dK_1}{dt_2} = \frac{-E^*(\bar{K} - K_1)}{\gamma_1 + \gamma_2} > 0, \quad (4)$$

where $\gamma_1 = f''(K_1) - t_1 E''(K_1) < 0$ and $\gamma_2 = f^{*''}(\bar{K} - K_1) - t_2 E^{*''}(\bar{K} - K_1) < 0$. These results are intuitive. If country 1 increases its emissions tax rate, its after-tax return to capital falls and more FDI flows to country 2. On the other hand, if country 2 increases its tax rate, the relative return to capital in country 1 increases which raises FDI in country 1. Also, note that:

$$\begin{aligned} \frac{d^2 K_1}{dt_1^2} &= (\gamma_1 + \gamma_2)^{-2} \left[E''(K_1) \frac{dK_1}{dt_1} (\gamma_1 + \gamma_2) - E'(K_1) \right] \\ &\left\{ \left[f'''(K_1) - t_1 E'''(K_1) - f^{*'''}(\bar{K} - K_1) + t_2 E^{*'''}(\bar{K} - K_1) \right] \frac{dK_1}{dt_1} - E''(K_1) \right\} \end{aligned} \quad (5)$$

and

$$\begin{aligned} \frac{d^2 K_1}{dt_1 dt_2} &= (\gamma_1 + \gamma_2)^{-2} \left[E''(K_1) \frac{dK_1}{dt_2} (\gamma_1 + \gamma_2) - E'(K_1) \right] \\ &\left\{ \left[f'''(K_1) - t_1 E'''(K_1) - f^{*'''}(\bar{K} - K_1) + t_2 E^{*'''}(\bar{K} - K_1) \right] \frac{dK_1}{dt_2} - E^{*''}(\bar{K} - K_1) \right\}. \end{aligned} \quad (6)$$

The sign of the equation (5) depends on the third derivatives—for example, if the third derivatives equal zero then the $\frac{d^2 K_1}{dt_1^2}$ is positive. In equation (6), $\frac{d^2 K_1}{dt_1 dt_2}$, has an ambiguous sign even if third derivatives equal zero.

Due to the symmetry between countries, to determine the interactions between tax policies of the two countries, it is sufficient to consider country 1's welfare function:

$$\underset{t_1}{Max} Y = B(K_1) + t_1 E(K_1) - E(K_1) - aE^*(\bar{K} - K_1), \quad (7)$$

where $B(K)$ is an increasing concave function representing the benefit the country receives from hosting capital.⁶ Examples of the benefits the country obtains from hosting capital include employment opportunities, knowledge and technology spillovers, and the profits not exported by the capital owners. A key assumption in equation (7) is the presence of transboundary pollution, that is, pollution in one country causes damages in both countries. The transfer coefficient represents the movement of pollution across borders. The transfer coefficient of emissions costs on the domestic emissions is normalized to 1 and the transfer coefficient of emissions costs from country 2's emissions on country 1 is a , where $a > 0$.

The first order condition of the government's problem is:

$$\frac{dY}{dt_1} = \left[B'(K_1) + t_1 E'(K_1) - E'(K_1) + aE^*(\bar{K} - K_1) \right] \frac{dK_1}{dt_1} + E(K_1) = 0. \quad (8)$$

The second order condition can be represented as follows after substituting in the first order condition:

$$\begin{aligned} \frac{d^2 Y}{dt_1^2} = & \left[B''(K_1) + t_1 E''(K_1) - E''(K_1) - aE^*(\bar{K} - K_1) \right] \left(\frac{dK_1}{dt_1} \right)^2 + \\ & + E'(K_1) \frac{dK_1}{dt_1} - E(K_1) \left(\frac{dK_1}{dt_1} \right)^{-1} \frac{d^2 K_1}{dt_1^2} < 0. \end{aligned} \quad (9)$$

⁶ While the focus of this study is on FDI flows, much of the story could be told in the framework of both foreign-owned and domestic-owned capital.

Also note that

$$\frac{d^2Y}{dt_1 dt_2} = \left\{ \left[B''(K_1) + t_1 E''(K_1) - E''(K_1) - a E^*(\bar{K} - K_1) \right] \left(\frac{dK_1}{dt_1} \right)^2 + E'(K_1) \frac{dK_1}{dt_1} \right\} \left(\frac{dK_1}{dt_1} \right)^{-1} \frac{dK_1}{dt_2} - E(K_1) \left(\frac{dK_1}{dt_1} \right)^{-1} \frac{d^2 K_1}{dt_1 dt_2}. \quad (10)$$

Using equation (9), I can show that $\frac{d^2Y}{dt_1 dt_2} > 0$. Hence, Proposition 1:

Proposition 1. The best response function of country 1's emissions tax to country 2's emissions tax has a positive slope:

$$\frac{dt_1}{dt_2} = - \frac{\begin{matrix} (+) \\ \left(\frac{d^2Y}{dt_1 dt_2} \right) \end{matrix}}{\begin{matrix} \left(\frac{d^2Y}{dt_1^2} \right) \\ (-) \end{matrix}} > 0. \quad (11)$$

Proposition 1 implies that when one country increases its emissions tax, the other country increases its emissions tax as well.

Now,

$$\frac{d \left[\frac{d^2Y}{dt_1 dt_2} \right]}{da} = -E''(\bar{K} - K_1) \frac{dK_1}{dt_1} \frac{dK_1}{dt_2} > 0, \quad (12)$$

$$\frac{d \left[\frac{d^2Y}{dt_1^2} \right]}{da} = -E''(\bar{K} - K_1) \left(\frac{dK_1}{dt_1} \right)^2 < 0, \quad (13)$$

and

$$\begin{aligned} & \frac{d \left[\frac{d^2 Y}{dt_1 dt_2} \right]}{da} \frac{d^2 Y}{dt_1^2} - \frac{d \left[\frac{d^2 Y}{dt_1^2} \right]}{da} \frac{d^2 Y}{dt_1 dt_2} = \\ & = E^*(\bar{K} - K_1) \frac{dK_1}{dt_1} E(K_1) \frac{E'(K_1) \left[E''(K_1) \left(\frac{dK_1}{dt_1} \right)^{-1} - E^*(\bar{K} - K_1) \left(\frac{dK_1}{dt_2} \right)^{-1} \right]}{(\gamma_1 + \gamma_2)^2} \frac{dK_1}{dt_2} < 0 \end{aligned} \quad (14)$$

imply Proposition 2:

Proposition 2. The slope of the best response function is increasing in a:

$$\frac{d \left[\frac{dt_1}{dt_2} \right]}{da} = - \frac{\left(\frac{d^2 Y}{dt_1^2} \right)^2}{\left\{ \frac{d \left[\frac{d^2 Y}{dt_1 dt_2} \right]}{da} \frac{d^2 Y}{dt_1^2} - \frac{d \left[\frac{d^2 Y}{dt_1^2} \right]}{da} \frac{d^2 Y}{dt_1 dt_2} \right\}} > 0. \quad (15)$$

(-)

(+)

This implies that if transboundary pollution increases, i.e. distance between two countries decreases, the response of one country to the other country's emissions tax change increases.

Given the similarity between the countries' problems, it is clear that the same holds for country 2. Next I discuss the empirical approach used to test the theoretical finding of a positive slope of the best response function.

IV. The Empirical Approach and Data

The theoretical model presents a testable hypothesis for presence of competition in emissions taxes. Since I am unable to find a good measure of emissions taxes for a panel of countries, I resort to environmental treaty participation by countries as the environmental policy measure. Strategic interactions in treaty participation may be caused by either a race to the bottom or a race to the top. However, consistent with most research, I focus on the former. Countries that are engaged in a race to the bottom have the strongest gains from cooperation as competition in emissions taxes leads to inefficiently low taxes. According to my model, these competing countries are likely located close to each other, and since they have stronger incentives to ratify treaties jointly, treaty participation may be characterized by a positive spatial lag. On the other hand, if countries are engaged in a race to the top, they may engage in environmental treaties to advertise their environmentally-friendly attitudes to their trading partners. Geographic space for the latter type of strategic interaction, though, seems less important because the transboundary emissions are no longer a big issue for the countries.

For the argument of a race to the bottom causing strategic interactions in environmental treaty participation, treaties should be viewed as policy tools that actually cause behavior changes and enhance environmental quality. On the other hand, if it was the race to the top that caused strategic interactions in environmental treaty participation, then treaties may be completely ineffective in improving environmental quality. Treaty effectiveness has been studied to some extent but the results vary not only by treaty but also by author. Where one author might find a treaty effective in its goals, the other might find

the same treaty ineffective (Mitchell, 2003). Therefore, the verdict is still out on general effectiveness of treaties, which implies that the alternative causes of strategic interactions in treaty participation could both apply.

The dependent variable chosen is treaty participation defined as the number of treaties a country has ratified in line with Roberts et al. (2004). Appendix A provides the list of included treaties. The current paper includes eleven treaties in its analysis. Of these eleven, three deal with air pollution, three with water pollution, two with hazardous materials, one with desertification, and two with a mix of environmental issues. For an excellent overview of international environmental treaties see Mitchell (2003).

The empirical model specification follows closely Fredriksson and Millimet (2002):

$$E_{it} = \alpha_i + \gamma_t + \delta \sum_{j=1}^{40} \omega_{ij} E_{jt} + \phi FDI_{it} + x_{it} \beta + \varepsilon_{it}, \quad (16)$$

where E_{it} is treaty participation by country i in year t ; α_i are country fixed effects; γ_t are year fixed effects; ω_{ij} is the weight assigned to country j by country i ($j \neq i$), where some of the weights may be zero; E_{jt} is treaty participation by country j in year t ; δ is the spatial lag coefficient that measures strategic interaction in treaty participation; FDI_{it} is the log of FDI flow into country i in year t ; x_{it} is a vector of country i characteristics in year t ; and ε_{it} represents idiosyncratic shocks uncorrelated across countries and over time.

