Ca' Foscari University of Venice

Department of Economics

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Jonas Werth

Alessia Russo

Fabio Miessi Sanches

Bandwagon Effects in International Environmental Agreements

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Jonas Werth
Ca' Foscari University of Venice; BI Norwegian Business School

Alessia Russo
University of Padua; CEPR

Fabio Miessi Sanches
São Paulo School of Economics

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This paper develops a dynamic model of environmental treaty formation with heterogeneous countries that allows for entry, exit and country specific uncertainty on the benefits from other countries ratifying the treaty. Using a dataset comprising the cross-section of ratification dates of global environmental treaties for 1980-2020, we structurally estimate the model's parameters. The estimates inform about the existence of strategic complementarity or substitutability in the formation of environmental treaties, which occur when the relative benefits from cooperation increase or decrease after the inclusion of an additional country. Through counterfactual experiments, we illustrate how mechanisms fostering strategic complementarity can expedite the establishment of a grand coalition in support of environmental treaties and quantify associated welfare gains.

Keywords
Dynamic Model Estimation, Heterogeneous Countries, International Environmental Agreement, Strategic Complementarity

JEL Codes
D86, F55, H87, Q54

Address for correspondence:
Alessia Russo
Department of Economics and Management
University of Padua
Via Del Santo, 33
35123 Padova - Italy
e-mail: alessia.russo@unipd.it

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Jonas Werth (Ca' Foscari University of Venice and BI Norwegian Business School)
Alessia Russo (University of Padua and CEPR)
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December 2024

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1 Introduction

Droughts, floods, heatwaves, and other environmental disasters have heightened awareness of climate change and the potential consequences of transboundary pollution in recent decades. Addressing these environmental challenges necessitates international cooperation. However, the historical track record of international environmental policy-making has cast doubts on the effectiveness of global agreements and the ability of the international community to forge a coordinated and meaningful policy response through global environmental treaties. International cooperation is beneficial in situations where unilateral policies are costly and have positive externalities. If states do not take those externalities into account the aggregate unilateral policy response will fall short of the social optimum (Samuelson, 1954).

Governments coordinate their environmental policies using international environmental agreements. Those function as intergovernmental contracts, constituting international law. National governments are free to express their consent to be bound by such treaties through ratification, partially giving up their sovereignty to set legislation in the respective policy domain. However, much like governments cannot be forced to ratify international treaties they cannot be forced to remain part of them. Countries are free to withdraw from international treaties and with the benefits of their peers' environmental policies being shared indiscriminatory they have an incentive to free-ride on other states coordinated environmental policies and stay out of environmental coalitions. If all the international treaty does is to coordinate policies that benefit members and non members indiscriminately the treaty does not change the individual states incentive to participate in the treaty.

The existing literature uses game theory models, both static and dynamic, to analyze the complexities of decision-making in the absence of a centralized enforcement authority. The central focus is on understanding the economic incentives and strategic considerations that shape countries' choices between active participation, with associated costs, and free-riding on the efforts of others. Studies often highlight the paradox of cooperation, emphasizing the challenges inherent in self-enforcing international treaties (Barrett, 1994). This paradox suggests that such agreements may suffer from either low participation when costs are high or achieve high participation only when cooperative efforts yield minimal additional gains. Implications of this paradox on the effectiveness of global environmental agreements have been examined considering factors such as treaty design, incentive structures, and the impact of economic considerations on countries' decisions to cooperate or defect.

Clubs have been proposed in the literature as a means to overcome the free-ride incentive that underlies the provision of global public goods. Nordhaus (2015) suggests the formation of "climate clubs," wherein groups of countries voluntarily join together to coordinate and enforce emission reduction policies. Clubs provide non-rivaleous goods, much like environmental treaties try do, but allow for discriminatory access to the provided good. This can take the form of sanctions against non members, as proposed by Nordhaus, or some intangible benefits that arise from being a member of the club. Such mechanisms effectively change the incentives of states to participate in the provision of the non-rivaleous good.

In this paper, we use an empirical estimation technique that is well established in the field of industrial organizations to study the type of strategic interaction that is at play when countries decide to participate in global environmental treaties. Our goal is to quantify the empirical relevance of free-ride incentives on the participation of global environmental treaties. The project combines a flexible model of treaty participation by sovereign, forward looking countries with a dataset on ratification and withdrawal dates of countries across a set of treaties. Each treaty is modeled as a repeated game of incomplete information with possible actions "participate" or "not participate" that countries take simultaneously.

We focus on stationary pure Markovian strategies that define each countries optimal decision as a function of a vector of states and an iid shock. We use data on the timing of ratifications and withdrawals of countries in environmental treaties to estimate conditional choice probabilities for countries in different states and the transition probabilities between those states. With this project we extend previous work done on estimating strategic games in treaty participation (Wagner, 2016) by broadening our analysis to multiple treaties and dropping the assumption of complete information. We use a panel of countries in major international environmental agreements signed between 1980 and 2019. This allows us to control for time-invariant country and treaty characteristics and therefore estimate the belief of a country about the likelihood of ratification in a given treaty from a single series of ratifications (line of play) over time. We find that increased participation has varying effects on the payoff of ratification for outsiders. We interpret this substantial heterogeneity as evidence against a pure public good model for international environmental treaties.

2 Model

The model is based on Pesendorfer & Schmidt-Dengler (2008) who derive the system of equations that characterizes the Markovian equilibrium in the general case of a dynamic game with finite and discrete actions for multiple players which extends previous work done by Rust (1987), Hotz and Miller (1993), and Aguirregabiria and Mira (2007). Our estimation strategy is borrowed from Sanches et at. (2016) who show that there exists a closed-form solution for the parameter vector that can be estimated using OLS.

We formalize the decision problem of country $i = 1, ..., I$ as follows. Time is discrete and denoted by $t = 1, .., \infty$. There are a $j \in \boldsymbol{J} = \{1, 2, ..., J\}$ environmental treaties that countries can decide to participate in during each period. Countries choose their actions to maximize the discounted sum of expected payoffs across treaties $j \in \boldsymbol{J}$. We use the terms "ratify" and "withdraw" for a countries decision to participate in treaty j conditional on having done so in the past or not. "Ratify" is used for countries that join the treaty, having not done so in the last period. "Withdraw" is used if a country leaves the treaty and has been a member in the previous period. We use "participate" if we do not want to make a distinction based on the countries past action. Countries' actions in treaty j at time t are denoted as $a_{ij}^t \in \{0, 1\}$ with the action being 1 if the country participates in treaty j in period t and 0 otherwise. We follow the notation used in Corbi & Sanches (2022) and use superscripts to indicate the period. We will use $\boldsymbol{a^t_{-ij}}$ for the vector of actions of all countries except i in period t. We use a_{ij}^{t-1} to denote the lagged action of country i in treaty j. This notation will be used throughout this section.

Given that country i participated in a given treaty in the last period it is free to withdraw from it. We allow for action profiles of ratification-withdrawal-ratification etc. We assume that the intertemporal payoff of each country i in treaty j and period t can be expressed as a sum of linear functions of payoff parameters and state variables plus a stochastic component. The payoff from treaty j and treaty $\tilde{j}$ with $j \neq \tilde{j}$ are independent from each other and we model the game for each treaty j individually.

Including multiple treaties in our model but modelling their payoffs as being orthogonal to each other has two reasons. First, we are interested in the variation in deep model parameters across treaties. Further, by including more than one treaty we can identify the reduced form parameters from a single line of play and control for unobserved heterogeneity when estimating beliefs and transition probabilities in the data. Second, throughout this project we need to balance model flexibility with the effect this has on the size of the state space and hence the computational tractability of the problem at hand. By modeling payoffs across treaties as orthogonal we can solve the game for each treaty separately in a much smaller state space than the one of a joint game.
The timing of the game in each j is

- Countries are endowed with a state depending on their past action and a payoff shock, the state is observed by all countries while the payoff shock is private information.
- Countries simultaneously choose their actions to maximize the expected discounted sum of payoffs given discount rate $\beta_j \in [0, 1)$
- Countries observe the actions of all players, period payoffs are collected, and the game restarts.

We refer to Pesendorfer and Schmidt-Dengler(2008) and Sanches et al. (2016) for proofs of existence and consistency of the equilibrium and the asymptotic least square, and ordinary least square estimator properties.

2.1 Ex-post payoff function

To introduce the discrete dynamic choice game and illustrate the correspondence to a public good game with linear payoffs and binary contributions let's start by comparing the ex-post deterministic payoff function in a single treaty j (we drop the subscript for to simplify notation) for the action *participate*, $a = 1$ and *abstain*, $a = 0$. Country i's payoff in t depends on it's past action, the actions chosen by all other countries in t, and some exogenous variables. We collect the realization of the exogenous variables in period t in the vector $\boldsymbol{x^t}$. We use a subscript $[0; 1]$ with the payoff parameters to distinguish between the payoff function for members and non members. Payoff parameters are allowed to vary between treaties. The deterministic ex-post payoffs are given by:

$$\pi_i(a_i^t = 0|\boldsymbol{a^t_{-i}}, a_i^{t-1}, \boldsymbol{x^t}) = \gamma_0 + \phi_0 \sum_{-i} a^t_{-i} + S a_i^{t-1} + \boldsymbol{x^t \mu_0} \tag{2.1}$$

and

$$\pi_i(a_i^t = 1|\boldsymbol{a^t_{-i}}, a_i^{t-1}, \boldsymbol{x^t}) = \gamma_1 + \phi_1 \sum_{-i} (a^t_{-i} + 1) + F(1 - a_i^{t-1}) + \boldsymbol{x^t \mu_1} \tag{2.2}$$

Interpretation of the two functions is straightforward. If the coalition was to increase by one additional member, the payoff for members and non members would change by ϕ_1, ϕ_0 ceteris paribus. We assume that increases in the coalition size translate to higher payoffs.

This is rooted in the assumption that the coalition provides some form of either public or club good with the size of the good being equal to the sum of contributors. Hence we assume that $\phi_1, \phi_0 \geq 0$. If $\phi_1 = \phi_0$ the environmental treaty is a global public good and increases in the coalition size of the treaty benefit members and non members to the same extent. If environmental treaties were club goods there would be no effect of changes in the club size on non members. Hence $\phi_0 = 0$. The terms γ_0, γ_1 are a countries payoff that is independent of the countries' past action or the actions of other players. We interpret γ_1 as the participation cost that each country must sustain to remain in the treaty and normalize $\gamma_0 = 0$. Ratification comes at cost F while withdrawal leads to a change in the payoff of S. The conventional interpretation of F, S is a fixed entry cost (i.e. investment) and the part of the investment that can be recovered when exiting, respectively. We interpret them as an investment in the ratification process that can not be recovered if the country were to withdraw from the treaty.

In this paper we focus on smaller economies and how their incentive to participate in an environmental treaty is dependent on their peers actions which we model too, and the actions of major economies who are assumed to not be affected by the behavior of smaller economies. We discuss this in more detail in the next section. Exogenous variables that affect the countries payoff are the participation level of G20 countries in j and period fixed effects. The coefficients for both are allowed to vary for members and non members. Finally, we introduce an iid shock ε_i^t to the countries' payoff when the choose $a_i^t = 1$. The shock is private information and distributed $N(0, 1)$. The distribution is known to all countries and the econometrician. The shock captures uncertainty about the cost of participation in j for i. The per-period ex-ante payoff taking the actions of other countries as given is:

$$\Pi_i^t(a_i^t, \boldsymbol{a_{-i}^t}, \boldsymbol{x^t}, \varepsilon_i^t) = \pi_i(a_i^t, \boldsymbol{a_{-i}^t}, a_i^{t-1}, \boldsymbol{x^t}) + a_i^t \varepsilon_i^t \tag{2.3}$$

Since players choose to participate or abstain simultaneously and the payoff shock for each player is private information, players need beliefs σ_i on the likelihood of their peers' actions conditional on the publicly observable states $\mathbf{s^t} \equiv (\mathbf{a^{t-1}}, \boldsymbol{x^t})$. These states are the vector of lagged actions by all players and the exogenous variables. The vector of states evolves according to a transition law $g(\boldsymbol{s^{t+1}}|\boldsymbol{s^t}, \boldsymbol{a^t})$ with $\sum_{\boldsymbol{s}^{t+1}} g(\boldsymbol{s^{t+1}}|\boldsymbol{s^t}, \boldsymbol{a^t}) = 1$. Player $i's$ expected period payoff follows:

$$\sum_{-i} \sigma_i(\boldsymbol{a_{-i}^t}|\boldsymbol{s^t}) \Pi_i^t(a_i^t, \boldsymbol{a_{-i}^t}, \boldsymbol{s^t}, \varepsilon_i^t) \tag{2.4}$$

Let's assume for a moment that countries are myopic to focus on the contemporaneous strategic interaction between countries. If countries were myopic we can express the *expected relative payoff of participation* in t for a given treaty by

$$\begin{aligned}\sum_{-i} \sigma_i(\boldsymbol{a_{-i}^t}|\boldsymbol{s^t})[(\gamma_1 - \gamma_0 + \phi_1) + (\phi_1 - \phi_0) \sum_{-i} a_{-i}^t + (F - S) a_i^{t-1} + S \\ + (\mu_{1,G20} - \mu_{0,G20}) x_{G20} + (\mu_{1,Y} - \mu_{0,Y}) x_Y + \varepsilon_i^t]\end{aligned} \tag{2.5}$$

We define $\gamma \equiv (\gamma_1 - \gamma_0 + \phi_1), \phi \equiv (\phi_1 - \phi_0), \mu_{G20} \equiv (\mu_{1,G20} - \mu_{0,G20}), \mu_Y \equiv (\mu_{1,Y} - \mu_{0,Y})$ and normalize $\gamma_0, S, \mu_{0,G20}, \mu_{0,Y} = 0$. Country i will find it optimal to participate in the treaty in period t if and only if the expected relative payoff of participation in that period is positive.

$$\sum_{-i}\sigma_i(\boldsymbol{a^t_{-i}}|\boldsymbol{s^t})[\gamma+\phi\sum_{-i}a^t_{-i}+Fa_i^{t-1}+\mu_{G20}x_{G20}+\mu_Y x_Y+\varepsilon_i^t]\geq 0 \tag{2.6}$$

The term ϕ captures how the incentive to participate of country i relates to the participation decision of other countries. We follow Wagner (2016) and distinguish between treaties for which participation is a strategic complement and those in which participation is a strategic substitute based on the parameter ϕ. If $\phi > 0$ participation of i and all $\tilde{i} \neq i$ in j are strategic complements and the participation game is supermodular. Thereby the positive spillovers that are created from higher membership are greater for members than for non members. It then becomes more profitable for i to become a member if $\tilde{i}$ does so too. If $\phi = 0$ the incentive to become a member is independent of the size of the coalition. Instead, the decision is determined by the net benefit γ, the effect of the existence of spillovers from G20 participation μ_{G20}, the fixed cost of entry F, and the impact of μ_Y. If $\phi < 0$ the relative payoff from participation is decreasing as the size of the coalition increases. Participation is a strategic substitute then. In general we will not assume that countries are myopic. Instead, we include a discount factor $\beta_j \in [0, 1)$ that we identify in addition to the payoff parameters $\gamma, \phi, \mu_{G20}, \mu_Y, F$. Countries will weigh the contemporaneous cost and benefit of participation with the consequences that the action a_i^t has on the future path of actions through the state transition probabilities and countries beliefs.

2.2 Bellman equations

As previously mentioned, we focus on pure Markovian strategies that are a function of player-specific payoff shocks and state variables (Pesendorfer & Schmidt-Dengler, 2008) . We can abstract from calendar time as the Markovian assumption requires that actions are identical given $(\varepsilon_i^t, \boldsymbol{s^t}) = (\varepsilon_i^{t'}, \boldsymbol{s^{t'}})$ and express the model using present and future state $\boldsymbol{s}, \boldsymbol{s'}$. We require that from each state $\boldsymbol{s}$ the transition probabilities sum up to one $\sum_{\boldsymbol{s'}\in \boldsymbol{S}} g(\boldsymbol{s'}|\boldsymbol{s},\boldsymbol{a}) = 1$ and $g(\boldsymbol{s'}|\boldsymbol{s},\boldsymbol{a}) < 1, g(\boldsymbol{s'}|\boldsymbol{s},\boldsymbol{a}) \geq 0, \forall \boldsymbol{s}, \boldsymbol{s'} \in \boldsymbol{S}$ where $\boldsymbol{S}$ denotes all possible states. We use m_s to denote the cardinality of $\boldsymbol{S}$. The present value of the expected payoff for country i in terms of states, payoff shocks, and beliefs is.

$$V_i(\boldsymbol{s},\varepsilon_i|\sigma_i)=\max_{a_i\in\{0,1\}}\{\sum_{\mathbf{a_{-i}}}\sigma_i\left(\mathbf{a_{-i}}|\mathbf{s}\right)\{\Pi_i\left(a_i,\mathbf{a_{-i}},\mathbf{s},\varepsilon_\mathbf{i}\right)+\beta\sum_{\mathbf{s'}}g(\boldsymbol{s'}|\boldsymbol{s},\boldsymbol{a})\int V_i\left(\mathbf{s'},\varepsilon'_i|\sigma_i\right)\}dQ(\varepsilon'_i)\} \tag{2.7}$$

The solution to the maximization problem in 2.7 gives a set of best response functions that map country is optimal decision to its beliefs for every possible state. Let's denote $V_i^1(\boldsymbol{s},\varepsilon_i|\sigma_i)$ as country is value function given today's action $a_i = 1$ net of the payoff shock ε_i. Further, let's denote $V_i^0(\boldsymbol{s}, 0|\sigma_i)$ as the value function of country i for $a_i = 0$ today. Given that the distribution of ε_i is $\Phi(0, 1)$ we can express the probability of country i choosing to play $a_i = 1$ today given today's state $\boldsymbol{s}$ and beliefs σ_i as:

$$P(a_i=1|\boldsymbol{s},\sigma_i)=\Phi(V_i^1(\boldsymbol{s},\varepsilon_i|\sigma_i)-V_i^0(\boldsymbol{s},0|\sigma_i)) \tag{2.8}$$

Doing this for all states $\boldsymbol{s} \in \boldsymbol{S}$ and $i \in I$ in a single treaty j and stacking them yields the $m_s \cdot I \times 1$ vector of best response functions in j. Let $\boldsymbol{\sigma}_j$ be the vector of believes σ_{ij} stacked for all countries $i \in I$ and $\boldsymbol{P}_j$ the stacked vector of $P(a_i = 1|\boldsymbol{s}, \sigma_i)$ for all states

$\boldsymbol{s} \in \boldsymbol{S}$ and $i \in I$ in a single treaty j. We can express 2.8 using vector notation as:

$$\boldsymbol{P}_j = \Psi(\boldsymbol{\sigma}_j, \boldsymbol{\theta}_j) \tag{2.9}$$

Thereby $\boldsymbol{\theta}_j = (\gamma_j, \phi_j, F_j, \mu_{G20,j}, \mu_{Y,j})$ is the vector of payoff parameters in treaty j and Ψ is a multivariate function that characterizes the best responses. In equilibrium beliefs are consistent such that $\boldsymbol{P}_j = \boldsymbol{\sigma}_j$ and

$$\boldsymbol{P}_j - \Psi(\boldsymbol{P}_j, \boldsymbol{\theta}_j) = 0 \tag{2.10}$$

is the fixed point problem of ex ante choice probabilities. The proof of existence is given in Pesendorfer & Schmidt-Dengler(2008).

3 Player Selection

Global environmental treaties are often criticized for their lack of ambition and bite. Voters in many countries feel like their governments ought to do more to protect environmental resources. Still, countries' commitment to ratifying these international treaties is exceptional. Global treaties like the Kyoto Protocol, the Paris Accord, and lesser-known agreements that target oil spills or protect marine species have been ratified by more than a hundred sovereign nations since they were negotiated and signed. This has puzzled

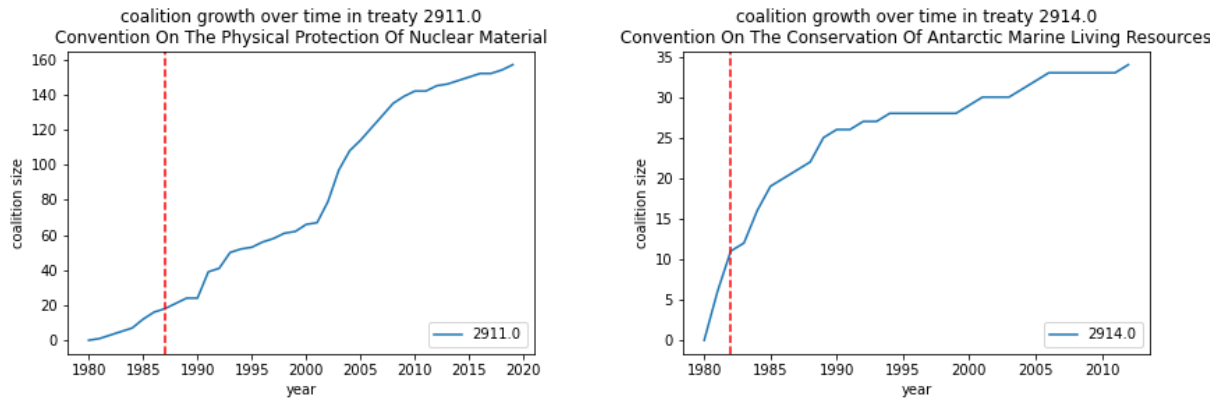


Figure 1: Coalition growth in selected treaties over time with entry-into-force date (dashed line)

economists who model international environmental treaties as global commons and have struggled to rationalize big coalitions in this framework. International environmental agreements are commonly modeled as a three stage game between homogeneous countries. These countries first start negotiations. After negotiations are concluded, countries sign the agreed-upon treaty. Finally, the treaty must undergo a ratification process, necessitating a political majority within the country's domestic sphere only after ratification does the treaty become legally binding for that particular country. This three-stage treaty formation game ignores some of the finer features of global environmental treaties..

Treaties usually feature a conditional entry into force or minimum ratification clauses. This clause, also known as the threshold number (Black et al. 1993) specifies a set of requirements that needs to be fulfilled for the treaty to enter into force and become legally binding for any of the ratifying countries. It allows for participation by countries contingent on the participation of their peers (Schmidt 2001) and has been discussed as an instrument to increase cooperation and deter free-riding (Barrett 2000, Carraro et al. 2009). The existence of ratification thresholds is relevant for us because it affects the strategic interaction of countries when they decide to ratify a treaty or not.

In the sample of 46 international environmental agreements and protocols that we study in this project, we identified such threshold numbers for all but two treaties. Commonly clauses set a minimum number of ratifications (n-rule). The average n-rule required in our sample is 25.7 ratifications while the highest is 65 (Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and their Destruction). The "Agreement Relating To The Implementation Of Part XI Of The United Nations Convention On The Law Of The Sea" requires at least 40 ratifications to enter into force and the "Paris Agreement under the United Nations Framework Convention on Climate Change" requires even 55. Besides the n-rule there are more complicated requirements adding further conditions that ensure some relevance of the coalition. Requirements that go beyond a simple n-rule set requirements on the composition of developing and developed countries among the ratifiers or even set a lower bound on the aggregate pollution that is caused by the ratifying countries. For example, "....States include at least seven of the States referred to in paragraph 1(a) of resolution II of the Third United Nations Conference on the Law of the Sea (hereinafter referred to as "resolution II") and that at least five of those States are developed States." (Agreement Relating To The Implementation Of Part XI Of The United Nations Convention On The Law Of The Sea, Article 6.1) and "...accounting in total for at least an estimated 55 per cent of the total global greenhouse gas emissions" (Paris Agreement under the United Nations Framework Convention on Climate Change, Article 21.1)..

The full set of requirements and n-rules for our sample can be found in the appendix. We mentioned above that classic models study the three-stage treaty participation game among homogenous countries. We document significant differences in the types of countries that ratify treaties after the n-threshold is met and before. Our data shows that countries that are commonly associated with the negotiation of international treaties, like the US, Canada, Europe, Japan, or Australia, ratify treaties before they enter into force. In contrast, countries that most commonly ratify treaties after they have entered into force (EIF) are often poorer, more likely to be located in the global south, or former Soviet states. We refer to those two types of countries as leaders and followers and map their relative pre vs. post EIF ratifications below.
Policymakers have stressed that successful global environmental policies can only exist if lower-income countries join IEAs instead of turning into pollution havens, ultimately undermining the efforts to reduce environmental externalities. We aim to bring this into focus by looking explicitly at the membership decision of emerging economies. The strategic interaction we aim to study is the simulatneous decision of forward looking countries to ratify IEAs. Therefore, we abstract away from n-rules and instead model treaties from their entry into force onwards.