The sum, $\sum_{j=1}^{40} \omega_{ij} E_{jt}$, is the weighted average of country i 's proximate countries' treaty participation (*particLAG*). The coefficient on *particLAG* (a.k.a. spatial lag), δ , provides information about the strategic interactions in treaty participation and the theoretical model

predicts it to be positive. On the other hand, a negative spatial lag would be indicative of a best response function with a negative slope. For an example of such interactions imagine that winds always blow from West to East and much of France's pollution is transferred to Germany but none of Germany's pollution crosses over to France. Then if France increases its emissions taxes, Germany would reduce its emissions taxes to encourage reductions in transboundary pollution and encourage FDI. Because wind direction is not quite so predictable and data on transboundary pollution is difficult to come by, I have not controlled for such variation in transboundary pollution in space. Yet, given this alternative effect on environmental policy and treaty participation, I would expect that such data would only increase the estimated spatial lag.⁷

The results presented in this paper use the following specification of spatial weights:

$$\omega_{ij} = \frac{1}{d_{ij}^2}, \quad (17)$$

where d_{ij} is the distance between country i and country j . Alternative spatial weight specifications provide qualitatively similar results.⁸

Unlike previous studies that estimate environmental policy variables, I include FDI as an explanatory variable in the environmental policy equation and, in line with my model, instrument for it. Ederington and Minier (2003), Fredriksson et al. (2003), List et al. (2003),

⁷ Data for transboundary pollution have been collected for the European countries. As an extension of my field paper I intend to use it to obtain more accurate estimate of the spatial lag for the European subsample.

⁸ Two alternative specifications considered were: $\omega_{ij} = \frac{\min}{d_{ij}}$, where *min* stands for the minimum of distances

between all country pairs, and $\omega_{ij} = \exp\left(-\frac{d_{ij}}{1000}\right)$.

and Fredriksson et al. (2004) estimate the impact of environmental policy on FDI, and these studies instrument for the environmental policy variable. Instrumenting for FDI in the estimation of environmental regulation resolves the inconsistency between the two lines of literature, one of which deals with the endogenous relationship between environmental regulation and FDI while the other does not.

I can make an argument for both a positive and a negative sign for the predicted sign of the coefficient on the FDI variable. As more investment flows into a country, the country is likely to see the added benefits from investment and to encourage more of it by lowering its environmental stringency. On the other hand, since investment increases industrial activity and pollution, higher levels of foreign capital flows may also boost environmental stringency.

The x_{it} vector includes fifteen variables. First, the log of the change in domestically-owned capital stock ($lcap$) is included to determine its effect on environmental regulation. Similar arguments as were made for the predicted sign of FDI can be made for $lcap$'s predicted sign. Further, I would predict that if FDI flows have no impact on treaty participation then the change in domestic capital stock will also have no impact on treaty participation. This is because foreign capital is relatively more footloose and may more effectively threaten governments to leave if environmental standards are increased.

Second, a set of standard variables are included in x_{it} . Log of gross national product ($lgnp$) controls for the economic size of the country. Since environmental quality is a normal good, higher income would imply higher demand for environmental quality. To control for the size of the country in terms of population I include log of population in thousands ($lpop$),

and predict that larger population increases the country's role in the international arena and the likelihood of the country to be drawn into talks and signing of new treaties. I also include in x_{it} the log of population density—number of people per square kilometer (*ldensity*); this indirectly also controls for land area. Larger population density (smaller land area for a given population) would reduce the country's ability to abide by international environmental regulations because population pressures on the land are higher, hence I predict a negative relationship between population density and treaty participation. Including urban population as a percentage of total population (*urban_perc*), similar to population density, measures a type of concentration; higher concentration of people in urban areas would mean higher industrial pressures, lower environmental quality, and reduction in treaty participation. Another environmental policy control variable that has been used in previous studies is unemployment; here measured as a percent of total labor force (*unemp_perc*). Higher unemployment in that country would provide more of a reason for a country to allow polluting industries to create jobs, akin to a rise in the marginal benefit function, $B'(K)$. The freedom index (*free*) is included to control for political rights and civil liberties in different countries.⁹ The higher the freedom index (the sum of political rights and civil rights indices) the more information are citizens getting about the negative effects of pollution and the more can the citizens affect the government's decisions to join environmental treaties. To control for corruption in a country I include the Corruption Perceptions Index (*corruption*).¹⁰ Higher

⁹ Instead of adopting the 0-0.5-1 scale typically used for the freedom index, I opted for the freedom index that is measured on a scale from 2 to 14 and represents the sum of the civil liberties and political rights indices which provides a higher level of gradation and reduces measurement error exacerbated by the arbitrary breaks of the 0-0.5-1 index.

¹⁰ The Corruption Perceptions Index varies between 1 and 10, and where larger number is associated with lower

Corruption Perceptions Index (lower corruption) implies that the country is more likely to be engaged and credible in the international arena and drawn into international environmental agreements.^{11, 12}

Third, I also control for European Union (EU) membership using a dummy variable (*union*).¹³ The EU countries seem to be on the forefront of emphasizing environmental issues, thus I predict that they may be joining more treaties on average than non-EU countries.

Fourth, I include a set of trade-related variables in x_{it} . The export diversification index (*exp_div*) controls for substitutability in exports, where the lower export diversification index implies a narrower export base (Roberts et al., 2004). The more diverse are a country's exports, the easier it can substitute toward different exports to improve environmental quality when environmental regulation becomes more stringent. Log of total exports (*lexports*) is included to control for the following impact: the more a country exports, the higher are the country's pressures to produce pollution. Therefore, I predict that higher exports reduce the number of treaties in which a country participates. I include log of total imports (*limports*),

levels of corruption.

¹¹ The log of density, urban population percentage, unemployment percentage, freedom index, and corruption are not highly correlated with the log of GNP, yet urban population percentage, freedom index and corruption are quite highly correlated with the OECD dummy, where the OECD dummy is a variable that takes on the value 1 if the country is in OECD and 0 otherwise. These correlations are 0.36, -0.72, and 0.75, respectively. The systematic differences in these independent variables may explain some of the discrepancies in the results for the OECD and non-OECD subsamples discussed later.

¹² The freedom index and the corruption measure have a correlation of -0.73. Including one of the variables but not the other does not change the results much. The most noteworthy change in the results occurs for the South American subsample when the freedom index is excluded from the base specifications—I find evidence of a positive spatial lag in treaty participation for two of the five specifications.

¹³ The EU dummy variable takes on the value 1 if the country was part of the European Economic Community formed in 1957 or the European Union created by the Maastricht Treaty in 1992 (http://europa.eu.int/abc/history/index_en.htm), 0 otherwise. Note that this dummy variable has time series variation.

but cannot make unambiguous predictions of its coefficient's sign. There are at least two avenues through which imports may impact treaty participation. On the one hand, higher imports for domestic consumption would imply less domestic production lowering pressures to pollute and higher probability of joining environmental treaties. On the other hand, if a country imports a lot of intermediate goods for production for re-exporting, then an increase in this country's imports would result in lower treaty participation. The fourth trade-related variable is the market potential variable, distance weighted average of proximate countries' GDPs (*lgdpLAG*). Higher market potential implies that the country would have higher production pressures. This in turn may result in downward pressure to join treaties.

Finally, I sequentially add log of domestic carbon dioxide (CO₂) emissions in metric tons per capita (*lco2emiss*), and the log of distance weighted average of proximate countries' CO₂ emissions (*lemissLAG*). Higher domestic emissions imply higher marginal costs of emissions and therefore more reasons to join treaties. Similarly, if there is a lot of pollution flowing into the country across the borders, even if the country itself does not produce much pollution the marginal cost of additional unit of pollution is high and therefore the country is more likely to join environmental treaties. Table 1 presents the predicted values for the coefficients on these variables and summarizes the reasons for these expectations. Variable definitions, sources and descriptive statistics are provided in Appendix B.

Estimating equation (16) using OLS would provide biased estimates because of the endogeneity problem: E_{it} depends on E_{jt} and E_{jt} on E_{it} , and also because E_{it} impacts FDI_{it} while FDI_{it} impacts E_{it} . I chose to use IV estimation instead of spatial maximum likelihood estimation for two reasons. First, because IV estimation provides consistent estimates even

in the presence of spatially correlated errors and second, for its relative ease of implementation in dealing with the second endogenous variable problem (the endogeneity of FDI). Brueckner (2003) describes both these methodologies and lists earlier studies that used them.

To instrument for the weighted average of proximate countries' treaty participation and for the log of FDI inflow, two first-stage equations must be estimated:

$$\sum_{j=1}^{40} \omega_{ij} E_{jt} = a_i + b_i + c \sum_{j=1}^{40} \omega_{ij} x_{jt} + z_{it} d + x_{it} f + e_{it} \quad (18)$$

and

$$FDI_{it} = \tau_i + \rho_i + z_{it} \kappa + \chi \sum_{j=1}^{40} \omega_{ij} x_{jt} + x_{it} \theta + u_{it} . \quad (19)$$

In equation (18) the weighted average of neighbors' treaty participation is instrumented for by the weighted average of the proximate countries' characteristics. FDI is instrumented for by a set of variables z_{it} , which are log of per capita GDP ($lgdp$), log of trade costs (ltc), log of average years of schooling for those over the age of 25 ($lblayr$), and log of investment costs ($lberi$). In the second stage, the fitted values of equations (18) and (19) are then used in

estimation of equation (16) in place of $\sum_{j=1}^{40} \omega_{ij} E_{jt}$ and FDI_{it} .¹⁴

Figures 1 through 5 provide average (per country) treaty participation measured in number of treaties and average (per country) CO₂ emissions in metric tons per capita for different samples. Figure 1 shows that the average treaty participation for the full sample has

¹⁴ Appendix C provides these first stage equations for the preferred specification using the full dataset.

steadily grown between 1980 and 2000. The most rapid growth occurred after 1993. The average CO₂ emissions have decreased slightly from 1980 to 2000. Figures 2 and 3 find similar patterns for the OECD and European sample. The non-OECD sample shown in Figure 4 saw its emissions per capita increase slightly over the 21 years. Also noteworthy is that non-OECD countries did not begin joining international environmental treaties until the late 1980s. The South American countries in Figure 5 saw their average treaty participation climb from zero in 1988 to four in 2000. Average emissions per capita remained roughly constant. Note that the number of countries across time within samples varies greatly. For example, South American sample only has two countries in the sample in 1980 and 1981 and seven countries in 1998 and 1999. Data deficiencies for the South American sample are such that even if I drop a control variable or two I am not able to increase the sample size much. The pair of control variables that increased this sample's size significantly was the BERI index and the Corruption Perceptions Index. Dropping these two variables from the model increased the sample size from 105 to 155. Yet the results using this expanded dataset did not provide any new insights.

V. Results

Tables 2 through 6 provide the key results for five different samples. For all five tables I provide a step-by-step progression of different specifications' results for the particular sample in each table. In column 1, I present the results of OLS. Column 2 instruments for the *particLAG* variable using 2SLS. Column 3 also instruments for the *FDI* variable. In column 4 I add own emissions as an additional control variable. Finally, in

column 5 I also add a distance-weighted average of proximate countries' emissions to the estimation equation. All specifications include both country and year fixed effects. The most preferred specification is the one presented in column 5 because it not only controls for both endogeneity problems but also allows for domestic and proximate countries' pollution levels to affect treaty participation.¹⁵

Table 2 provides the results for the full sample. This table presents evidence of economically and statistically significant competition in treaty participation. Depending on the specification, the coefficient describing strategic interactions in treaty participation (spatial lag) is approximately 0.7 and is always significant at one percent significance level. The interpretation of this result is following: if a country's neighbors increase their (distance-weighted) average treaty participation by 1 treaty in a given year, then the average first round effects on its treaty participation is 0.7, all else equal.

The *FDI* variable and change in domestic capital stock, *lcap*, are always statistically insignificant. Therefore, neither foreign nor domestic capital flows do not seem to affect treaty participation decisions. Log of GNP, log of population, log of population density, urban population percentage, corruption, and the EU dummy are statistically significant variables across the board. Except for the coefficient on log of GNP, the signs of statistically significant coefficients match the expectations. The following are the marginal effects of each of the statistically and economically significant variables on treaty participation, where everything else is held constant. The coefficients on *lgnp* imply that if a country's GNP

¹⁵ Adding the emissions variables to the estimation equation may introduce another endogeneity problem as environmental treaty participation may impact emissions levels.

increased by ten percent, its treaty participation would on average decrease by 0.1. One explanation for this result may be that higher GNP implies higher industrial production and pollution which in turn may prevent the country from choosing to join treaties in order to protect its industries. If population increased by ten percent, the country's treaty participation would increase by approximately 1.7 on average. If population density increased by ten percent, treaty participation would decrease on average by 1.8 treaties. Urban population percentage seems to play a role in treaty participation as well. An increase in urban population by one standard deviation (0.17) decreases treaty participation on average by more than 0.5 treaties. Decreasing corruption by one unit (an increase in the Corruption Perceptions Index) would increase treaty participation by a fraction of 0.17. Finally, the EU countries join 0.6 more treaties on average than non-EU countries.¹⁶ Appendix C provides the first stage equations of the model in column 5 of Table 2.

A recent study by Blonigen et al. (2004) examines spatial aspects of FDI, and finds that spatial interactions may vary by subsamples. For the OECD countries overall Blonigen et al. find that FDI is a complement in space while for the European subsample FDI is a substitute in space. This is because including far-flung countries alters the size of space under consideration. Since most countries are tightly packed in Europe, considering the full OECD sample leads to a potentially spurious positive spatial lag. Similarly, the size of the space under consideration may influence the spatial lag in this study because some set of countries may compete in environmental standards others might not. Thus, results for OECD, European, non-OECD, and South American subsamples are presented in Tables 3

¹⁶ In the specifications without the EU dummy, the coefficient on the log of GNP remained negative.

through 6. The lists of countries for each subsample along with the number of years each country is in the sample are presented in Appendix B.

An additional reason for distinguishing between subsamples in this study is the possibility of finding evidence of a leader/follower story in the framework of treaty participation. For example, it may be that the rich OECD countries join treaties for the reasons discussed earlier whereas the poorer non-OECD countries join treaties to be viewed favorably by their rich counterparts. Therefore, there may not be any strategic interplay between the proximate countries treaty participation for the poorer countries, but rather a reaction to richer countries joining treaties.

When I limit the sample to OECD countries, the results presented in Table 3 change somewhat from the full sample results. I still find that there is a positive strategic interaction between countries' decision to join treaties. While this effect remains statistically significant its economic size is reduced somewhat from the full sample results. Now, I find that if a country's neighbors choose to increase their treaty participation by one, the country on average joins 0.48 treaties that year. For the OECD sample the export diversification index, log of own CO₂ emissions, and log of the weighted average of neighbors CO₂ emissions became statistically significant for this subsample. If the export diversification index increases by one standard deviation (0.16), treaty participation increases by about one treaty. A ten percent increase in own CO₂ emissions would increase treaty participation by about 0.07; while a ten percent increase in the distance-weighted average of proximate countries' emissions would increase a country's treaty participation by 0.22.

The coefficient on *lgnp* increases in absolute value by five fold from the full sample. That is, a ten percent increase in GNP reduces treaty participation by 0.5. The coefficients on population and population density increased slightly in absolute value while the coefficient on the EU dummy decreased slightly from the full sample results to OECD sample results. The coefficient on urban population percentage and Corruption Perceptions Index doubled in magnitude, while keeping the same signs.

In Table 4 I have restricted my sample to European countries only.¹⁷ For the European subsample, competition in treaty participation becomes statistically insignificant after own emissions are added to the model.¹⁸ The coefficients are statistically significant in columns 2 and 3 only. Again, I find that capital flows do not affect treaty participation. Also, population, population density, and export diversification index become statistically insignificant. Log of GNP, urban population percentage, corruption, EU membership, own emissions and weighted average of proximate countries' emissions are still statistically significant in determining treaty participation. A ten percent increase in GNP would on average decrease treaty participation by 0.4. One (full-sample) standard deviation (0.17) increase in urban population percentage would reduce treaty participation by more than 1.4 treaties. The coefficients on corruption and the EU dummy have virtually the same magnitudes in the European sample as they did in the OECD sample. In the European subsample there are sixteen observations that are not part of the OECD. When I exclude those sixteen observations, the results do not change qualitatively.

¹⁷ European countries are those designated either Western Europe or Eastern Europe by the Penn World Tables 6.1. Therefore, it does not include Turkey. Including Turkey leaves results qualitatively unchanged.

¹⁸ This may be evidence of the endogeneity of emissions variables.

The freedom indices and corruption levels (measured by the negative of *corruption*) are systematically lower for the non-OECD as is the flow of FDI into non-OECD countries. Therefore, the story about competition for FDI may not really apply to the non-OECD countries because FDI tends to flow into countries that have relatively secure property rights and increased political openness. Another reason to believe that OECD and non-OECD countries are going through very different processes is that their average per capita emissions levels have been moving in different directions. Figure 2 reveals that the average CO₂ emissions fell by approximately ten percent for the OECD sample, while Figure 4 shows an approximate doubling of the average CO₂ emissions for the non-OECD sample.¹⁹

Table 5 presents the results for the non-OECD sample, and Table 6 presents the results for the South American sample. The results here are not statistically significant, likely because the sample is not very complete and the countries that did make it into the sample are spread few and far across the globe or across the South American continent. Even though South America provides the best concentration of poor countries in our sample, as noted earlier, South America only has two countries in the sample in the early years and six to seven countries in the later years. Also, with smaller sample sizes, multicollinearity (with two first-stage equations) is likely to cause larger problems in estimation.²⁰

¹⁹ The differences in the dynamics of the emissions across regions serve as motivation for the second paper in my dissertation where I will not only consider spatial interactions in emissions but also effectiveness of environmental treaties.

²⁰ “Because the multicollinearity problem is essentially a data problem, additional data that do not contain the multicollinearity feature could solve the problem. Even getting additional data with the same multicollinearity character would help, since the larger sample size would provide some additional information, helping to reduce variances” (Kennedy 2003, 210).

Appendix D presents the estimated year fixed effects for the non-OECD specifications presented in Table 5. These results suggest that the leader/follower story discussed above may be true. Starting from early 1990's the year fixed effects are economically and statistically significant and increasing across time for all five specifications. Thus, the story that the non-OECD countries are simply reacting to OECD countries participation in treaties seems reasonable.²¹

For robustness checks and for identification of cross-sectional and time series dynamics I present Tables 7 and 8. Table 7 provides the estimated spatial lag coefficient for the five specifications with and without different fixed effects and country-specific linear time trends when the independent variable is treaty participation for the full sample. The first row provides the spatial lags when no fixed effects or country-specific time trends are included in the analysis. The second row includes country but no year fixed effects. The third row only has the year fixed effects and no country fixed effects. The fourth row provides the results when both country and year fixed effects are included, thus, this matches the coefficient estimates for *particLAG* variable in Table 2. The fifth row contains no fixed effects but does allow for country-specific time trends. Then sixth and seventh row separately add the country and year fixed effects, respectively. Finally, in eighth row country-specific time trends along with country and year fixed effects are included.

As is apparent, the spatial lag is economically and statistically significant for all specifications even though its magnitude varies somewhat. Note that in both Tables 7 and 8 moving from the models with country and year fixed effects to models with only year or

²¹ Note that for the full sample most of the country and year fixed effects are also statistically significant.

country fixed effects always increases the spatial lag. This result indicates that both cross-sectional and time series variation contribute to the spatial interactions in treaty participation.

Another interesting result that is evident here and in Tables 2 through 4 is that the move from the OLS specification in column 1, where the spatial lag model is not properly instrumented for, to the 2SLS specification in column 2 always increases the magnitude of the spatial lag coefficient. The endogeneity bias of the spatial lag of treaty participation, thus, is negative. I cannot explain the sign of this bias.²² Similarly, moving from column 4 without the proximate countries' emissions to column 5 with it always decreases the spatial lag coefficient. This is not surprising because the proximate countries' emission levels are also related to the proximate countries' treaty participation. In fact, what is not considered in this study is the possible endogeneity of the proximate countries' pollution emissions.