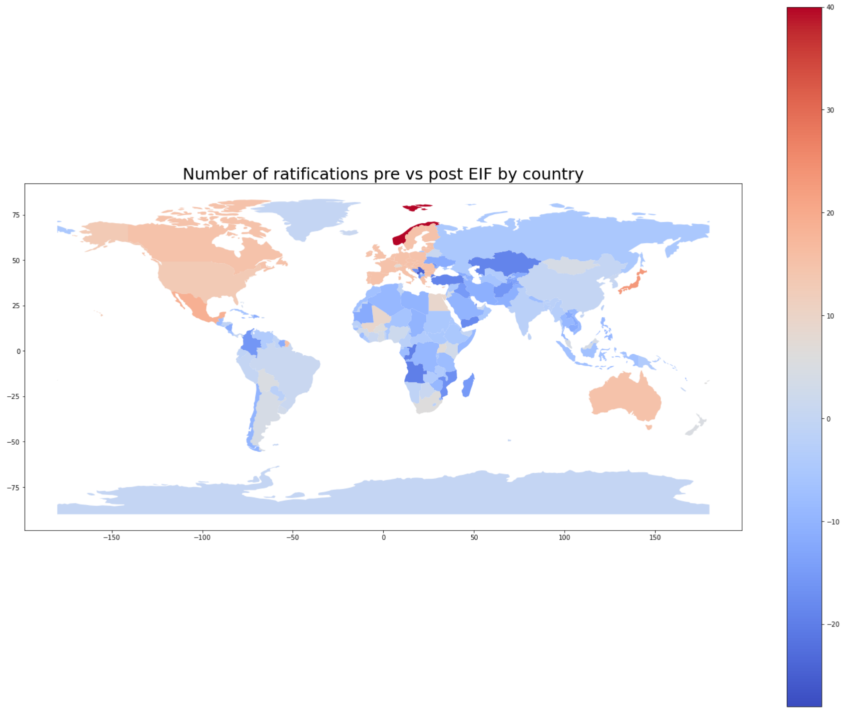


Figure 2: World map illustrating the sum of pre-EIF ratifications relative to the sum of post-EIF ratifications in our sample of 46 global IEAs from 1980-2019

Figure 3: Treaty timeline illustration

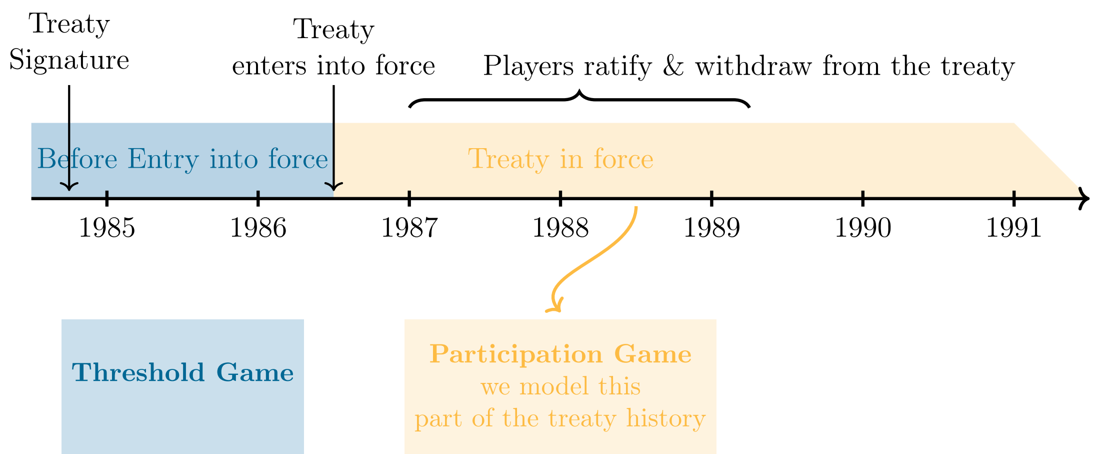


Figure 4: Treaty timeline illustration

Table 1: List of contries

ISO3	Country Name
VNM	Vietnam
PAN	Panama
MYS	Malaysia
TTO	Trinidad and Tobago
CHL	Chile
MAR	Morocco
GHA	Ghana
PER	Peru
PHL	Philippines
TUN	Tunisia

3.1 Treaty Selection

In this project, we focus on the participation game played among follower countries after the treaty has entered into force.

For each of the 46 global treaties, we therefore consider the period after the entry into force date up to 2019, or the year in which the treaty was terminated (if applicable). We hypothesize that the number of leader countries participating in a treaty matters to follower countries in either of two ways. First, participation by economically strong nations could lead to higher positive spillovers for those countries that decide to ratify the treaty. In contrast, if treaty participation constitutes a global public good countries would have an incentive to free-ride on treaty participation of economically strong nations. Leader countries are chosen based on G20 membership.

Computational constraints require us to select a subset of countries that we consider in our analysis. This is mostly driven by the effect that any additional players would have on the size of the state space. Modeling the participation game between 10 countries who choose simultaneously, and a world that can take either of 12 exogenous macro states (a combination of participation levels of G20 countries the treaty, and year characteristics), leaves us with $|\boldsymbol{S}| = 2^{10} \cdot 12 = 12288$ possible states. Each state constitutes a combination of actions (participate, abstain) by each country and one macro state. To avoid selecting our sample of countries on outcomes we establish a decision rule to include players based on their average GDP growth over the past 29 years (1990-2019). We end up with a sample of 10 developing economies that contain Asian Tigers as well as commodity, and mineral-rich nations in central and south America, plus some African states.

With respect to treaties, our sample of multilateral international environmental agreements and protocols is signed between 1980 and 2015 that were identified by the IEAD. We chose those treaties for a series of reasons. First, we use modern treaties to ensure that the notion of an environmental agreement is comparable between the different treaties. In particular we focus on treaties that were signed after the Stockholm conference in 1972.[1]Second, we restrict the sample to those multilateral treaties that allow for ratification or accession by all members of the United Nations. Because of this, all countries could

[1]See Mitchell et al. 2020.

have potentially joined each treaty in each year and we obtain a panel dataset that is balanced within each treaty. Third, we do not use amendments but only those treaties classified as agreements or protocols by the IEADB. We follow other papers on this (Aftab et al., 2023; Cazals & Sauquet, 2015) which also exclude amendments because of the different entry-into-force procedures, scope, focus, and interdependence with the agreement or protocol they are amending.

Our sample of treaties covers a variety of different subjects from climate to protection of endangered species. We are interested in the interdependency of followers' decisions to participate in global environmental treaties given the actions of G20 countries. We model participation across treaties to be orthogonal conditional on the state variables. While the question of interdependencies in ratification between treaty j and some other treaty $\tilde{j}$ is both interesting and largely unexplored we do not address it in this paper.

Our objective is to examine whether there is evidence of positive spillovers in international environmental policy-making among emerging economies. Additionally, we aim to investigate whether for these countries participation in global treaties is a global public good and therefore they engage in free-riding on the participation of their peers.

4 Reduced Form Model

We use ratification, withdrawal, and termination dates together with entry-into-force data from the "International Environmental Agreement Database Project" (IEADB) (Mitchell, 2023) to estimate players beliefs conditional on states $\boldsymbol{s}$ and transition probabilities between $\boldsymbol{s'}, \boldsymbol{s}$.[2] We do so by estimating the conditional choice probability (CCP) of country i ratifying treaty j in year t given a set of covariates $\boldsymbol{X}$.

$$P(a_{ij}^t = 1|\boldsymbol{X}) \tag{4.1}$$

We use the resulting estimates to construct the beliefs conditional on states $\boldsymbol{s}$. The IEADB data is used to construct a treaty-country-year panel of treaty membership in the selected treaties for all countries. In a second step, we trim the dataset to those observations that belong to the countries and years that match our sample restrictions. Since we only considered treaties that allow for ratification by all UN members, the number of country-year observations is balanced. The dataset includes a membership dummy for each country, a treaty identifier, the number of countries that have ratified the treaty at $t-1$, and the number of G20 economies (leaders) that have ratified the treaty at $t-1$. The estimation is done in two steps due to biased estimates of fixed effects in nonlinear models (Greene, 2002). The variation we are using for the reduced form estimation stems from ratifications and withdrawals of countries in treaties over time. To give a better overview of how this variation looks we summarize the number of moves by countries and the time we observe for each treaty in the appendix.

First, we estimate a linear probability model of country actions on the sum of G20 countries that participated in treaty j in year $t-1$, the sum of ratifications by the countries $i \in I$ in $j, t-1$, and past action. Withdrawals from international environmental agreements are rare. Consequently, estimation of past action by country i in j is not

[2]Data from Ronald B. Mitchell. 2002-2023. International Environmental Agreements Database Project (Version 2020.1). Available at: http://iea.uoregon.edu/ Date accessed: 14 December 2023

Table 2: Player participation in treaties

	Total number of years played In/Out across treaties		
Country ISO3	0	1	Total
	No.	No.	No.
CHL	440.0	571.0	1,011.0
GHA	469.0	542.0	1,011.0
MAR	432.0	579.0	1,011.0
MYS	460.0	551.0	1,011.0
PAN	414.0	597.0	1,011.0
PER	426.0	585.0	1,011.0
PHL	436.0	575.0	1,011.0
TTO	470.0	541.0	1,011.0
TUN	412.0	599.0	1,011.0
VNM	566.0	445.0	1,011.0
Total	4,525.0	5,585.0	10,110.0

possible. Instead, we estimate past action across countries and treaties. To control for unobserved heterogeneity we include country, treaty, and year fixed effects (FE). Standard errors are clustered at the country level. Below L, F stand for leaders and followers respectively.

$$a_{i,j}^t = \alpha + \gamma_i + \gamma_j + \gamma_t + \beta_0 a^{t-1} + \beta_j^F \sum_i a_{i,j}^{F,t-1} + \beta_j^L \sum_i a_{i,j}^{L,t-1} \tag{4.2}$$

The chosen fixed effect structure constitutes a trade-off. Interacted country-year fixed effects capture more of the unobserved heterogeneity we want to control for. However, this comes at a computational cost as the state space increases in size, limiting the number of players that we can include. We compare β_j^F (our coefficient of interest) and the average coefficient across treaties, for the interacted and non interacted fixed effects specifications and do not find significant differences (see appendix). To reduce the number of macro states we bin year-fixed effects into three groups based on the size of the coefficient estimate and collect them in a new variable μ_t. Those bins capture years with high, average, and below average likelihood of ratification. We group year FE such that the number of observations in each bin is balanced in the dataset but not in the treaty. In the second step, we use this variable to replace the year FE and estimate the following probit regression model.

$$P(a_{i,j}^t = 1|\mu_t, a^{t-1}) = \Phi(\alpha + \gamma_i + \gamma_j + \beta_0 \mu_t + \beta_1 a_{t-1} + \beta_j^F \sum_i a_{i,j,t-1}^F + \beta_j^L \sum_i a_{i,j,t-1}^L) \tag{4.3}$$

The coefficient estimates $\hat{\gamma}_j, \hat{\beta}_j^F, \hat{\beta}_j^L, \hat{\beta}_0, \hat{\beta}_1$ are reported below. Coefficients for country FE and past action are reported in a separate table. Coefficients of country FE are relative to Vietnam, treaty fixed effects are relative to the "Convention On The Physical Protection Of Nuclear Material and Nuclear Facilities" (mitch id: 2911). Looking first at the treaty FE we see significant variation among treaties. Those persist mostly when we look at treaties in the same lineage or subject. Treaty FE are uncorrelated with the signature year of the treaty. When we compare the coefficients for the lagged coalition size of followers and leaders, leader countries participating in a treaty in year $t-1$ tends to have

Table 3: Coefficient estimates binary choice model.