Table 8 differs from Table 7 in that the dependent variable is not treaty participation, but the change in treaty participation. Because I am interested in the responsiveness of countries to their proximate countries' decision to join treaties rather than to their treaty participation level, I want to ensure that the results are not driven by historical treaty participation levels but rather concurrent changes in treaty participation. As is apparent from Table 8, for the large part I still find positive economically and statistically significant spatial lags. The exceptions occur when country-specific time trends are included together with year fixed effects. Also note that when the dependent variable is the change in treaty participation, the control variables that may have been statistically significant earlier become

²² Based on Table 2 it may seem that the export diversification index may be the culprit causing the negative bias but excluding it from the analysis does not remove the negative endogeneity bias.

insignificant for almost all the specifications. The full results for Tables 7 and 8 are available upon request.

VI. Conclusion

In this study I examine the competition in emissions taxes across countries theoretically, provide an explanation why such competition may lead to a positive spatial lag in environmental treaty participation, and empirically investigate such strategic interaction in treaty participation. A relatively simple theoretical model is presented in order to highlight the importance of transboundary pollution in strategic tax competition for FDI. This model is the first to explicitly identify the relationship between transboundary pollution effects and countries' best response functions in their emissions taxes—an increase in the transboundary effect between two countries, i.e. a decrease in distance, increases the strategic interaction effects in emissions taxes. If countries compete in their emissions taxes and if such competition is stronger between proximate countries, as my model suggests, then the countries located close together are more likely to be involved in stiff competition and would have a lot to gain from jointly ratifying international environmental treaties. Thus, environmental treaty participation may also display evidence of strategic interaction. The empirical estimates support such a hypothesis and find a positive spatial lag in treaty participation.

In the two-country theoretical model I find that the slope of the best response function is positive, and that this strategic complementarity increases as distance between countries decreases. My empirical estimates for the full and the OECD sample find positive

economically and statistically significant strategic effects between countries' decisions to join treaties. Given the theoretical literature concluding that competition in environmental regulation is not Pareto optimal, these results may indicate that perhaps it is necessary to couple international trade agreements with environmental clauses.

European Union countries, on average, participate in more treaties than non-EU countries. I also find that growth in GNP, population, population density, urban population percentage and corruption affects treaty participation. For the OECD subsample changes in export diversification affect treaty participation. And for OECD and European samples increases in own and/or proximate countries' CO₂ emissions increase treaty participation. It cannot be overlooked that foreign and domestic capital flows do not seem to influence countries' treaty participation decisions.

As an extension of my field paper I plan to estimate spatial probit models for individual treaties and a system of unrelated regressions of the treaty ratification decisions. The second part of my dissertation will extend the current analysis to consider spatial effects in the pollution levels across countries. In particular, I am interested to see if the strategic effects in environmental policy carry over to the policy outcome variable, and shed light on effectiveness of environmental treaties. Also, using the current dataset I will analyze the effect of treaty participation on FDI flows and/or stocks.

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Figure 1 Average Treaty Participation (number of treaties) and Average CO₂ Emissions (metric tons per capita) for the Full Sample, 1980-2000

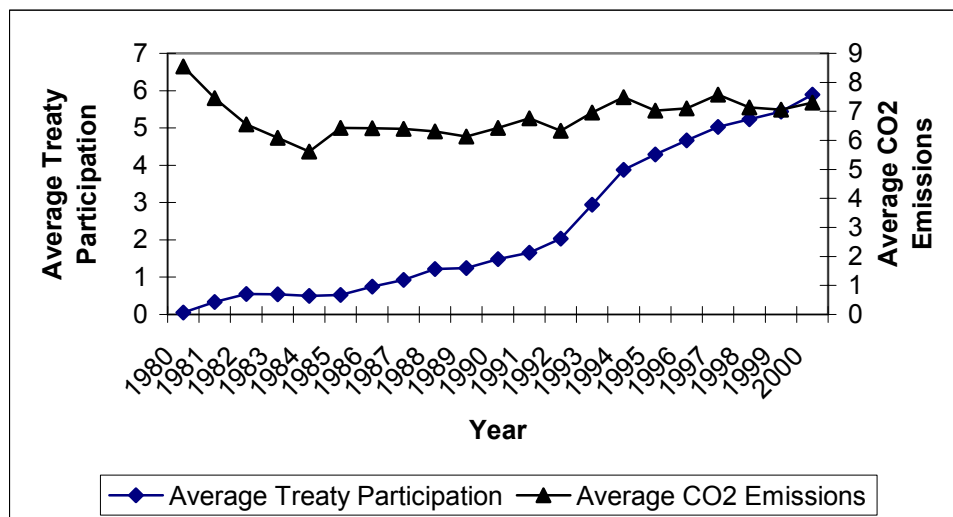


Figure 2 Average Treaty Participation (number of treaties) and Average CO₂ Emissions (metric tons per capita) for the OECD Sample, 1980-2000

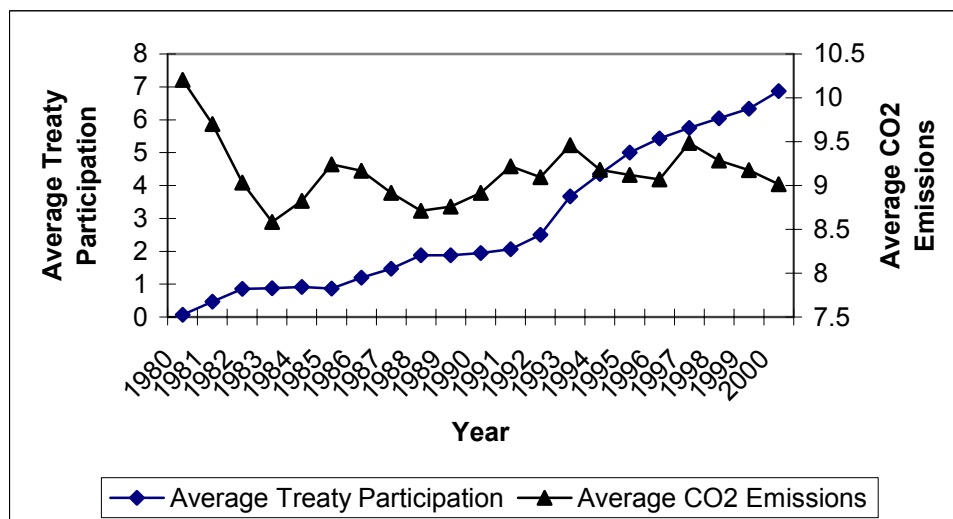


Figure 3 Average Treaty Participation (number of treaties) and Average CO₂ Emissions (metric tons per capita) for the European Sample, 1980-2000

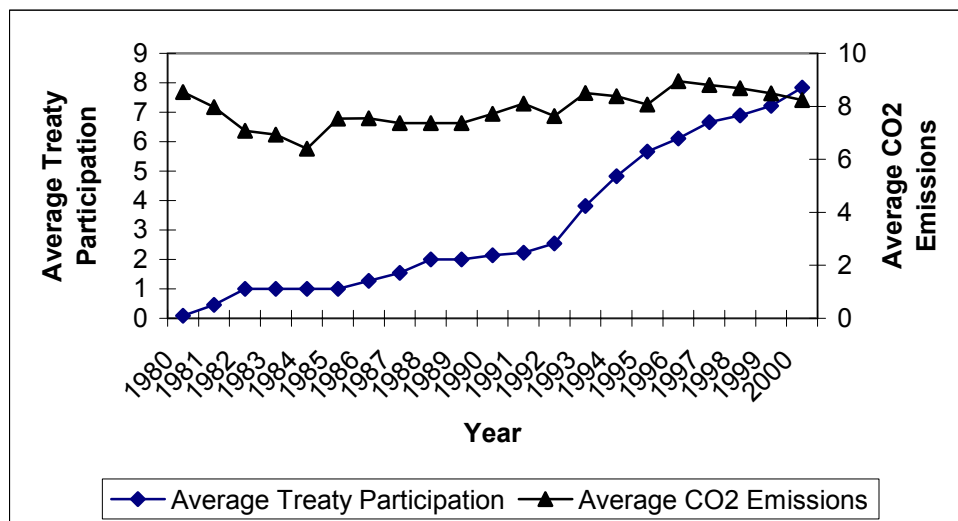


Figure 4 Average Treaty Participation (number of treaties) and Average CO₂ Emissions (metric tons per capita) for the Non-OECD Sample, 1980-2000

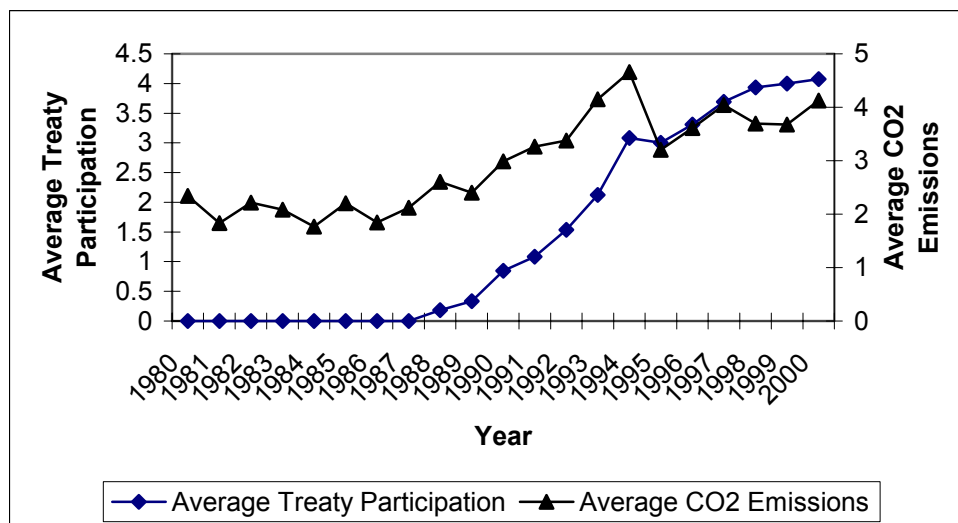


Figure 5 Average Treaty Participation (number of treaties) and Average CO₂ Emissions (metric tons per capita) for the South American Sample, 1980-2000

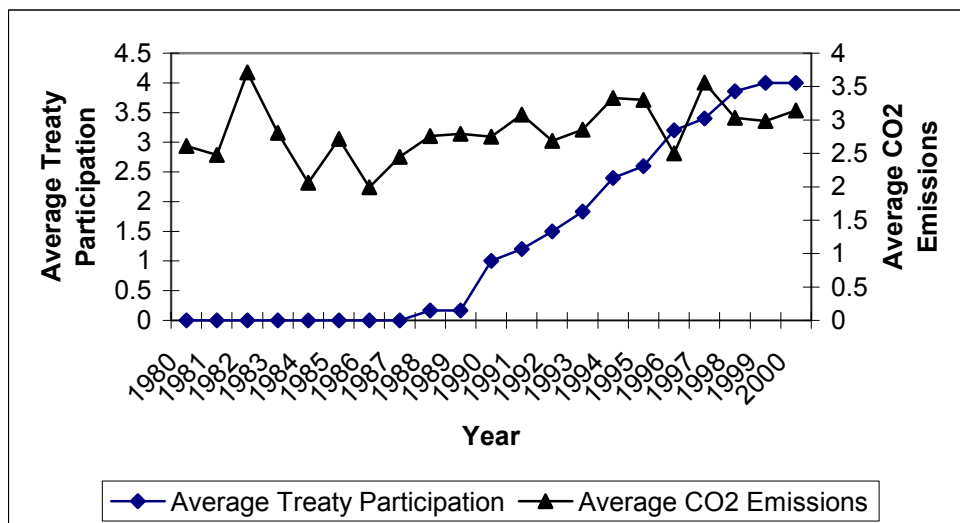


Table 1 Expected Signs

Variable	+/-	Reason
<i>particLAG</i>	+	The theoretical model predicts that this variable is positive.
<i>FDI</i>	+/-	As more investment flows into a country, the country is likely to see the added benefits from investment and to encourage more of it by lowering its environmental stringency. On the other hand, since investment increases industrial activity and pollution, higher levels of foreign capital flows may also boost environmental stringency.
<i>lcap</i>	+/-	Similar arguments as made for <i>FDI</i> may be made here. (Because foreign investment is relatively more mobile, I would predict that if <i>FDI</i> has no impact on treaty participation then also <i>lcap</i> will have no impact on treaty participation.)
<i>lgnp</i>	+	Since environmental quality is a normal good, higher income would imply higher demand for environmental quality.
<i>lpop</i>	+	Larger population size would increase the country's role in the international arena and the likelihood of the country to be drawn into talks and signing of new treaties.
<i>ldensity</i>	-	Larger population density (smaller area for a given population size) would reduce the country's ability to abide by international environmental regulations because population pressures on the land are higher.
<i>urban_perc</i>	-	Similar to the argument for the <i>ldensity</i> variable, higher concentration of people in urban areas would mean higher industrial pressures and lower environmental quality.
<i>unemp_perc</i>	-	Higher unemployment in a country would provide more of a reason for a country to allow polluting industries to create jobs.
<i>free</i>	+	The higher the freedom index (the sum of political rights and civil rights indices) the more information are citizens getting about the negative effects of pollution and the more can the citizens affect the government's decisions to join environmental treaties.
<i>corruption</i>	+	Higher Corruption Perceptions Index (lower corruption) implies that the country is more likely to be engaged and credited in the international arena and drawn into international environmental agreements.
<i>union</i>	+	The European Union countries seem to be on the forefront of emphasizing environmental issues.
<i>exp_div</i>	+	The more diverse are a country's exports (the higher <i>exp_div</i>), the easier it can substitute toward different exports to improve environmental quality.
<i>lexports</i>	-	The more a country exports, the higher are the country's pressures

Variable	+/-	Reason
		to produce pollution. Therefore, I predict that higher exports reduce the number of treaties in which a country participates.
<i>limports</i>	+/-	There are at least two avenues through which imports may impact treaty participation. On the one hand, higher imports for domestic consumption would imply less domestic production would be required and lower pressures to pollute and higher probability of joining environmental treaties. On the other hand, if a country imports a lot of intermediate goods for production then an increase in this country's imports would result in lower treaty participation.
<i>lgdpLAG</i>	-	Higher market potential (distance weighted average of proximate countries' GDPs) implies that the country would have higher pressures to produce. This in turn may result in downward pressure to join treaties.
<i>lco2emiss</i>	+	Higher domestic emissions imply higher marginal costs of emissions and therefore more reasons to join treaties.
<i>lemissLAG</i>	+	Similarly, if there is a lot of pollution flowing into the country across the borders, even if the country itself does not produce much pollution the marginal cost of additional unit of pollution is high and therefore the country is more likely to join environmental treaties.

Table 2 Estimated Treaty Participation Equations for the Full Sample

	(1) OLS	(2) 2SLS	(3) End FDI	(4) Own	(5) Neighbor
<i>particLAG</i>	0.595*** (8.63)	0.708*** (3.62)	0.731*** (3.94)	0.735*** (3.95)	0.689*** (4.69)
<i>FDI</i>	0.030 (0.74)	0.024 (0.56)	0.103 (0.68)	0.129 (0.83)	0.129 (0.85)
<i>lcap</i>	0.395 (1.47)	0.382 (1.41)	0.354 (1.29)	0.350 (1.27)	0.354 (1.28)
<i>lgnp</i>	-0.983** (2.09)	-0.957** (2.02)	-0.861* (1.71)	-1.023* (1.94)	-1.011* (1.91)
<i>lpop</i>	19.638*** (3.22)	19.881*** (3.25)	17.867** (2.49)	16.940** (2.33)	17.021** (2.35)
<i>ldensity</i>	-21.821*** (3.54)	-21.334*** (3.43)	-19.160*** (2.62)	-18.213** (2.46)	-18.579** (2.52)
<i>urban_perc</i>	-2.829** (2.56)	-2.768** (2.48)	-2.729** (2.44)	-2.945** (2.58)	-3.025*** (2.64)
<i>unemp_perc</i>	0.015 (0.01)	-0.014 (0.01)	-0.169 (0.11)	-0.264 (0.17)	-0.229 (0.15)
<i>free</i>	-0.006 (0.23)	-0.007 (0.28)	-0.001 (0.04)	0.001 (0.04)	0.003 (0.11)
<i>corruption</i>	0.199*** (3.73)	0.191*** (3.49)	0.176*** (2.91)	0.165*** (2.68)	0.171*** (2.79)
<i>union</i>	0.624*** (3.93)	0.598*** (3.64)	0.580*** (3.49)	0.578*** (3.47)	0.599*** (3.61)
<i>exp_div</i>	2.148** (2.12)	1.673 (1.31)	1.245 (0.89)	1.141 (0.81)	1.312 (0.97)
<i>lexports</i>	-0.239 (0.94)	-0.282 (1.06)	-0.320 (1.18)	-0.392 (1.39)	-0.398 (1.38)
<i>limports</i>	-0.287 (1.09)	-0.251 (0.93)	-0.323 (1.06)	-0.325 (1.06)	-0.325 (1.07)
<i>lgdpLAG</i>	0.140 (1.42)	0.144 (1.46)	0.127 (1.21)	0.108 (1.01)	0.139 (1.01)
<i>lco2emiss</i>				0.224 (1.00)	0.229 (1.02)
<i>lemissLAG</i>					-0.102 (0.38)
<i>Constant</i>	-128.274** (2.58)	-131.693*** (2.63)	-114.958* (1.94)	-101.843* (1.67)	-102.622* (1.69)
Observations	619	619	619	619	619
R-squared	0.94	0.94	0.94	0.94	0.94

All specifications include year and country fixed effects.

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 Estimated Treaty Participation Equations for the OECD Sample

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	End FDI	Own	Neighbor
<i>particLAG</i>	0.379*** (4.61)	0.599*** (5.20)	0.585*** (5.04)	0.588*** (5.04)	0.481*** (4.38)
<i>FDI</i>	-0.019 (0.34)	-0.021 (0.38)	-0.013 (0.08)	0.091 (0.51)	-0.005 (0.03)
<i>lcap</i>	0.356 (0.59)	0.325 (0.53)	0.319 (0.50)	0.425 (0.67)	0.514 (0.84)
<i>lgnp</i>	-5.154*** (3.93)	-5.131*** (3.87)	-5.129*** (3.86)	-6.002*** (4.30)	-5.469*** (3.99)
<i>lpop</i>	22.131* (1.94)	24.881** (2.15)	24.678** (2.14)	25.295** (2.19)	23.522** (2.09)
<i>ldensity</i>	-26.532** (2.38)	-28.196** (2.50)	-28.042** (2.49)	-28.266** (2.51)	-26.327** (2.39)
<i>urban_perc</i>	-4.064** (2.39)	-3.983** (2.31)	-3.967** (2.24)	-4.947*** (2.73)	-5.468*** (3.09)
<i>unemp_perc</i>	-4.760* (1.73)	-5.274* (1.89)	-5.209* (1.83)	-4.666 (1.63)	-5.364* (1.92)
<i>free</i>	-0.053 (0.68)	-0.066 (0.83)	-0.064 (0.74)	-0.036 (0.41)	-0.090 (1.05)
<i>corruption</i>	0.339*** (4.00)	0.297*** (3.42)	0.300*** (3.43)	0.298*** (3.41)	0.272*** (3.16)
<i>union</i>	0.644*** (3.29)	0.608*** (3.07)	0.605*** (2.76)	0.575*** (2.62)	0.489** (2.27)
<i>exp_div</i>	8.162*** (4.34)	6.623*** (3.34)	6.677*** (3.00)	5.139** (2.12)	6.824*** (2.93)
<i>lexports</i>	-0.669 (1.31)	-0.793 (1.53)	-0.792 (1.47)	-0.872 (1.62)	-0.605 (1.15)
<i>limports</i>	0.161 (0.25)	0.289 (0.45)	0.295 (0.42)	0.449 (0.64)	-0.220 (0.31)
<i>lgdpLAG</i>	0.200 (1.05)	0.228 (1.18)	0.224 (1.15)	0.244 (1.25)	-0.262 (1.04)
<i>lco2emiss</i>				0.728** (1.97)	0.712** (2.00)
<i>lemissLAG</i>					2.231*** (3.03)
<i>Constant</i>	-79.878 (0.76)	-104.328 (0.97)	-102.614 (0.96)	-93.817 (0.87)	-77.537 (0.74)
Observations	381	381	381	381	381
R-squared	0.95	0.95	0.95	0.95	0.95

All specifications include year and country fixed effects.