Treaty ID	coef β_j^L	std err β_j^L	coef β_j^F	std err β_j^F	coef γ_j	std err γ_j	coef β_0	std err β_0
2911	0.13134	0.131632	0.03972	0.108456	omitted	-	0.28017 ***	0.054431
2914	0.46014 ***	0.172381	-0.96216 **	0.432062	-2.3712	1.954480	0.28017 ***	0.054431
2947	0.55452 ***	0.195361	-1.57257 ***	0.504431	7.3304 ***	2.074390	0.28017 ***	0.054431
2965	1.07354	1.056132	-2.15052	1.830815	1.39402	1.319483	0.28017 ***	0.054431
2972	0.80174 *	0.435528	-1.0877 ***	0.401889	-1.16858	3.063476	0.28017 ***	0.054431
2982	0.2174	0.153516	-0.20321	0.180823	1.57227	1.643446	0.28017 ***	0.054431
3003	-0.02865	0.057752	0.02096	0.106872	2.14176	1.609113	0.28017 ***	0.054431
3004	-0.02957	0.070280	0.01532	0.115550	2.1573	1.637285	0.28017 ***	0.054431
3021	0.17207	0.130626	-0.20668	0.165090	2.13639	1.502827	0.28017 ***	0.054431
3042	0.33391	0.205296	-0.43169 **	0.217057	1.35835	1.838449	0.28017 ***	0.054431
3083	0.1059	0.191769	-0.2276	0.260190	1.6662	1.670897	0.28017 ***	0.054431
3103	0.50066	0.377517	-0.92519 *	0.554475	-2.57835	3.247916	0.28017 ***	0.054431
3126	2.49984 ***	0.248137	-1.56085 ***	0.165877	-15.84202 ***	3.022180	0.28017 ***	0.054431
3128	-0.00801	0.680474	0.21084	0.920317	2.71421	1.709527	0.28017 ***	0.054431
3145	0.1089	0.172385	0.05674	0.241952	1.59597	1.540619	0.28017 ***	0.054431
3146	-0.04399	0.501956	-0.05317	0.516516	2.46548	1.937336	0.28017 ***	0.054431
3149	0.66358	0.566485	-0.76558	0.657953	0.3072	2.408543	0.28017 ***	0.054431
3173	0.23418	0.572685	-0.94158	0.767367	2.94615	2.749203	0.28017 ***	0.054431
3176	0.4148	0.481654	-0.96822	0.795610	1.04555	1.357905	0.28017 ***	0.054431
3178	1.0407 **	0.440972	-1.00725 **	0.473236	-3.12923	2.849011	0.28017 ***	0.054431
3188	0.11921	0.141301	-0.20395	0.287180	3.64254 ***	1.177687	0.28017 ***	0.054431
3193	0.02807	0.228926	-0.19464	0.377726	2.91724 ***	1.118987	0.28017 ***	0.054431
3197	-0.04938	0.109095	-0.10656	0.229432	2.41893	1.731241	0.28017 ***	0.054431
3221	0.06424	0.115115	0.16656	0.161648	0.85077	1.821679	0.28017 ***	0.054431
3253	0.58059 **	0.225589	-0.02087	0.154891	-2.56642	1.860964	0.28017 ***	0.054431
3264	0.27912 ***	0.090907	-0.23883	0.152126	-0.69381	0.999082	0.28017 ***	0.054431
3266	0.76892 **	0.362731	-2.81245 ***	1.089562	2.44728 *	1.290852	0.28017 ***	0.054431
3269	0.24816	0.218371	-0.1323	0.262628	1.18758	1.784089	0.28017 ***	0.054431
3289	0.28946 **	0.126492	-0.244	0.203579	0.85532	1.362293	0.28017 ***	0.054431
3314	-0.01821	0.287020	-0.15773	0.358248	3.55923 ***	1.321057	0.28017 ***	0.054431
3316	0.50472 *	0.259021	-1.6874 **	0.676841	1.24593	1.414734	0.28017 ***	0.054431
3337	0.13337	0.234468	-0.43899	0.329395	2.70858 **	1.339768	0.28017 ***	0.054431
3341	-0.27086 *	0.144234	0.15247	0.369462	3.93724 ***	1.492692	0.28017 ***	0.054431
3345	0.02308	0.160667	-0.03899	0.249602	2.28247 *	1.292298	0.28017 ***	0.054431
3346	0.72693 ***	0.202862	-1.24694 ***	0.240075	5.27698 ***	1.471516	0.28017 ***	0.054431
3841	0.79291 ***	0.288037	-2.29816 ***	0.566308	-3.82324	2.910369	0.28017 ***	0.054431
4249	2.18812 ***	0.343100	-0.80514 **	0.315639	-14.95116 ***	2.893853	0.28017 ***	0.054431
4439	0.49633	0.432274	-1.63907 **	0.770198	9.15613 ***	2.539674	0.28017 ***	0.054431
4441	0.01769 **	0.006879	-1.30791 **	0.513315	4.47276 **	1.762397	0.28017 ***	0.054431
4514	1.04451 ***	0.290616	-4.28411 ***	1.182173	-0.28064	1.272724	0.28017 ***	0.054431
4558	0.35148 *	0.187337	-0.59571 *	0.339581	1.82543	1.388364	0.28017 ***	0.054431
4580	1.20865 ***	0.288531	-1.95964 ***	0.415130	4.05124 ***	1.275419	0.28017 ***	0.054431
4587	0.2122	1.152797	-0.4178	2.015991	2.42867 *	1.369282	0.28017 ***	0.054431
4638	0.20118	0.340309	-0.43424 *	0.258681	2.49595	2.273691	0.28017 ***	0.054431
5007	0.74053 *	0.412632	-1.39102 **	0.552284	2.39874	1.578680	0.28017 ***	0.054431
5046	-0.60552 ***	0.184463	1.52469 ***	0.303606	3.46056 ***	1.321447	0.28017 ***	0.054431

a positive marginal effect on the probability of follower countries to access the treaty in t. An increase in the number of followers' (i.e. peers') ratifications in $t-1$ tends to have a negative marginal effect on the likelihood of ratification.

Table 4: Country FE & past action

variable	coef	std err
country CHL	0.28398 ***	0.051256
country GHA	0.23962 ***	0.037692
country MAR	0.19796 ***	0.050803
country MYS	0.22399 ***	0.034661
country PAN	0.39379 ***	0.049360
country PER	0.19427 ***	0.033115
country PHL	0.34368 ***	0.037044
country TTO	0.17218 ***	0.031859
country TUN	0.36171 ***	0.037491
country VNM	omitted	NaN
past action	12.17699 ***	1.702615

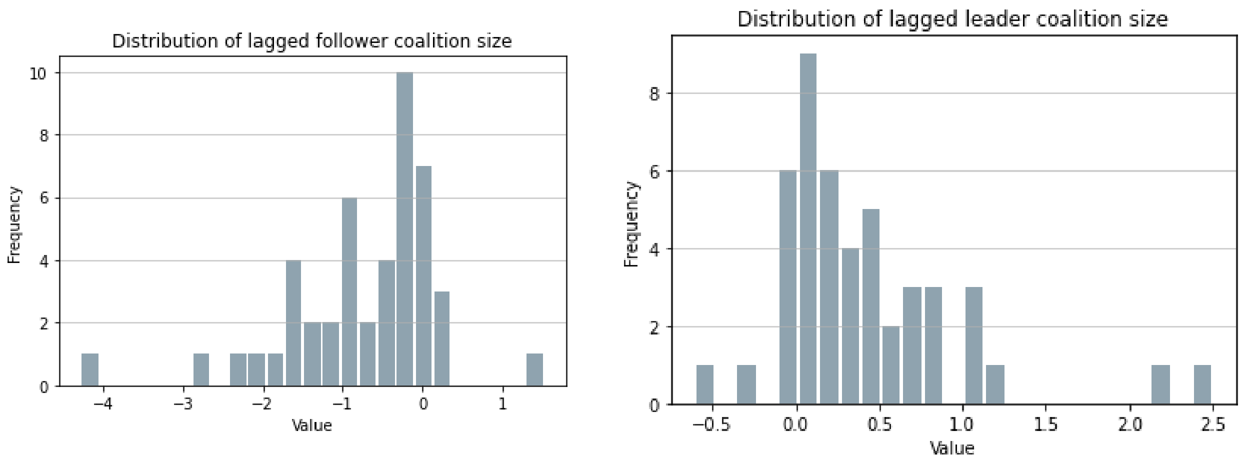


Figure 5: Probit coefficients for lagged coalition size in treaties for leader and followers

4.1 Conditional Choice Probabilities

We use the probit estimates to predict the probability of $a_{ij}^t = 1$ for each player in a given state $\boldsymbol{s}^t = (\boldsymbol{a}^{t-1}, N_{t-1}^F, N_{t-1}^L, \mu)$ in a single treaty j (we omit the j subscript from here onwards). The state space of treaty j and $\tilde{j} \neq j$ have the same size and states but are independent from each other. For computational reasons, we include the lagged coalition size of leader countries as one of four bins (0-4, 4-8, 8-12, 12-16) instead of discrete values between 0-16. Each state is a combination of peer actions in $\{0, 1\}$ a macro state μ_t, and a level of G20 participation. The size of the resulting state space is given by $|\boldsymbol{S}| = \{2^{10} \cdot 3 \cdot 4\}$. We obtain a matrix of conditional choice probabilities (CCP) for each treaty of size $|CCP| = \{2^{10} \cdot 3 \cdot 4 \times 10\}$ with $CCP_{s,i} = P(a_i^t = 1 | s = s^t) \in (0, 1)$. By construction, $a_i^{t-1} = 1$ in half of the states for each player. Because withdrawals are rarely observed in the data and the resulting positive coefficient for a^{t-1} the probability for country to participate conditional on having done so in the last period is very high. The result is a CCP matrix with around half of its entries close to 1. We plot the histogram of

Table 5: Transition probabilities between Year FE bins, rows are $t-1$, columns are t

	$\mu_{Y,1}$	$\mu_{Y,2}$	$\mu_{Y,3}$
$\mu_{Y,1}$	.1712431	.3185989	.5101579
$\mu_{Y,2}$	.2984531	.365627	.3359199
$\mu_{Y,3}$	.4669215	.3358485	.19723

conditional choice probabilities in a few treaties below for illustration. We then estimate

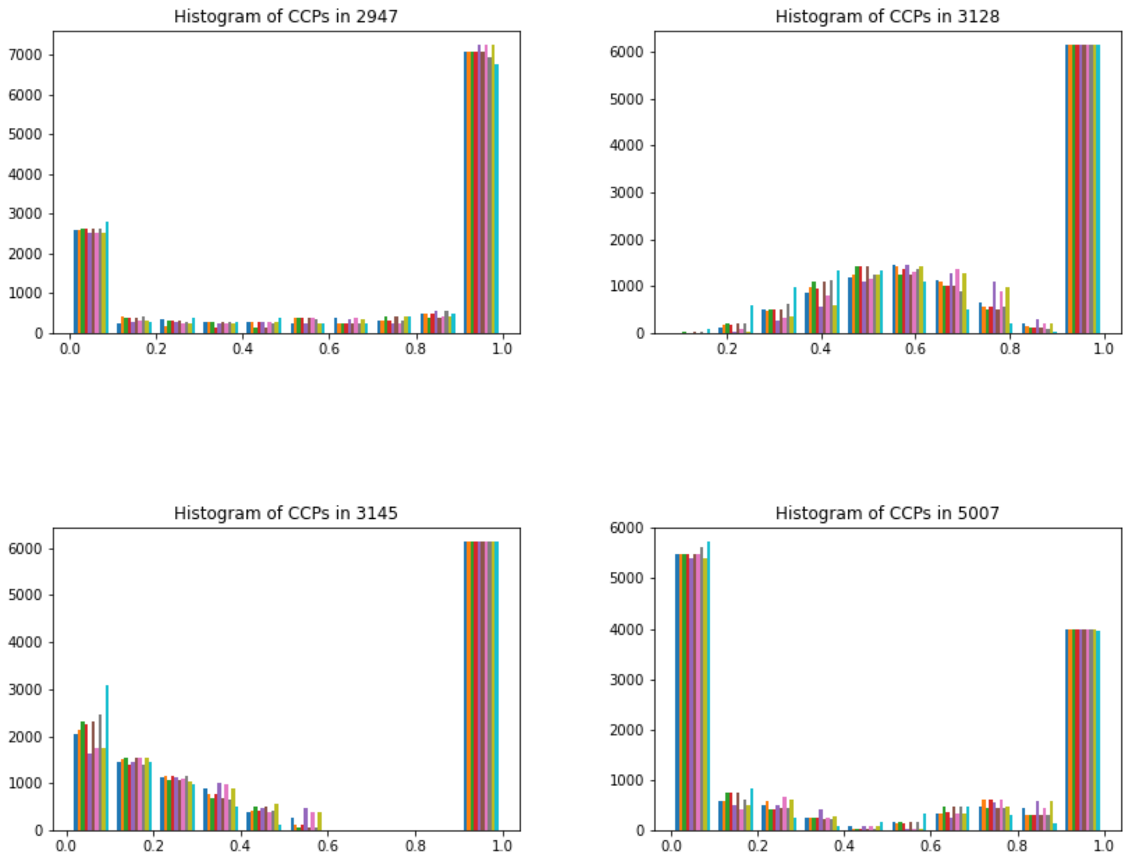


Figure 6: Predicted conditional choice probabilities, examples

an ordered logit model for the binned year FE and G20 coalition sizes and their one period lag and use those estimates to predict transition probabilities between the different bins. The transition matrices are reported below. To conclude the estimation part we construct the matrix of transition probabilities between states $\boldsymbol{s'}, \boldsymbol{s}$. Using the conditional choice probabilities of countries $i = 1, ..., 10$ and the transition probabilities of μ_L, μ_Y. This transition law applies to all treaties equally while the payoff from different levels of μ_L varies across treaties.

Table 6: Transition probabilities between G20 participation bins, rows are $t-1$, columns are t

	$\mu_{L,1}$	$\mu_{L,2}$	$\mu_{L,3}$	$\mu_{L,4}$
$\mu_{L,1}$	.8714408	.1273875	.0011709	8.32e-07
$\mu_{L,2}$	.0159223	.6545611	.3291681	.0003485
$\mu_{L,3}$	.0000386	.0047947	.867737	.1274297
$\mu_{L,4}$	9.22e-08	.0000115	.01607	.9839184

5 Structural Estimation

We identify the vector of structural payoff parameters $\boldsymbol{\theta}_j = (\gamma_j, \phi_j, F_j \mu_{G20,j}, \mu_{Y,j})$ together with a discount factor β_j for each $j \in \boldsymbol{J}$. We assume the standard assumptions in the literature (Aguirregabiria and Mira, 2007, Pakes et al., 2008, and Pesendorfer and Schmidt-Dengler 2008) hold. We briefly repeat those assumptions below.

- **Assumption M1** (Additive separability). $\pi_i(a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t, \varepsilon_i^t) = \pi_i(a_i^t, \boldsymbol{a}_{-i}^t) + \varepsilon_i^t \mathbf{1}[a_i^t \neq 0]$ for all $i, , t, a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t, \varepsilon_i^t$
- **Assumption M2** (Conditional independence). The transition distribution of states has the following factorization: $P(\boldsymbol{s}^{t+1}, \boldsymbol{\varepsilon}^{t+1} | \boldsymbol{s}^t, \boldsymbol{a}^t, \boldsymbol{\varepsilon}^t) = Q(\boldsymbol{\varepsilon}^{t+1}) g(\boldsymbol{s}^{t+1} | \boldsymbol{s}^t, \boldsymbol{a}^t)$ where Q is the cumulative distribution function of $\boldsymbol{\varepsilon}^t$ and g denotes the transition law of $\boldsymbol{s}^{t+1}$ conditioning on $\boldsymbol{a}^t, \boldsymbol{s}^t$ with $\boldsymbol{a}^t, \boldsymbol{s}^{t+1}, \boldsymbol{s}^t, \boldsymbol{\varepsilon}^{t+1}, \boldsymbol{\varepsilon}^t$ being the vector over all players of the respective variable.
- **Assumption M3** (Independent private values). The private information is independently distributed across players, and each is absolutely continuous with respect to the Lebesgue measure whose density ins bounded on $\mathbb{R}^2$.
- **Assumption M4** (Discrete public values). The support of $\boldsymbol{s}^t$ is finite, $m_s < \infty$.

We follow Corbi and Sanches (2016) and proceed in two main steps. First, we estimate beliefs $\sigma_{i,j}(\boldsymbol{a^t_{-i,m}} | \boldsymbol{s^t_j})$ and state transition probabilities $g(\boldsymbol{s}_j^{t+1} | \boldsymbol{s}_j^t, \boldsymbol{a}_j^t)$ for each treaty j in the data. Secondly, we fix β_j and use the beliefs and state transition probabilities in the system of best response functions that we obtain from 2.8. We identify $\boldsymbol{\theta}_j$ for a given $\beta_j \in [0, 1)$ by forcing 2.10 to hold approximately.

Identification of $\boldsymbol{\theta}_j$ is done using OLS by rewriting the system of equilibrium equations in 2.10 as a linear function of $\boldsymbol{\theta}_j$. Rewriting $\Psi(\boldsymbol{P}_j, \boldsymbol{\theta}_j) - \boldsymbol{P}_j$ as $\boldsymbol{Y}_j = \boldsymbol{X}_j \boldsymbol{\theta}_j$ where $\boldsymbol{Y}_j$ is a $m_s \cdot 10 \times 1$ vector and $\boldsymbol{X}_j$ is a $m_s \cdot 10 \times 5$ matrix that both depend on $\boldsymbol{P}_j$ can be done under common set of four assumptions plus M5.

- **Assumption M5** (Linear-in-parameter payoffs). For all $(i, j, t, \boldsymbol{\theta}_j, a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t)$,

$$\pi_{i,j,\boldsymbol{\theta}_j}(a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t) = \boldsymbol{\theta}_j \pi_{i,j,0}(a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t)$$

  for some p_i-dimensional vector $\pi_{i,j,0}(a_i^t, \boldsymbol{a}_{-i}^t, \boldsymbol{s}^t)$, where $p_i < m_s$ such that identification the necessary order condition on the payoffs is satisfied (Sanches et al., 2016; Pesendorfer and Schmidt-Dengler 2008).

The advantage of a closed form solution for $\boldsymbol{\theta}_j$ is decrease in computational time and the stability that we gain relative to a numerical method as we do not rely on multiple rounds of re-initialization to find a stable minimum. We refer to Sanches et al. (2016) for more information on this.

In common applications of similar models in Industrial Organization the players are firms that maximize profits. To discount future profits using risk free interest rates is a coherent strategy, hence those models do not rely on a separate identification of the discount factor. In our context of countries that choose to participate in an international treaty interest rates are likely unsuitable as discount factors, while the degree to which countries discount the future does not have to correspond to market interest rates and may be specific to the treaty itself. We therefore identify the discount factor β_j as part of our model parameters. We proceed in two steps. First, we evaluate the residual sum of squares (SSR) on a one dimensional grid of discount factors from $[0, 1)$. In the second step we use the discount factor that corresponds to the minimum of the SSR on our grid as the starting value for a minimization routine.

6 Results

Below we report the full sample of parameter estimates, standard errors will be estimated in the future using block-bootstrap of the reduced form sample. The coefficients are strucutral estimates of the model parameters from section 2. We first discuss ϕ_j. The parameter ϕ_j captures the effect that an increase in the coalition size has on members relative to the effect it has on non-members. As we discussed earlier, this is important because if the relative payoff of participation is increasing in the coalition size participation is a strategic complement and the participation game is supermodular. Below we plot the structural estimates of ϕ_j for $j \in J$. Our estimates of ϕ_j vary between -0.535 in the treaty "International Convention On Civil Liability For Bunker Oil Pollution Damage" to 1.836 in the "Protocol To Amend The 1992 International Convention On The Establishment Of An International Fund For Compensation For Oil Pollution Damage". We note that the distribution of ϕ_j is not symmetric but right-skewed. The variation in ϕ_j is suggestive of structural differences between treaties in the broader space of international environmental policy-making concerning the relevance that free-riding has on attracting more members after the treaty has entered into force. We find that $\phi_j > 0$ in 60.8% of our sample. We would need to conclude that here the incentive to participate in an environmental treaty is increasing if other countries decide to participate. The main challenge then becomes coordination between countries instead of cooperation as such. If we focus on treaties that are given the same subject code by the IEADB we find that climate treaties have the highest average ϕ_j. Since the number of treaties in each subject group varies a lot, these comparisons are mostly for illustration and are not sufficient as evidence for systematic differences in ϕ_j across subjects. The full table is below:

Besides the subject codes the IEADB also provides a hierarchic structure of environmental treaties which consists of agreements, protocols, and amendments (level 2) and further splits agreements into Conventions, Treaties, Statues, and a residual group called Agreements (level 3). While the average coefficient on level 2 (Agreement and Protocol) is about the same there are significant differences within the "Agreements" on level 2. International environmental legal documents (we refrain from using the word treaty here since it is used as a category too) are grouped on level 2 based on the name they are given in their title. We briefly discussed how the incentive of a country to participate

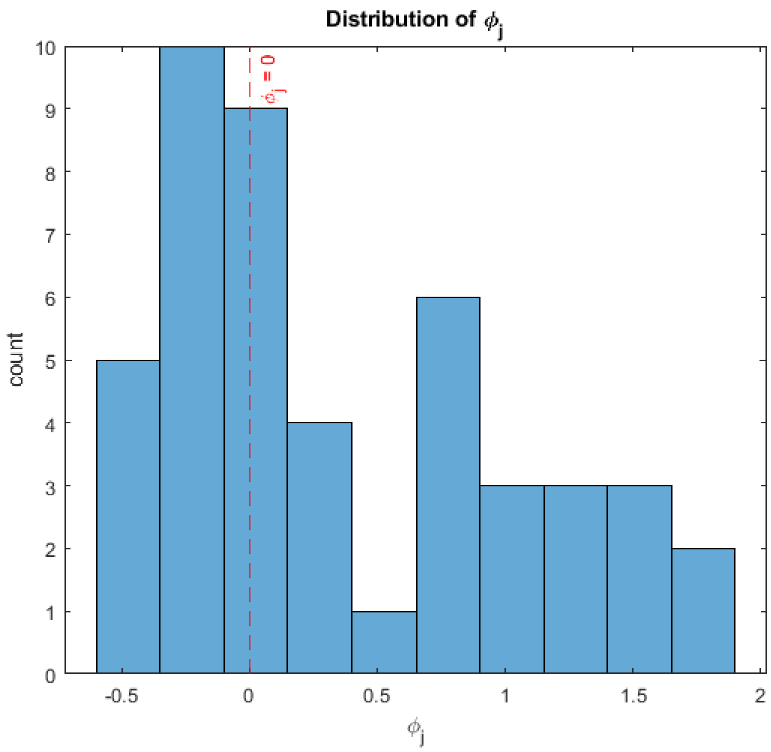


Figure 7: Distribution of ϕ_j in our sample of treaties

independently of the actions of other countries is captured in the parameter γ given that the country has participated in the past. Below we assume that our normalization was correct and indeed $S = 0$, such that there is no cost associated with withdrawing from the environmental treaty. The identified coefficients change if the true $S \neq 0$. Assuming that $\gamma_j = \gamma_{1,j} + \phi_{1,j}$ and interpreting $\gamma_{1,j} < 0$ as the period cost of participation while $\phi_{1,j} > 0$ is the period marginal effect from increasing the coalition size by one, $\gamma_j > 0$ indicates that each countries *expected relative payoff of participation* 2.5 is bigger than zero given that $a_{i,j}^{t-1} = 1$ and ignoring the payoffs that result from the two exogenous states. Hence, γ_j gives us two important insights. First, given some fixed cost of ratification F_j, $\gamma_j > 0$ implies that the expected flow payoff from withdrawal is lower than the expected flow payoff from remaining a treaty member. Second, if we could reduce the fixed cost of treaty ratification to zero $\gamma_j > 0$ would be sufficient to ensure the treaty will reach full participation in the limit (assuming that $E[\varepsilon_{i,j}^t] = 0$). We plot the distribution of γ_j below: As before, we can document substantial variations in the parameter estimates across the different treaties in our sample. We further note that the distribution is more symmetric than the one of ϕ_j. Coefficient estimates range from around -12 and -11 for the "International Convention on Salvage" and the "United Nations Framework Convention On Climate Change" respectively up to 7 and 8 for the "Desertification Convention" and the "Cartagena Protocol on Biosafety to the Convention On Biological Diversity".[3] To have a better understanding how γ_j, ϕ_j vary we plot them together. There is a very pronounced negative correlation between the estimates of γ_j and ϕ_j. This means that as net participation costs decrease (going from a net cost to a net benefit) the effect that an increase in the coalition size has for members relative to the effect it has on non-members

[3]Full name of the "Desertification Convention" is "Convention To Combat Desertification In Those Countries Experiencing Serious Drought And/Or Desertification, Particularly In Africa"

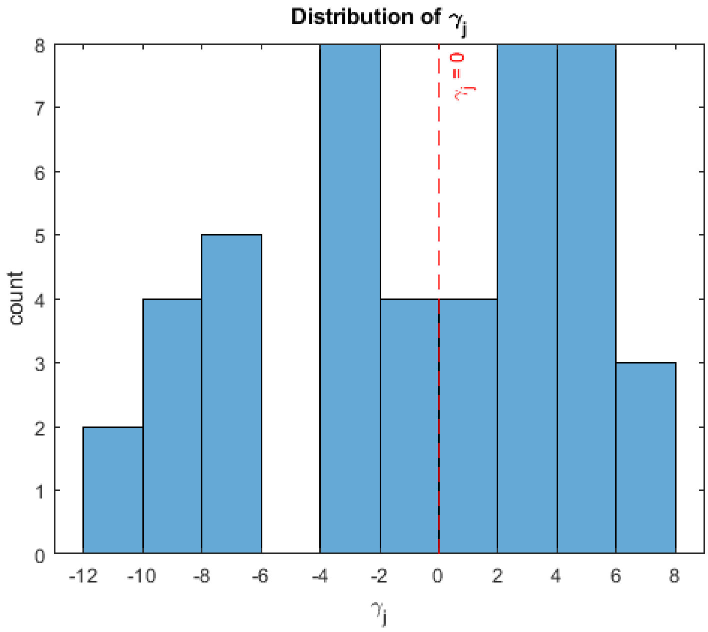


Figure 8: Distribution of γ_j in our sample of treaties

goes down (from positive to negative). We can split the (γ_j, ϕ_j) space into four regions by including lines at $\gamma_j = 0, \phi_j = 0$. Let's recall that for $\phi_j > 0$ we concluded that the incentive to participate for a country is increasing in the number of countries that are members of the environmental treaty and for $\gamma_j > 0$ the idiosyncratic expected relative payoff is high enough to not withdraw from the treaty, even if there are no other members. Almost all treaties lie in the lower right and upper left region of 9. The upper right region of the 9 contains treaties for whom the expected net benefit of participation, having done so in the last period, is high enough to ensure continued participation in expectation, and the expected relative payoff from participation is increasing in the number of members in the treaty. For this set of treaties the case is very favorable, each individual country has an incentive to participate and since this spills over into a higher relative payoff of participation membership becomes increasingly attractive (given $E[\varepsilon_{i,j}^t] = 0$ and exogenous macro states, ceteris paribus). The lower left region contains treaties with both $\gamma_j, \phi_j < 0$. Here, the participation cost outweigh the idiosyncratic benefit of being a member while the expected relative payoff from participation is decreasing in the number of members (taking $\varepsilon_{i,j}^t$ and the macro states as given). Treaties in this region should only attract members through high positive payoff shocks or if the relative payoff of macro states is positive and substantial. Furthermore, the incentive to withdraw is increasing as the coalition size increases. Next, we discuss the upper left part of the plot. This part of the parameter space is populated by around half of the treaties (47.8%). If $(\gamma_j < 0, \phi_j > 0)$ and taking payoff shock and macro states as given, the participation cost outweighs the idiosyncratic benefit from being a member but membership becomes more attractive as the treaty coalition increases in size. We would expect the coalition to grow increasingly stable (i.e. the likelihood of withdrawals to decrease) if more countries become members of the treaty. However, if the incentive to participate outweighs the incentive to withdraw depends on $|\phi_j|$ relative to $|\gamma_j|$. If we ignore the impact of the two exogenous variables we can compute the threshold N_{-i} of coalition members that are needed such that positive spillovers within the coalition outweigh the participation cost for country i, and i has no incentive to withdraw. We refer to this as the internal stability threshold. The threshold