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4 Estimated Treaty Participation Equations for the European Sample

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	End FDI	Own	Neighbor
<i>particLAG</i>	-0.085 (0.46)	0.904** (2.04)	0.810* (1.93)	0.435 (1.09)	0.284 (0.77)
<i>FDI</i>	-0.058 (0.83)	-0.121 (1.54)	-0.180 (1.09)	0.013 (0.08)	0.005 (0.03)
<i>lcap</i>	0.828 (1.42)	0.391 (0.61)	0.453 (0.71)	0.785 (1.28)	0.921 (1.54)
<i>lgnp</i>	-3.328** (2.38)	-3.538** (2.38)	-3.424** (2.30)	-4.411*** (3.00)	-3.973*** (2.72)
<i>lpop</i>	-9.842 (0.53)	-9.865 (0.50)	-7.071 (0.35)	-9.539 (0.49)	0.500 (0.03)
<i>ldensity</i>	10.893 (0.64)	14.379 (0.79)	11.714 (0.63)	14.211 (0.80)	4.751 (0.26)
<i>urban_perc</i>	-7.139*** (3.54)	-6.386*** (2.96)	-6.695*** (3.05)	-8.147*** (3.81)	-8.338*** (3.98)
<i>unemp_perc</i>	-1.911 (0.62)	-5.991 (1.65)	-5.399 (1.51)	-2.757 (0.79)	-1.682 (0.50)
<i>free</i>	-0.203* (1.73)	-0.122 (0.95)	-0.153 (1.13)	-0.053 (0.39)	-0.092 (0.69)
<i>corruption</i>	0.364*** (3.61)	0.291*** (2.63)	0.314*** (2.75)	0.316*** (2.89)	0.303*** (2.84)
<i>union</i>	0.615*** (3.10)	0.700*** (3.29)	0.694*** (3.29)	0.669*** (3.33)	0.555*** (2.75)
<i>exp_div</i>	4.089* (1.85)	2.671 (1.11)	3.017 (1.25)	0.598 (0.24)	1.405 (0.57)
<i>lexports</i>	-0.376 (0.62)	-1.023 (1.48)	-0.947 (1.39)	-0.874 (1.35)	-0.557 (0.88)
<i>limports</i>	-0.617 (0.79)	0.416 (0.45)	0.343 (0.38)	0.052 (0.06)	-0.526 (0.62)
<i>lgdpLAG</i>	0.521 (1.52)	0.404 (1.10)	0.439 (1.20)	0.588* (1.67)	0.448 (1.25)
<i>lco2emiss</i>				1.121*** (2.74)	1.259*** (3.17)
<i>lemissLAG</i>					2.039** (2.01)
<i>Constant</i>	109.269 (1.10)	102.835 (0.98)	85.310 (0.76)	111.273 (1.04)	55.383 (0.51)
Observations	292	292	292	292	292
R-squared	0.95	0.95	0.95	0.95	0.96

All specifications include year and country fixed effects.

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5 Estimated Treaty Participation Equations for the Non-OECD Sample

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	End FDI	Own	Neighbor
<i>particLAG</i>	0.076 (0.79)	0.025 (0.16)	0.008 (0.05)	0.008 (0.05)	0.067 (0.43)
<i>FDI</i>	0.021 (0.39)	0.021 (0.39)	-0.035 (0.23)	-0.028 (0.19)	-0.054 (0.38)
<i>lcap</i>	0.108 (0.45)	0.086 (0.35)	0.086 (0.35)	0.115 (0.46)	0.116 (0.46)
<i>lgnp</i>	0.193 (0.46)	0.229 (0.53)	0.153 (0.31)	0.257 (0.50)	0.268 (0.51)
<i>lpop</i>	6.194 (1.01)	6.114 (0.99)	7.004 (1.06)	6.874 (1.05)	7.950 (1.20)
<i>ldensity</i>	-5.651 (0.91)	-5.648 (0.91)	-6.559 (0.99)	-6.432 (0.98)	-7.334 (1.11)
<i>urban_perc</i>	0.328 (0.21)	0.208 (0.13)	0.309 (0.19)	-0.010 (0.01)	0.106 (0.06)
<i>unemp_perc</i>	1.280 (0.71)	1.430 (0.78)	1.732 (0.91)	1.463 (0.75)	1.550 (0.79)
<i>free</i>	-0.019 (0.85)	-0.019 (0.88)	-0.022 (0.97)	-0.023 (1.02)	-0.024 (1.04)
<i>corruption</i>	-0.077 (1.33)	-0.073 (1.25)	-0.062 (1.00)	-0.051 (0.83)	-0.047 (0.75)
<i>exp_div</i>	0.410 (0.34)	0.499 (0.41)	0.775 (0.58)	0.467 (0.33)	0.435 (0.30)
<i>lexports</i>	-0.345 (1.13)	-0.342 (1.12)	-0.297 (0.91)	-0.201 (0.61)	-0.226 (0.67)
<i>limports</i>	-0.208 (0.84)	-0.199 (0.80)	-0.122 (0.40)	-0.147 (0.47)	-0.129 (0.42)
<i>lgdpLAG</i>	0.049 (0.52)	0.044 (0.47)	0.055 (0.55)	0.077 (0.77)	0.091 (0.91)
<i>lco2emiss</i>				-0.285 (0.90)	-0.244 (0.77)
<i>lemissLAG</i>					-0.075 (0.60)
<i>Constant</i>	-45.620 (0.88)	-45.281 (0.87)	-53.558 (0.95)	-56.938 (1.03)	-66.214 (1.18)
Observations	238	238	238	238	238
R-squared	0.96	0.96	0.96	0.96	0.96

All specifications include year and country fixed effects.

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6 Estimated Treaty Participation Equations for the South American Sample

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	End FDI	Own	Neighbor
<i>particLAG</i>	0.049 (0.27)	0.321 (1.15)	0.355 (1.34)	0.280 (1.08)	0.497 (1.49)
<i>FDI</i>	0.175* (1.67)	0.195* (1.81)	0.190 (1.03)	0.123 (0.66)	0.182 (0.94)
<i>lcap</i>	0.192 (0.43)	0.219 (0.49)	0.218 (0.47)	0.180 (0.39)	0.241 (0.50)
<i>lgnp</i>	1.485 (1.64)	1.430 (1.55)	1.415 (1.52)	1.391 (1.45)	1.461 (1.48)
<i>lpop</i>	-5.603 (0.26)	-10.239 (0.46)	-10.484 (0.45)	-6.697 (0.29)	-10.427 (0.43)
<i>ldensity</i>	-1.697 (0.09)	2.712 (0.14)	2.996 (0.15)	-0.284 (0.01)	3.645 (0.17)
<i>urban_perc</i>	5.601 (1.15)	6.364 (1.28)	6.408 (1.25)	5.754 (1.13)	7.791 (1.33)
<i>unemp_perc</i>	3.199 (1.24)	2.735 (1.03)	2.671 (1.01)	2.721 (1.02)	2.619 (0.95)
<i>free</i>	-0.029 (0.72)	-0.019 (0.47)	-0.018 (0.44)	-0.024 (0.56)	-0.013 (0.29)
<i>corruption</i>	-0.013 (0.14)	-0.018 (0.19)	-0.017 (0.16)	0.003 (0.02)	-0.001 (0.01)
<i>exp_div</i>	-0.800 (0.26)	-1.934 (0.59)	-2.021 (0.58)	-1.220 (0.35)	-1.967 (0.55)
<i>lexports</i>	-1.334* (1.79)	-1.250 (1.64)	-1.235 (1.61)	-1.224 (1.59)	-1.070 (1.30)
<i>limports</i>	-0.934* (1.73)	-1.019* (1.85)	-1.016 (1.67)	-0.897 (1.44)	-1.046 (1.60)
<i>lgdpLAG</i>	-0.141 (0.62)	-0.068 (0.29)	-0.053 (0.22)	-0.040 (0.16)	-0.013 (0.05)
<i>lco2emiss</i>				-0.055 (0.10)	-0.029 (0.05)
<i>lemissLAG</i>					0.278 (0.64)
<i>Constant</i>	72.048 (0.39)	108.574 (0.56)	110.152 (0.55)	77.643 (0.38)	101.208 (0.49)
Observations	105	105	105	105	105
R-squared	0.96	0.96	0.96	0.96	0.96

All specifications include year and country fixed effects.

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7 Estimated Spatial Lag Coefficients for the Full Sample with and without Different Fixed Effects and Country-Specific Time Trends, where the Dependent Variable is Treaty Participation

Treaty Participation	(1) OLS	(2) 2SLS	(3) EndFDI	(4) Own	(5) Neighbor
No FE or country-trends	0.961*** (40.96)	1.017*** (29.96)	1.003*** (27.63)	0.983*** (27.97)	0.960*** (25.40)
Country FE	0.926*** (29.57)	1.086*** (17.00)	1.047*** (15.88)	1.067*** (15.92)	1.006*** (16.54)
Year FE	0.942*** (20.95)	1.107*** (17.41)	1.082*** (15.97)	1.068*** (16.70)	1.011*** (12.49)
Country and year FE	0.595*** (8.63)	0.708*** (3.62)	0.731*** (3.94)	0.735*** (3.95)	0.689*** (4.69)
Country-trends	0.819*** (21.54)	1.030*** (16.48)	1.028*** (16.59)	1.021*** (16.71)	0.932*** (15.37)
Country-trends and country FE	0.770*** (17.42)	0.937*** (10.88)	1.027*** (10.54)	1.001*** (10.61)	0.925*** (10.52)
Country-trends and year FE	0.481*** (6.42)	0.895*** (3.59)	0.806*** (3.39)	0.663*** (3.03)	0.419** (2.19)
Country-trends, and country and year FE	0.492*** (6.19)	1.066*** (4.08)	1.194*** (4.29)	0.910*** (4.51)	0.805*** (4.27)

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8 Estimated Spatial Lag Coefficients for the Full Sample with and without Different Fixed Effects and Country-Specific Time Trends, where the Dependent Variable is the Change in Treaty Participation

Change in Treaty Participation	(1) OLS	(2) 2SLS	(3) EndFDI	(4) Own	(5) Neighbor
No FE or country-trends	0.617*** (9.44)	0.811*** (3.11)	0.774*** (3.17)	0.803*** (3.42)	0.775*** (3.48)
Country FE	0.601*** (8.73)	0.845*** (3.98)	0.925*** (4.34)	0.942*** (4.57)	0.844*** (4.41)
Year FE	0.432*** (4.87)	0.918** (2.52)	0.958** (2.56)	0.911** (2.50)	0.837** (2.13)
Country and year FE	0.409*** (4.35)	0.942** (2.06)	0.892** (2.01)	0.895** (2.02)	0.726* (1.71)
Country-trends	0.610*** (8.85)	0.927*** (4.03)	0.957*** (4.43)	0.951*** (4.46)	0.844*** (4.16)
Country-trends and country FE	0.593*** (8.09)	0.893*** (3.93)	0.960*** (4.50)	0.954*** (4.52)	0.925*** (4.41)
Country-trends and year FE	0.416*** (4.43)	1.046** (2.23)	0.987** (2.11)	0.967** (2.09)	0.698 (1.600)
Country-trends, and country and year FE	0.395*** (3.99)	1.012* (1.69)	0.91 (1.57)	0.85 (1.52)	0.670 (1.44)

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix A—List of Environmental Treaties Included in the Study

1. Convention on Long-range Transboundary Air Pollution (Geneva, 13 November 1979)*
2. Vienna Convention for the Protection of the Ozone Layer (Vienna, 22 March 1985)*
3. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel, 22 March 1989)
4. Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, Finland, 25 February 1991)*
5. Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 17 March 1992)
6. Convention on the Transboundary Effects of Industrial Accidents (Helsinki, 17 March 1992)*
7. United Nations Framework Convention on Climate Change (New York, 9 May 1992)*
8. Agreement on the conservation of small cetaceans of the Baltic and North Seas (New York, 17 March 1992)
9. United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 14 October 1994)*
10. Convention on the Law of the Non-Navigational Uses of International Watercourses (New York, 21 May 1997)
11. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 10 September 1998)

* Roberts et al. (2004) provide short descriptions of the goals of these treaties.

The treaties included in this study were collected from the United Nations Treaty Database. This database contains ten more treaties that were formed as amendments to the treaties above. Using these along with the eleven above replicates much of the results in the presented analysis. One crucial difference in the results with the extended set of treaties is that for the South American subsample I find a negative spatial lag. That is if one's neighbors are joining more treaties the country on average joins fewer treaties.

Appendix B—Data

Table B 1 Variable Definitions and Data Sources

Variable	Definition	Source
<i>partic</i>	Treaty participation	UN Treaty Database
<i>particLAG</i>	Distance weighted average of treaty participation	Generated by author
<i>FDI</i>	Log of inbound FDI flows (millions of dollars)	UNCTAD Foreign Direct Investment database at http://www.unctad.org/Templates/Page.asp?intlItemID=1923&lang=1
<i>lcap</i>	Log of gross capital formation (constant 1995 US\$)	World Bank, World Development Indices 2004
<i>lgnp</i>	Log of gross national product	PWT Version 6.1
<i>lpop</i>	Log of population (in thousands)	PWT Version 6.1
<i>ldensity</i>	Log of population density (people per sq km)	Health, Nutrition, and Population Statistics Database, World Development Indices, World Bank, http://devdata.worldbank.org/hnpstats/query/default.html
<i>urban_perc</i>	Urban population (% of total)	World Bank, World Development Indices 2004
<i>unemp_perc</i>	Unemployment, total (% of total labor force)	World Bank, World Development Indices 2004
<i>free</i>	A sum of civil liberties and political rights indices	Freedom House, http://www.freedomhouse.org/ratings/index.htm
<i>corruption</i>	Corruption Perceptions Index	Transparency International, Internet Center for Corruption Research, http://www.icgg.org/corruption.cpi.html
<i>union</i>	European Union dummy	Generated by author
<i>exp_div</i>	Export diversification index ²³	UNCTAD, http://www.unctad.org/Templates/Page.asp?intlItemID=1890&lang=1

²³ “Diversification index that ranges from 0 to 1, reveals the extremal of the difference between the structure of trade of the country and the world average. The index value closer to 1 indicates a bigger difference from the

Variable	Definition	Source
<i>lexports</i>	Log of exports of goods and services (constant 1995 US\$)	World Bank, World Development Indices 2004
<i>limports</i>	Log of imports of goods and services (constant 1995 US\$)	World Bank, World Development Indices 2004
<i>lgdpLAG</i>	Distance weighted average of neighboring countries' GDP	Generated by author
<i>lco2emiss</i>	Log of CO2 emissions, (metric tons per capita)	Health, Nutrition, and Population Statistics Database, World Development Indices, World Bank, http://devdata.worldbank.org/hnpstats/query/default.html
<i>lemissLAG</i>	Log of distance weighted average of CO2 emissions, (metric tons per capita)	Generated by author and see <i>lco2emiss</i> source
<i>lgdp</i>	Log of GDP.	PWT Version 6.1
<i>ltc</i>	Trade costs = $\frac{1}{openness}$, where $Openness = \frac{Exports + Imports}{Real\ GDP\ per\ capita}$ and real GDP per capita is calculated using Laspeyres method (constant prices, in %).	PWT Version 6.1
<i>lblayr</i>	Log of average years of schooling for those over age 25. (Data every five years, with linear interpolation by authors for in-between years)	Barro and Lee International Data on Educational Attainment. Available at: http://www.cid.harvard.edu/ciddat/ciddata.html

world average. Absolute deviation of the country share from world structure, as follows: $S_j = \frac{\sum_{i=1}^n |h_{ij} - h_i|}{2}$,

where h_{ij} is a share of commodity i in total exports (or imports) of country j and h_i is a share of commodity i in total world exports (or imports). This index is a modified Finger-Kreinin measure of similarity in trade. For more information, please consult the article of Finger, J. M. and M. E. Kreinin (1979), "A measure of 'export similarity' and its possible uses" in the *Economic Journal*, 89: 905-12." (UNCTAD, <http://stats.unctad.org/restricted/eng/TableViewer/wdsdim/itemSummary.asp>)

Variable	Definition	Source
<i>lberi</i>	Log of measure of business environment risk. Composite measure of operations risk index, political risk index and remittance and repatriation factor index.	Business Environment Risk Intelligence S.A. CD-ROM of data purchased by Blonigen. More information at www.beri.com .

Table B 2 Descriptive Statistics for the Full Sample

Variable	Obs	Mean	St Dev	Min	Max
<i>partic</i>	619	2.70	2.39	0.00	10.00
<i>particLAG</i>	619	2.91	2.32	0.00	8.62
<i>FDI</i>	619	7.57	1.70	2.20	12.66
<i>lcap</i>	619	24.64	1.36	21.63	28.33
<i>lgnp</i>	619	23.96	1.20	21.47	27.61
<i>lpop</i>	619	10.21	1.17	8.14	14.05
<i>ldensity</i>	619	4.07	1.33	0.65	6.17
<i>urban_perc</i>	619	0.68	0.17	0.17	0.92
<i>unemp_perc</i>	619	0.08	0.04	0.01	0.24
<i>free</i>	619	4.25	2.81	2.00	14.00
<i>corruption</i>	619	5.89	2.51	1.00	10.00
<i>union</i>	619	0.29	0.45	0.00	1.00
<i>exp_div</i>	619	0.52	0.16	0.23	0.88
<i>lexports</i>	619	24.73	1.26	21.56	27.77
<i>limports</i>	619	24.72	1.23	22.04	28.08
<i>lgdpLAG</i>	619	19.92	0.69	18.23	22.65
<i>lco2emiss</i>	619	1.62	0.88	-0.84	3.01
<i>lemissLAG</i>	619	1.89	0.39	0.60	2.89
<i>lgdp</i>	619	19.38	1.19	16.87	23.01
<i>ltc</i>	619	-3.84	0.58	-5.27	-2.21
<i>lblayr</i>	619	1.96	0.39	0.57	2.51
<i>lberi</i>	619	3.98	0.22	3.50	4.42
<i>lcapLAG</i>	619	24.73	0.77	22.66	27.15
<i>lgnpLAG</i>	619	23.97	0.69	22.39	26.51
<i>lpopLAG</i>	619	10.11	0.64	8.67	12.41
<i>ldensLAG</i>	619	4.27	0.80	1.52	5.53
<i>urbLAG</i>	619	0.70	0.09	0.30	0.84
<i>unempLAG</i>	619	0.08	0.02	0.03	0.16
<i>freeLAG</i>	619	3.85	1.68	2.08	9.52
<i>cpiLAG</i>	619	6.31	1.54	2.80	8.51
<i>exp_divLAG</i>	619	0.49	0.11	0.32	0.80
<i>lexportsLAG</i>	619	24.90	0.80	22.50	26.94
<i>limportsLAG</i>	619	24.87	0.81	22.75	27.14
<i>gdpLAG2</i>	619	19.88	0.52	18.57	21.89
<i>emissLAG1</i>	619	1.72	0.49	0.12	2.79
<i>emissLAG2</i>	619	1.92	0.30	0.96	2.77