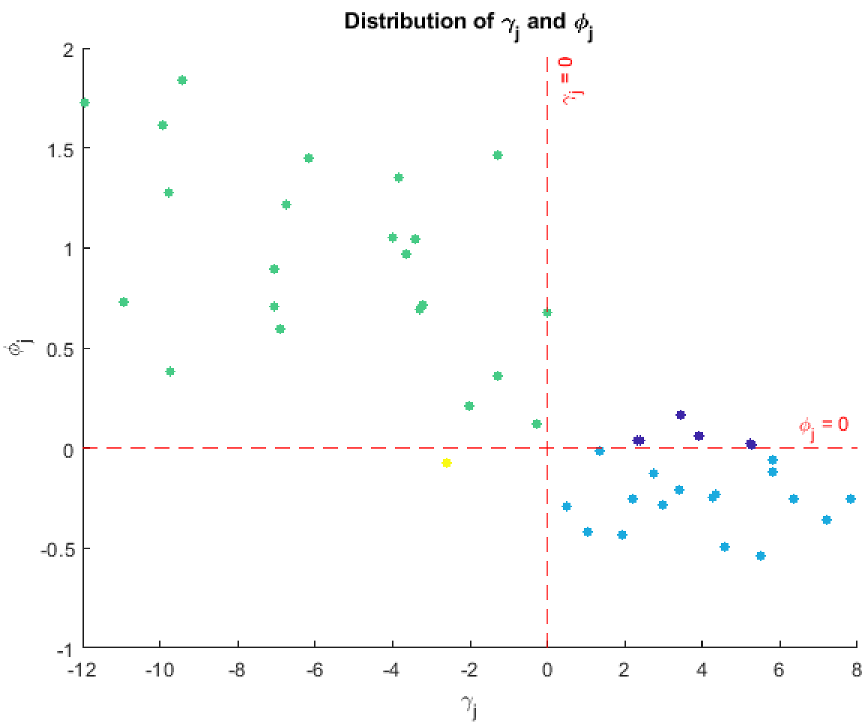


Figure 9: Joint plot of ϕ_j, γ_j in our sample of treaties

$\tilde{N}_{-i}$ is given by:

$$\tilde{N}_{-i,j} = -\frac{\gamma_j}{\phi_j}$$

This follows directly from $N_{-i,j}\phi_j + \gamma_j \geq 0$. For $\phi_j > 0$ this is a lower bound. Given that the parameter estimates are for a game with a total of 10 players the threshold is in the support of $N_{-i} \in [0, 9]$. We add a table with the threshold $\tilde{N}_{-i,j}$ to the appendix. For 17 out of the 22 treaties that lie in this part of the parameter space the coalition becomes internally stable if all 10 countries participate in the treaty. To compare this, if we look at treaties in which a coalition of half of the countries we model (5 out of 10) is internally stable we look at 8 out of 22 treaties. Lastly, the lower right section ($\gamma_j > 0, \phi_j < 0$) contains 17 treaties which corresponds to roughly 37% of our sample. Here, the participation cost is lower than the idiosyncratic benefit of being a member but as more countries ratify the treaty non-membership becomes increasingly attractive. This story corresponds well with much of the theoretical literature that has been used to study international environmental policy-making in the past. There is an idiosyncratic incentive to implement environmental policies. However, as more countries commit to doing so in a coordinated way (i.e. through an international treaty) the incentive to withdraw and free-ride on the participation of other countries is increasing. We can repeat the previous exercise and find the upper bound $\tilde{N}_{-i,j}$ up to which the incentive to withdraw through ϕ_j is lower than the incentive to participate through γ_j, given a country has participated in the previous period and ignoring both macro states and the payoff shock. Besides the "Joint Convention On The Safety Of Spent Fuel Management And On The Safety Of Radioactive Waste Management", the "Convention On The Prior Informed Consent Procedure For Certain Hazardous Chemicals And Pesticides In International Trade", the "Statute of the International Renewable Energy Agency", and the "Convention On The Control Of Transboundary Movements Of Hazardous Wastes And Their Disposal" all

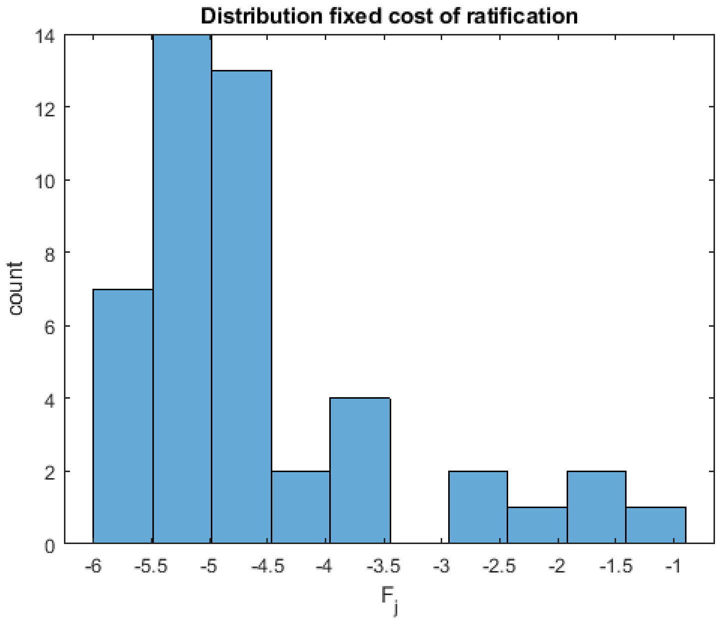


Figure 10: Histogram of fixed costs F_j

treaties are internally stable over the full support of $\tilde{N}_{-i,j}$. We next turn to the estimates of the fixed cost of ratification F_j, again noting that our interpretation and identification of this parameter hinges on the assumption that $S = 0$. The previous discussion focused on internal stability, i.e. the incentive to withdraw from the treaty given some level of participation and estimates of γ_j and ϕ_j. Next, we discuss the incentive to participate and how significant the fixed cost of ratification F_j is in our model.

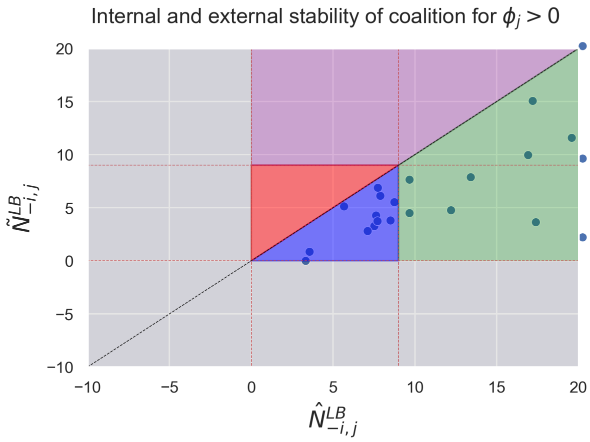
We find $F_j < 0, \forall j \in J$ which confirms that treaty ratification comes at a net cost. The distribution of estimates is right-skewed and we note that the cost varies between treaties but that the support of F_j is much smaller than the support of other estimates like γ_j. We can use our estimates of F_j to think about the external stability of the treaty coalition. When talking about external stability, we refer to the incentive of non-members to ratify the treaty for some coalition size, given the macro states and payoff shock. For 23 treaties the ratification cost F_j is higher than the idiosyncratic benefit of ratification, implying that given $N_{-i} = 0$ country i might not want to withdraw but the fixed cost of ratification prevents other countries from ratifying the treaty. We define the threshold from which ratification becomes rational for non-members (ignoring the macro states and the payoff shock respectively) as:

$$\hat{N}_{-i,j} = -\frac{F_j + \gamma_j}{\phi_j}$$

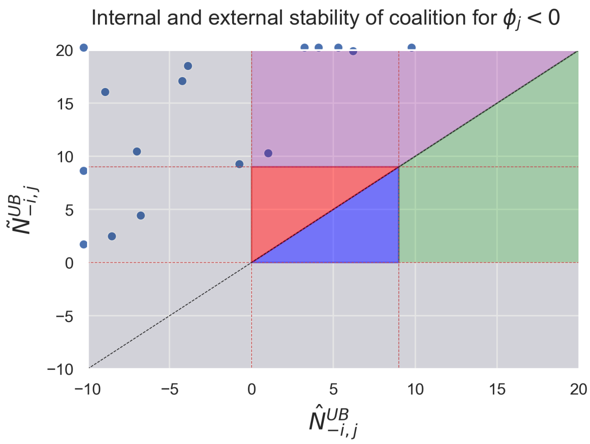
For $\phi_j > 0$ this is a lower bound while for $\phi_j < 0$ this is an upper bound. If we focus on the region $(\gamma_j > 0, \phi_j < 0)$ and $(\gamma_j < 0, \phi_j > 0)$ in plot 9 we find that $\tilde{N}_{-i,j} < \hat{N}_{-i,j}$ for the first and $\tilde{N}_{-i,j} < \hat{N}_{-i,j}$ for the latter. This implies that it is more difficult to attract ratifications through the joint effect of ϕ_j, γ_j, and F_j than it is to prevent withdrawals.

Further, if $(\gamma_j > 0, \phi_j < 0)$ the upper bound $\hat{N}_{-i,j} < 0$ and is not in the support of N for 11 out of 17 treaties. For $(\gamma_j < 0, \phi_j > 0)$ the difference between $\tilde{N}_{-i,j}$ and $\hat{N}_{-i,j}$ is much smaller. For 16 out of 22 treaties in this part of 9 $\hat{N}_{-i,j}$ is part of the support of

Figure 11: Internal and external stability, absent of exogenous payoffs



(a) Joint scatter plot of $\hat{N}_{-i,j}, \tilde{N}_{-i,j}$ for treaties with $\gamma_j > 0, \phi_j > 0$



(b) Joint scatter plot of $\hat{N}_{-i,j}, \tilde{N}_{-i,j}$ for treaties with $\gamma_j > 0, \phi_j < 0$

N. We can look at the threshold of internal stability $\tilde{N}_{-i,j}$ and the threshold of external stability $\hat{N}_{-i,j}$ jointly. We plot $\hat{N}_{-i,j}$ on the xaxis and $\tilde{N}_{-i,j}$ on the yaxis. The support of $\hat{N}_{-i,j}, \tilde{N}_{-i,j} \in [0, 9]$ is indicated using dashed red lines and a dashed black 45 degree line to easier identify if $\tilde{N}_{-i,j} < \hat{N}_{-i,j}$ or vice versa. We highlight five sections of the plot. First, we use red and blue to to highlight sections of the plot that are within the support and for which $\tilde{N}_{-i,j} < \hat{N}_{-i,j}$ (blue) or $\tilde{N}_{-i,j} > \hat{N}_{-i,j}$ (red). Second, we use purple and green for sections that are above the threshold for at least one of the two and grey for areas that are below the threshold for both. For $\phi_j > 0$ the two axis are lower bounds while for $\phi_j < 0$ they are upper bounds. The dots in the scatter plot refer to one treaty, dots on the border of the plot refer to treaties with $\hat{N}_{-i,j}, \tilde{N}_{-i,j}$ outside of the plotted region.

In Figure 11a we visualize the lower bound of $\hat{N}_{-i,j}, \tilde{N}_{-i,j}$ for $\phi_j > 0$. As stated before, we see that internal stability is achieved at lower coalition sizes than external stability and all treaties lie within the blue section of the plot. When we turn to treaties with estimates of $\phi_j < 0$ we find that none of the treaties lie within the support region of $\hat{N}_{-i,j}, \tilde{N}_{-i,j}$.

In the discussion of the estimation results, we have simplified the model by ignoring the

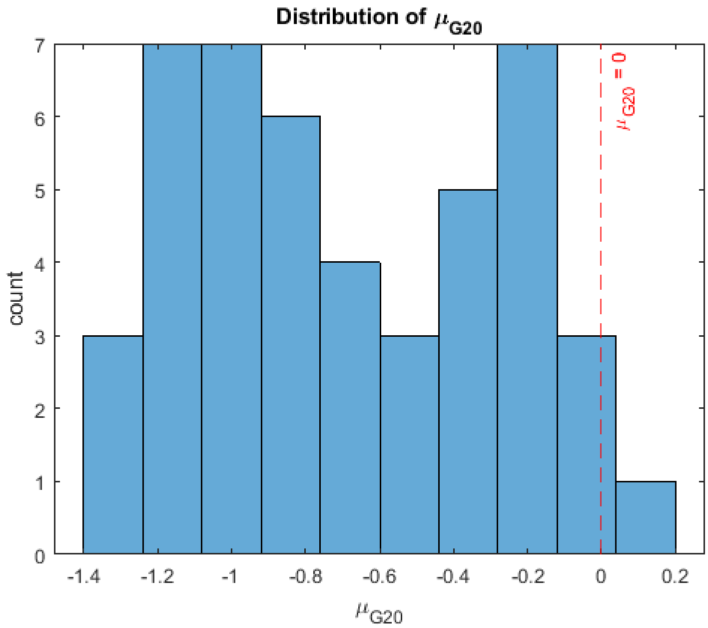


Figure 12: Distribution of μ_{G20} in our sample of treaties

effect that the two macro states x_{G20}, x_Y have on the relative payoff of treaty participation. We refer to those variables as macro variables because they vary independently of the actions of countries $i \in I$, and are common across treaties $j \in J$.