Table B 3 Full Sample Countries

Country	Number of Years
Argentina	20
Australia	21
Austria	15
Brazil	15
Canada	21
Chile	18
China	6
Colombia	21
Czech Republic	7
Denmark	20
Ecuador	12
Egypt	13
Finland	19
France	21
Germany	9
Hungary	9
Indonesia	2
Ireland	20
Israel	5
Italy	20
Japan	18
Korea, Republic of	20
Malaysia	15
Mexico	11
Netherlands	21
Norway	17
Pakistan	17
Peru	3
Philippines	20
Poland	10
Portugal	21
Russia	5
Spain	21
Sweden	20
Switzerland	17
Thailand	20
Turkey	13
USA	20
United Kingdom	20
Venezuela	16
Total	619

Table B 4 OECD Sample Countries

Country	Number of Years
Australia	21
Austria	15
Canada	21
Czech Republic	5
Denmark	20
Finland	19
France	21
Germany	9
Hungary	5
Ireland	20
Italy	20
Japan	18
Korea, Republic of	5
Mexico	7
Netherlands	21
Norway	17
Poland	5
Portugal	21
Spain	21
Sweden	20
Switzerland	17
Turkey	13
USA	20
United Kingdom	20
Total	381

Table B 5 European Sample Countries

Country	Number of Years
Austria	15
Czech Republic	7
Denmark	20
Finland	19
France	21
Germany	9
Hungary	9
Ireland	20
Italy	20
Netherlands	21
Norway	17
Poland	10
Portugal	21
Russia	5
Spain	21
Sweden	20
Switzerland	17
United Kingdom	20
Total	292

Table B 6 Non-OECD Sample Countries

Country	Number of Years
Argentina	20
Brazil	15
Chile	18
China	6
Colombia	21
Czech Republic	2
Ecuador	12
Egypt	13
Hungary	4
Indonesia	2
Israel	5
Korea, Republic of	15
Malaysia	15
Mexico	4
Pakistan	17
Peru	3
Philippines	20
Poland	5
Russia	5
Thailand	20
Venezuela	16
Total	238

Table B 7 South American Sample Countries

Country	Number of Years
Argentina	20
Brazil	15
Chile	18
Colombia	21
Ecuador	12
Peru	3
Venezuela	16
Total	105

Appendix C—First Stage Equations for the Model in Column 5 of Table 2.

Table C 1 First Stage Equations for the Model in Column 5 of Table 2

Variable	<i>particLAG</i> equation		<i>FDI</i> equation	
	Coefficient	Absolute t-value	Coefficient	Absolute t-value
<i>lcapLAG</i>	0.225	0.85	-0.373	0.80
<i>lgnpLAG</i>	1.133**	2.08	2.119**	2.21
<i>lpopLAG</i>	-1.117***	3.03	-1.066	1.64
<i>ldensLAG</i>	-0.068	0.53	0.294	1.30
<i>urbLAG</i>	-3.838***	5.70	-1.799	1.52
<i>unempLAG</i>	2.912*	1.84	-1.95	0.70
<i>freeLAG</i>	-0.027	0.85	0.014	0.25
<i>cpiLAG</i>	0.182***	3.08	-0.284***	2.73
<i>exp_divLAG</i>	2.156**	2.28	0.566	0.34
<i>lexportsLAG</i>	0.383	1.54	0.314	0.72
<i>limportsLAG</i>	-0.863***	3.37	-0.362	0.80
<i>gdpLAG2</i>	0.038	0.23	0.829***	2.92
<i>lgdp</i>	-0.981	0.69	-0.927	0.37
<i>ltc</i>	-0.058	0.10	-0.494	0.48
<i>lblayr</i>	-0.558	1.33	-1.423*	1.92
<i>lberi</i>	1.004***	2.91	1.085*	1.79
<i>lcap</i>	0.215	1.33	0.299	1.05
<i>lgnp</i>	0.476	0.34	0.045	0.02
<i>lpop</i>	-0.683	0.18	23.958***	3.65
<i>ldensity</i>	-4.479	1.19	-22.922***	3.46
<i>urban_perc</i>	-0.207	0.28	-1.144	0.89
<i>unemp_perc</i>	-0.798	0.83	1.17	0.69
<i>free</i>	0.007	0.46	-0.084***	3.00
<i>corruption</i>	0.076**	2.29	0.073	1.25
<i>union</i>	0.255***	2.64	0.245	1.44
<i>exp_div</i>	3.68***	5.93	4.372***	4.00
<i>lexports</i>	0.564*	1.84	0.306	0.57
<i>limports</i>	-0.47	1.33	0.481	0.77
<i>lgdpLAG</i>	-0.124	0.62	-0.594*	1.67

Variable	<i>particLAG</i> equation		<i>FDI</i> equation	
	Coefficient	Absolute t-value	Coefficient	Absolute t-value
<i>yr1981</i>	0.385***	2.87	0.246	1.04
<i>yr1982</i>	0.773***	4.57	-0.225	0.76
<i>yr1983</i>	0.619***	3.14	0.008	0.02
<i>yr1984</i>	0.524**	2.38	0.024	0.06
<i>yr1985</i>	0.699***	2.93	-0.093	0.22
<i>yr1986</i>	1.009***	3.98	0.333	0.75
<i>yr1987</i>	1.301***	4.61	0.437	0.88
<i>yr1988</i>	1.69***	5.47	0.742	1.36
<i>yr1989</i>	1.823***	5.40	0.804	1.35
<i>yr1990</i>	2.175***	5.85	0.812	1.24
<i>yr1991</i>	2.594***	6.39	0.42	0.59
<i>yr1992</i>	3.068***	7.22	0.603	0.81
<i>yr1993</i>	4.197***	9.64	0.606	0.79
<i>yr1994</i>	4.991***	10.93	0.821	1.02
<i>yr1995</i>	5.671***	12.08	0.737	0.89
<i>yr1996</i>	6.154***	12.68	0.842	0.99
<i>yr1997</i>	6.636***	13.07	0.962	1.08
<i>yr1998</i>	6.92***	13.27	1.253	1.37
<i>yr1999</i>	7.192***	13.20	1.406	1.47
<i>yr2000</i>	7.646***	13.40	1.4	1.39
<i>cny2</i>	-8.097**	2.06	-24.594***	3.56
<i>cny3</i>	9.071	0.69	77.581***	3.34
<i>cny4</i>	3.315	0.79	-27.48***	3.70
<i>cny5</i>	-5.337	1.17	-28.816***	3.60
<i>cny6</i>	-0.165	0.03	27.996***	3.22
<i>cny7</i>	13.036***	2.69	-32.197***	3.77
<i>cny8</i>	4.359	1.17	19.999***	3.04
<i>cny9</i>	11.754	0.87	80.819***	3.41
<i>cny10</i>	9.718	0.62	94.19***	3.41
<i>cny11</i>	3.355	0.39	49.2***	3.21
<i>cny12</i>	7.064*	1.78	19.277***	2.75
<i>cny13</i>	0.691	0.08	48.575***	3.31
<i>cny14</i>	12.08**	2.00	34.986***	3.29

Appendix D—Year Fixed Effects for the Models in Table 5.

Table D 1 Year Fixed Effects for the Models in Table 5

	(1) OLS	(2) 2SLS	(3) EndFDI	(4) Own	(5) Neighbor
<i>yr1981</i>	-0.052 (0.19)	-0.055 (0.20)	0.002 (0.01)	-0.026 (0.08)	-0.024 (0.08)
<i>yr1982</i>	-0.050 (0.19)	-0.052 (0.20)	-0.022 (0.08)	-0.050 (0.18)	-0.058 (0.20)
<i>yr1983</i>	-0.138 (0.49)	-0.144 (0.51)	-0.095 (0.31)	-0.130 (0.41)	-0.137 (0.43)
<i>yr1984</i>	-0.187 (0.64)	-0.194 (0.66)	-0.149 (0.47)	-0.201 (0.61)	-0.221 (0.66)
<i>yr1985</i>	-0.189 (0.59)	-0.195 (0.60)	-0.144 (0.41)	-0.209 (0.57)	-0.219 (0.59)
<i>yr1986</i>	-0.198 (0.58)	-0.202 (0.59)	-0.136 (0.35)	-0.220 (0.54)	-0.238 (0.58)
<i>yr1987</i>	-0.187 (0.50)	-0.189 (0.50)	-0.106 (0.25)	-0.202 (0.44)	-0.210 (0.45)
<i>yr1988</i>	-0.158 (0.39)	-0.152 (0.38)	-0.046 (0.10)	-0.141 (0.28)	-0.137 (0.27)
<i>yr1989</i>	0.088 (0.20)	0.105 (0.24)	0.223 (0.44)	0.119 (0.22)	0.099 (0.18)
<i>yr1990</i>	0.473 (1.01)	0.515 (1.08)	0.634 (1.19)	0.520 (0.93)	0.471 (0.82)
<i>yr1991</i>	0.662 (1.31)	0.710 (1.38)	0.836 (1.46)	0.713 (1.18)	0.658 (1.06)
<i>yr1992</i>	0.946* (1.74)	1.022* (1.79)	1.160* (1.88)	1.031 (1.59)	0.951 (1.42)
<i>yr1993</i>	1.421** (2.43)	1.524** (2.42)	1.675** (2.51)	1.544** (2.21)	1.444** (2.00)
<i>yr1994</i>	2.292*** (3.54)	2.441*** (3.33)	2.616*** (3.44)	2.465*** (3.10)	2.314*** (2.80)
<i>yr1995</i>	2.436*** (3.65)	2.575*** (3.49)	2.738*** (3.59)	2.584*** (3.24)	2.416*** (2.88)
<i>yr1996</i>	2.672*** (3.68)	2.840*** (3.46)	3.030*** (3.57)	2.882*** (3.27)	2.688*** (2.91)
<i>yr1997</i>	3.083*** (4.03)	3.270*** (3.73)	3.477*** (3.85)	3.318*** (3.54)	3.117*** (3.18)
<i>yr1998</i>	3.285*** (4.16)	3.476*** (3.85)	3.685*** (3.96)	3.529*** (3.67)	3.309*** (3.27)
<i>yr1999</i>	3.336*** (4.08)	3.529*** (3.80)	3.743*** (3.90)	3.582*** (3.61)	3.355*** (3.21)
<i>yr2000</i>	3.425*** (4.05)	3.621*** (3.79)	3.822*** (3.92)	3.645*** (3.60)	3.414*** (3.22)

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%