Let's recall that we use four discrete levels of G20 participation as x_{G20} and the transition probabilities $P(x'_{G20}|x_{G20})$ are as specified in 6. The coefficient estimates for $\mu_{G20,j}$ are smaller than zero for 44 out of 46 treaties. We have to interpret this as evidence of free-riding by countries $i \in I$ on the treaty participation of major economies. When we look at the estimates of ϕ_j and $\mu_{G20,}$ jointly we find a clear positive correlation. This suggests that if membership is a strategic substitute for countries $i \in I$, an increase in the number of G20 countries that participate in treaty j will also reduce the expected relative payoff of participation. The same holds for treaties in which membership of countries $i \in I$ is a strategic complement, but to a lesser extent.

To conclude the discussion of our preliminary results let's focus on the results for β_j. We cannot estimate the discount factor as part of $\boldsymbol{\theta}_j$ because it does not enter linearly, hence violating assumption M5. We decide against using risk-free interest rates to approximate the discount factor and instead estimate β_j in two steps. Below we plot the distribution of estimates of β_j for our sample of treaties: For a total of 35 treaties the discount factor that is implied by the model is below 0.05 and for 34 we model a game among myopic players. That suggests that for those treaties forward looking strategies do not play an important role. We inspect those 34 treaties for which the implied discount factor is below 5% in detail. Figure 15 plots the residual sum of squares (SSR) in for different discount factors relative to the SSR under the assumption of myopic players. We focus on those 34 treaties for which the implied discount factor was around zero. We find that the SSR increases drastically for some treaties (mitch id: 3269, 3289, 2982, 3021; average increase from $\beta_j \approx 0$ to $\beta_j = 0.1053$ of 8.39%) while for others the SSR does not change much when increasing the discount factor.

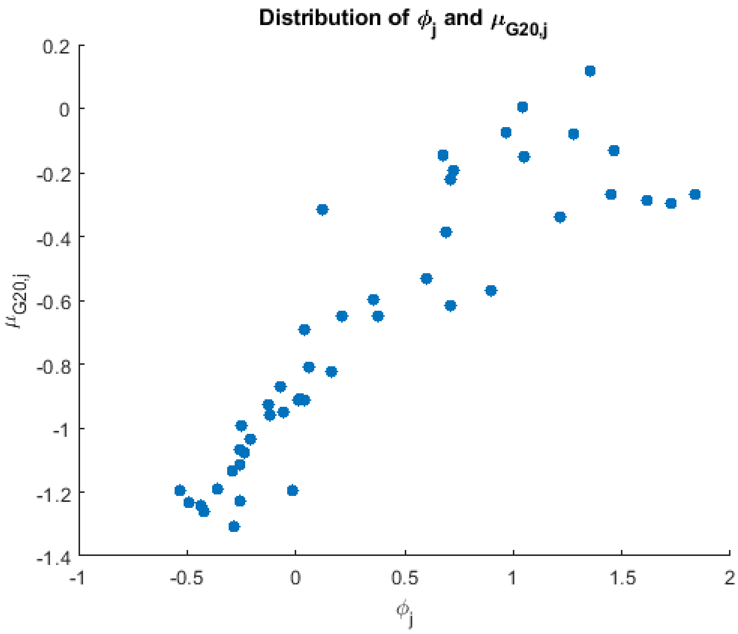


Figure 13: Joint plot of $\phi_j, \mu_{G20,j}$ in our sample of treaties

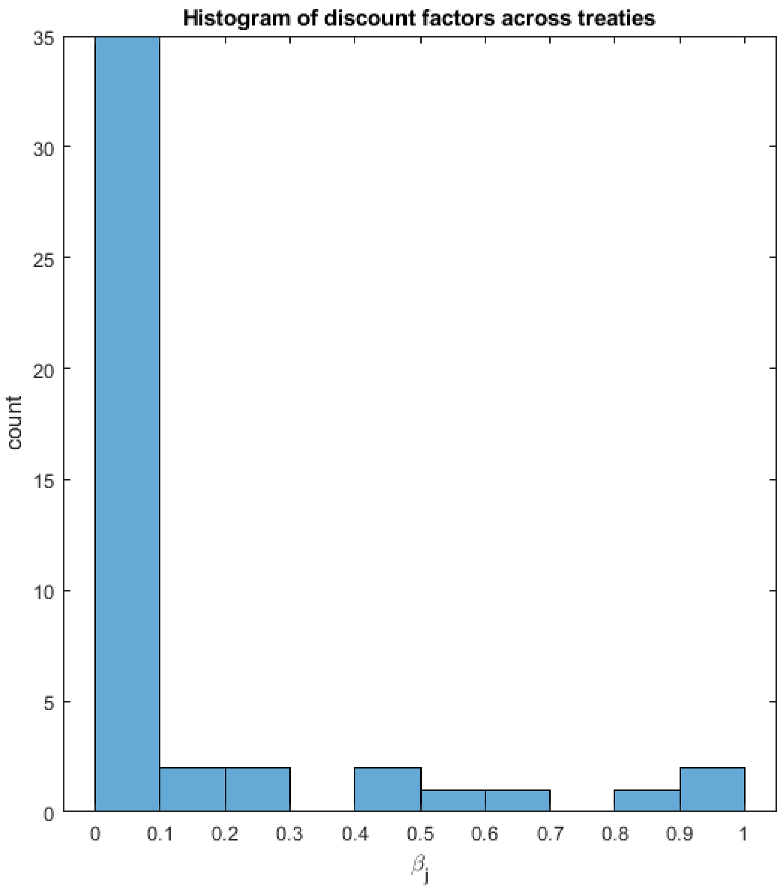


Figure 14: Distribution of discount factor in the sample of treaties

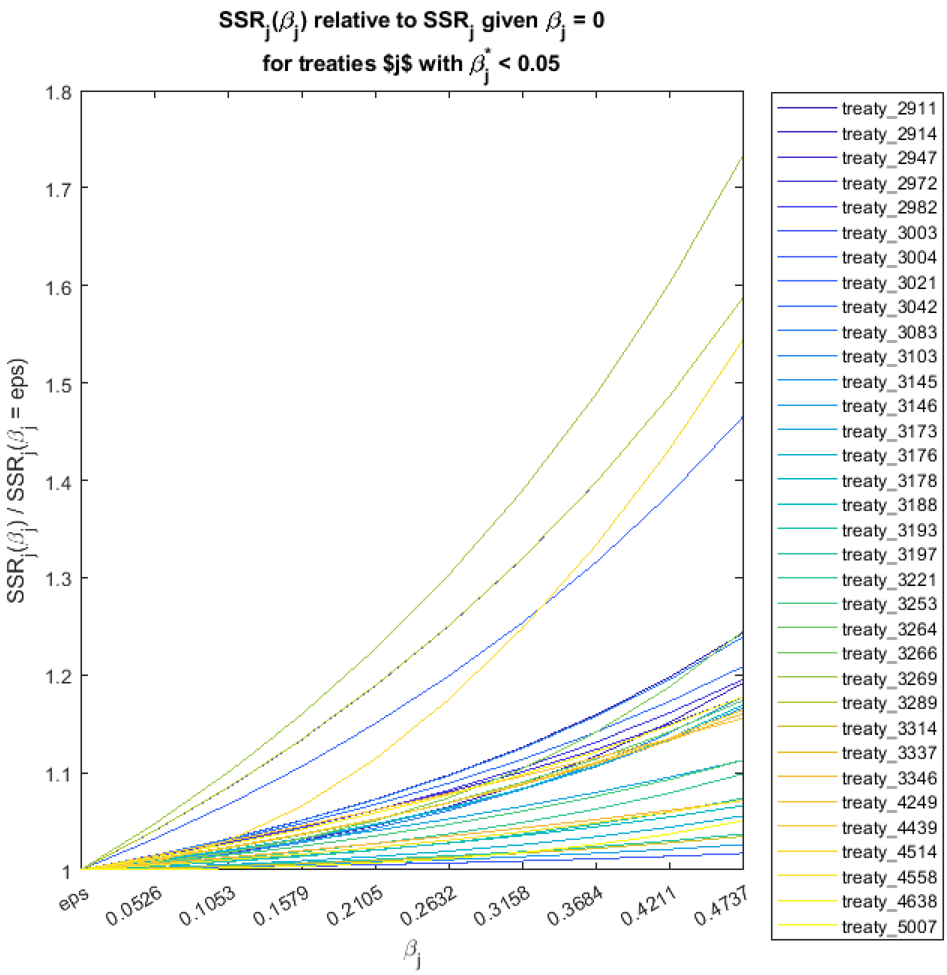


Figure 15: Comparison SSR for treaties with implied discount factor below 5%

7 Conclusion

This paper provides a novel approach to understanding the drivers of ratification in international environmental agreements by extending the empirical environmental economics literature (Wagner, 2016) through the application of structural estimation methods widely used in industrial organization (Aguirregabiria and Mira, 2007; Pesendorfer and Schmidt-Dengler, 2008; Pakes, Ostrovsky, and Berry, 2007).

Using a constructed panel dataset, we estimate the conditional choice probabilities of countries' ratification decisions under a set of identifying assumptions. Our structural model reveals significant heterogeneity across treaties negotiated within United Nations frameworks, particularly regarding the net marginal benefits of ratification. This heterogeneity highlights the varying effects of coalition size on treaty insiders versus outsiders, challenging the traditional view of environmental treaties as pure public goods, which dominates much of the theoretical literature. Additionally, we document considerable variation in the net ratification costs of treaties and the influence of G20 participation on the payoffs of ratification for the sample countries. We also analyze the implicit discount factors underlying different treaties, finding substantial variation and, on average, very low discount factors, results likely driven by the composition of our sample—primarily low- and middle-income economies.

Overall, our findings suggest that this structural approach can generate novel insights into the political economy of international environmental cooperation. By uncovering previously overlooked dimensions of treaty design and ratification dynamics, this methodology offers a more robust empirical framework for analyzing the effectiveness and determinants of international environmental agreements.

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Table 7: Coefficient estimates from the structural model

Treaty ID	γ_j	ϕ_j	F_j	$\mu_{G20,j}$	$\mu_{Y,j}$	β
2911	2.315680	0.040614	-5.575858	-0.913070	0.552314	2.325838e-04
2914	-7.042850	0.894166	-4.940326	-0.568189	1.298864	2.249940e-03
2947	-3.416512	1.042689	-4.428822	0.003647	-0.099019	5.692112e-06
2965	-6.748448	1.217663	-3.884362	-0.340833	0.473854	2.781960e-01
2972	-6.915098	0.597074	-4.779938	-0.531937	1.909290	6.836020e-04
2982	3.391093	-0.211136	-5.279204	-1.036911	1.044543	1.497837e-07
3003	5.247091	0.022079	-5.557131	-0.907619	-0.119247	2.248390e-03
3004	5.286552	0.016091	-5.551666	-0.911025	-0.123883	1.124999e-05
3021	4.351760	-0.234806	-5.264702	-1.077095	0.862995	4.183412e-05
3042	1.941892	-0.435866	-4.891488	-1.242609	1.834037	6.823652e-04
3083	4.243365	-0.248481	-5.291110	-0.991699	0.478569	1.739873e-03
3103	-7.075268	0.708873	-4.914338	-0.615995	1.483405	1.928909e-03
3126	-10.942726	0.726324	-1.538288	-0.193713	1.938745	4.500000e-01
3128	-0.268124	0.121058	-5.110492	-0.314780	-0.005100	9.999330e-01
3145	3.923497	0.061272	-5.565665	-0.808592	0.415252	2.249829e-03
3146	5.796077	-0.059322	-5.481419	-0.952857	-0.192849	4.798913e-05
3149	-2.038565	0.211161	-4.726939	-0.651751	0.894791	5.263169e-01
3173	-1.301809	0.357869	-4.916405	-0.599880	0.645463	4.697506e-07
3176	-3.309622	0.690921	-5.120521	-0.386080	0.658509	2.250015e-03
3178	-9.742456	0.380879	-4.458813	-0.648222	3.164302	9.769769e-06
3188	7.199963	-0.361862	-4.954949	-1.191470	0.667965	2.250095e-03
3193	6.338297	-0.253842	-5.301012	-1.113460	0.143375	2.247694e-03
3197	5.798143	-0.115214	-5.425222	-0.960946	-0.217841	2.167014e-03
3221	3.429484	0.163891	-5.685075	-0.823890	0.243379	1.664748e-03
3253	-2.600927	-0.072557	-5.254654	-0.868921	2.460011	2.250042e-03
3264	0.495048	-0.289015	-5.242846	-1.131882	1.423980	1.013164e-04
3266	-9.933574	1.615979	-2.804210	-0.287422	0.854512	2.248530e-03
3269	2.732500	-0.123509	-5.329405	-0.928287	1.114772	2.777769e-05
3289	2.194159	-0.253747	-5.225813	-1.068938	1.397242	1.848932e-05
3314	7.820269	-0.255431	-5.323042	-1.226568	-0.102008	1.161009e-05
3316	-6.174703	1.448663	-4.852980	-0.268256	0.465542	1.554528e-01
3337	5.511350	-0.535251	-4.963862	-1.196301	0.718986	2.250003e-03
3341	2.393889	0.038893	-5.188578	-0.693943	-0.344607	8.374155e-01
3345	1.342548	-0.014207	-5.531518	-1.196271	0.016287	9.995887e-01
3346	-3.206834	0.711096	-3.669268	-0.219015	0.728145	3.620517e-06
3841	-11.950405	1.729575	-1.411849	-0.295173	1.357074	2.631579e-01
4249	-9.777050	1.276891	-2.555102	-0.081692	0.861509	1.360975e-03
4439	-3.641627	0.969855	-3.835745	-0.074684	0.120950	2.166315e-04
4441	-3.828032	1.351158	-5.771426	0.119738	-0.019240	1.186184e-01
4514	-9.408721	1.836202	-0.983587	-0.270192	-0.078239	2.137775e-03
4558	1.046488	-0.422246	-4.651421	-1.259907	1.974027	2.250008e-03
4580	-1.275318	1.462455	-3.935199	-0.131516	-2.329094	6.408643e-01
4587	2.981737	-0.284561	-4.974592	-1.310520	0.737712	4.499855e-01
4638	4.564993	-0.492123	-4.931558	-1.234282	1.117687	6.086215e-08
5007	-3.985353	1.048205	-4.919517	-0.152640	0.185549	2.251976e-03
5046	-0.010705	0.677326	-2.245536	-0.144028	-0.417290	5.263708e-02

Table 8: Distribution of ϕ_j for treaties in different subject categories as coded by the IEADB (Mitchell et al., 2023)

subject code	count	mean	min	median	max
Climate	2.0	0.701825	0.677326	0.701825	0.726324
Energy	1.0	-0.422246	-0.422246	-0.422246	-0.422246
Habitat	2.0	0.173506	-0.361862	0.173506	0.708873
Human_sphere	3.0	0.546749	0.211161	0.380879	1.048205
Other	2.0	0.394423	-0.253842	0.394423	1.042689
Pollution	20.0	0.208782	-0.535251	-0.065940	1.836202
Species	15.0	0.585465	-0.492123	0.690921	1.462455

Table 9: Distribution of ϕ_j for treaties of different type as coded by the IEADB

Agreement Type (level 2)	Agreement Type Level 3	count	mean	min	median	max
Agreement	Agreement	12.0	0.674071	-0.284561	0.684124	1.462455
	Convention	21.0	0.236367	-0.535251	0.022079	1.729575
	Statute	1.0	-0.422246	-0.422246	-0.422246	-0.422246
	Treaty	1.0	0.711096	0.711096	0.711096	0.711096
Protocol	Protocol	11.0	0.310394	-0.492123	-0.059322	1.836202

A Figures & Tables

Table A.1: Entry into force thresholds in treaties

mitch_id	Agreement Name	n-rule	N	Further requirement
3103	Protocol On Environmental Protection To The An...	True	NaN	True
2914	Convention On The Conservation Of Antarctic Ma...	True	8.0	False
2972	Protocol Amending The International Convention...	True	7.0	False
3128	Convention On Biological Diversity	True	30.0	False
3314	Cartagena Protocol on Biosafety to the Convent...	False	50.0	False
4638	Nagoya Protocol on Access to Genetic Resources...	True	50.0	False
3149	Convention On The Prohibition Of The Developme...	True	65.0	False
3337	International Convention On Civil Liability Fo...	True	18.0	True
3266	Convention On Supplementary Compensation For N...	True	5.0	True
3126	United Nations Framework Convention On Climate...	True	50.0	False
3188	Convention To Combat Desertification In Those ...	True	50.0	False
3253	Protocol To The Convention On The Prevention O...	True	26.0	True
4587	Agreement on Port State Measures to Prevent, D...	True	25.0	False
3173	Agreement To Promote Compliance With Internati...	True	25.0	False
4441	Agreement For The Establishment Of The Global ...	True	7.0	True
5007	Agreement on the establishment of the Global G...	True	3.0	False
3042	Convention On The Control Of Transboundary Mov...	True	20.0	False
4558	Statute of the International Renewable Energy ...	True	25.0	False
2965	International Tropical Timber Agreement	False	16.0	True
3176	International Tropical Timber Agreement	True	16.0	True
4249	International Tropical Timber Agreement	True	12.0	True
2947	United Nations Convention On The Law Of The Sea	True	60.0	False
3193	Agreement Relating To The Implementation Of Pa...	True	40.0	True
3221	Agreement For The Implementation Of The Law Of...	True	30.0	False
3269	Protocol Adopting Annex VI - Regulations For T...	True	15.0	True
3345	International Convention On The Control Of Har...	True	25.0	True
3841	International Convention On Salvage	True	15.0	False
4439	World Health Organization Framework Convention...	True	40.0	False
3003	Convention On Early Notification Of A Nuclear ...	True	3.0	False
3004	Convention On Assistance In The Case Of A Nucl...	True	3.0	False
3197	Convention On Nuclear Safety	True	22.0	True
3145	Protocol To Amend The International Convention...	False	10.0	True
3146	Protocol To Amend The International Convention...	True	8.0	True
4514	Protocol To Amend The 1992 International Conve...	False	NaN	True
3083	International Convention On Oil Pollution Prep...	True	15.0	False
3316	Protocol On Preparedness, Response And Coopera...	True	15.0	True
2982	Convention For The Protection Of The Ozone Layer	True	20.0	False
3021	Montreal Protocol On Substances That Deplete T...	True	11.0	True
3341	Convention On Persistent Organic Pollutants	True	50.0	False
2911	Convention On The Physical Protection Of Nucle...	True	21.0	False
3346	International Treaty On Plant Genetic Resource...	True	40.0	True
3289	Convention On The Prior Informed Consent Proce...	True	50.0	False
3264	Joint Convention On The Safety Of Spent Fuel M...	True	25.0	True
3178	Agreement Establishing The World Trade Organiz...	True	NaN	True
4580	World Trade Organization Agreement on the Appl...	False	NaN	True
5046	Paris Agreement under the United Nations Frame...	True	55.0	True

Table A.2: Overview of membership actions in treaties

mitch_id	Year, min	Year, max	Coalition size, min	Coalition size, max	Witdrawals	Ratifications
2911.0	1987.0	2018.0	1.0	9.0	0.0	8.0
2914.0	1982.0	2018.0	1.0	3.0	0.0	2.0
2947.0	1994.0	2018.0	5.0	9.0	0.0	5.0
2965.0	1985.0	2018.0	0.0	6.0	6.0	6.0
2972.0	1997.0	2018.0	3.0	6.0	0.0	4.0
2982.0	1988.0	2018.0	0.0	10.0	0.0	10.0
3003.0	1986.0	2018.0	0.0	9.0	0.0	9.0
3004.0	1987.0	2018.0	2.0	9.0	0.0	9.0
3021.0	1989.0	2018.0	5.0	10.0	0.0	10.0
3042.0	1992.0	2018.0	2.0	10.0	0.0	9.0
3083.0	1995.0	2018.0	1.0	7.0	0.0	7.0
3103.0	1998.0	2018.0	2.0	3.0	0.0	1.0
3126.0	1994.0	2018.0	7.0	10.0	0.0	8.0
3128.0	1993.0	2018.0	3.0	10.0	0.0	10.0
3145.0	1996.0	2018.0	0.0	10.0	0.0	10.0
3146.0	1996.0	2018.0	0.0	7.0	0.0	7.0
3149.0	1997.0	2018.0	7.0	10.0	0.0	6.0
3173.0	2003.0	2018.0	3.0	5.0	0.0	3.0
3176.0	1997.0	2018.0	0.0	6.0	6.0	2.0
3178.0	1995.0	2018.0	8.0	10.0	0.0	4.0
3188.0	1996.0	2018.0	5.0	10.0	0.0	8.0
3193.0	1996.0	2018.0	3.0	9.0	0.0	8.0
3197.0	1996.0	2018.0	1.0	5.0	0.0	5.0
3221.0	2001.0	2018.0	0.0	7.0	0.0	7.0
3253.0	2006.0	2018.0	1.0	6.0	0.0	5.0
3264.0	2001.0	2018.0	1.0	5.0	0.0	4.0
3266.0	2015.0	2018.0	1.0	2.0	0.0	1.0
3269.0	2005.0	2018.0	1.0	10.0	0.0	9.0
3289.0	2004.0	2018.0	3.0	10.0	0.0	7.0
3314.0	2003.0	2018.0	5.0	9.0	0.0	9.0
3316.0	2007.0	2018.0	1.0	2.0	0.0	1.0
3337.0	2008.0	2018.0	1.0	5.0	0.0	5.0
3341.0	2004.0	2018.0	7.0	9.0	0.0	5.0
3345.0	2008.0	2018.0	1.0	8.0	0.0	8.0
3346.0	2004.0	2018.0	5.0	9.0	0.0	6.0
3841.0	1996.0	2018.0	0.0	2.0	0.0	2.0
4249.0	2011.0	2018.0	5.0	7.0	0.0	2.0
4439.0	2005.0	2018.0	8.0	9.0	0.0	4.0
4441.0	2004.0	2018.0	2.0	3.0	0.0	1.0
4514.0	2005.0	2018.0	0.0	1.0	0.0	1.0
4558.0	2010.0	2018.0	1.0	8.0	0.0	8.0
4580.0	1995.0	2018.0	8.0	10.0	0.0	10.0
4587.0	2016.0	2018.0	3.0	5.0	0.0	4.0
4638.0	2014.0	2018.0	3.0	5.0	0.0	4.0
5007.0	2012.0	2018.0	2.0	3.0	0.0	1.0
5046.0	2016.0	2018.0	6.0	10.0	0.0	10.0

Table A.3: Thresholds for internal, and external stability by treaty

mitch_id	Agreement Name	N, internally stable	N, externally stable	lower bound	upper bound
2911	Convention On The Physical Protection Of Nucle...	-57.017	80.272	True	False
2914	Convention On The Conservation Of Antarctic Ma...	7.876	13.402	True	False
2947	United Nations Convention On The Law Of The Sea	3.277	7.524	True	False
2965	International Tropical Timber Agreement	5.542	8.732	True	False
2972	Protocol Amending The International Convention...	11.582	19.587	True	False
2982	Convention For The Protection Of The Ozone Layer	16.061	-8.943	False	True
3003	Convention On Early Notification Of A Nuclear ...	-237.647	14.042	True	False
3004	Convention On Assistance In The Case Of A Nucl...	-328.533	16.475	True	False
3021	Montreal Protocol On Substances That Deplete T...	18.533	-3.888	False	True
3042	Convention On The Control Of Transboundary Mov...	4.455	-6.767	False	True
3083	International Convention On Oil Pollution Prep...	17.077	-4.217	False	True
3103	Protocol On Environmental Protection To The An...	9.981	16.914	True	False
3126	United Nations Framework Convention On Climate...	15.066	17.184	True	False
3128	Convention On Biological Diversity	2.215	44.430	True	False
3145	Protocol To Amend The International Convention...	-64.034	26.801	True	False
3146	Protocol To Amend The International Convention...	97.706	5.304	False	True
3149	Convention On The Prohibition Of The Developme...	9.654	32.039	True	False
3173	Agreement To Promote Compliance With Internati...	3.638	17.376	True	False
3176	International Tropical Timber Agreement	4.790	12.201	True	False
3178	Agreement Establishing The World Trade Organiz...	25.579	37.285	True	False
3188	Convention To Combat Desertification In Those ...	19.897	6.204	False	True
3193	Agreement Relating To The Implementation Of Pa...	24.969	4.086	False	True
3197	Convention On Nuclear Safety	50.325	3.237	False	True
3221	Agreement For The Implementation Of The Law Of...	-20.925	13.763	True	False
3253	Protocol To The Convention On The Prevention O...	-35.846	-108.267	False	True
3264	Joint Convention On The Safety Of Spent Fuel M...	1.713	-16.428	False	True
3266	Convention On Supplementary Compensation For N...	6.147	7.882	True	False
3269	Protocol Adopting Annex VI - Regulations For T...	22.124	-21.026	False	True
3289	Convention On The Prior Informed Consent Proce...	8.647	-11.948	False	True
3314	Cartagena Protocol on Biosafety to the Convent...	30.616	9.777	False	True
3316	Protocol On Preparedness, Response And Coopera...	4.262	7.612	True	False
3337	International Convention On Civil Liability Fo...	10.297	1.023	False	True
3341	Convention On Persistent Organic Pollutants	-61.550	71.855	True	False
3345	International Convention On The Control Of Har...	94.497	-294.848	False	True
3346	International Treaty On Plant Genetic Resource...	4.510	9.670	True	False
3841	International Convention On Salvage	6.909	7.726	True	False
4249	International Tropical Timber Agreement	7.657	9.658	True	False
4439	World Health Organization Framework Convention...	3.755	7.710	True	False
4441	Agreement For The Establishment Of The Global ...	2.833	7.105	True	False
4514	Protocol To Amend The 1992 International Conve...	5.124	5.660	True	False
4558	Statute of the International Renewable Energy ...	2.478	-8.538	False	True
4580	World Trade Organization Agreement on the Appl...	0.872	3.563	True	False
4587	Agreement on Port State Measures to Prevent, D...	10.478	-7.003	False	True
4638	Nagoya Protocol on Access to Genetic Resources...	9.276	-0.745	False	True
5007	Agreement on the establishment of the Global G...	3.802	8.495	True	False
5046	Paris Agreement under the United Nations Frame...	0.016	3.331	True	False