ERF Working Papers Series

Agree to Disagree? Making Sense of Vagueness in International Environmental Agreements

Dina Kassab and Chahir Zaki

ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

Working Paper No. 1405
October 2020

AGREE TO DISAGREE? MAKING SENSE OF VAGUENESS IN INTERNATIONAL ENVIRONMENTAL AGREEMENTS

Dina Kassab[1] and Chahir Zaki[2]

Working Paper No. 1405

October 2020

We would like to particularly thank Johannes Urpelainen (Johns Hopkins University) and Jeffrey Staton (Emory University) that have shaped our view on the subject.

Send correspondence to:
Dina Kassab
Cairo University
dina.kassab@feps.edu.eg

[1] Assistant Professor in Economics, Faculty of Economics and Political Science, Cairo University.
[2] Associate Professor of Economics and Director of the French Section, Faculty of Economics and Political Science, Cairo University and Economic Research Forum (ERF). E-mail: chahir.zaki@feps.edu.eg.

First published in 2020 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

This paper explains vagueness in International Environmental Agreements (IEAs) by the heterogeneity in institutional capacities of the negotiating countries. Using a game-theoretic model, where information regarding institutional capacities of potential participants is asymmetric, this paper endogenizes countries' participation and compliance behavior and explains the level of ambiguity in the IEA design, thus contributing to a more realistic modeling of the treaty formation. It is shown that (1) generally, a country is more likely to ratify a given agreement the larger the number of its ratifiers and the closer its institutional capacity relative to that of the other ratifiers, (2) countries with higher institutional capacities are more likely to ratify precise agreements and to comply to their obligations therein, (3) an increased level of precision in the agreement is likely to increase participation when the distribution of institutional capacities of negotiating countries is skewed to the right or slightly skewed to the left, and (4) in the case where institutional capacities are quite skewed to the left or uniformly distributed, more ambiguity is required to increase participation; this is the case where countries agree to disagree regarding the implementation of the IEA. To test our theoretical predictions, we use a dataset with information on countries' ratification behavior towards five climate change-related IEAs (Vienna Convention, Montreal Protocol, United Nations Framework Convention on Climate Change, Kyoto Protocol and Paris Agreement) from 1980 to 2018 and construct our own index of agreements precision by focusing on six criteria (specifity of controlled substances and time schedule; numerical mitigation targets; clarity of implementation mechanism; reporting, monitoring and review process; sanctions for noncompliance and incentives for developing countries). Our empirical results show that (i) there exists a band-wagon effect in countries' ratification decisions, (ii) large institutional differences reduce this bandwagon effect and hence the likelihood of ratification, (iii) vagueness reduces countries' incentives to ratify, yet, (iv) when countries ratify vague agreements, the latter are likely to be less binding and consequently are associated to more CO2 emissions.

Keywords: Vagueness, International Environmental Agreements, Institutional capacity, Noncompliance.
JEL Classifications: F53, H87, Q52, Q54.

1 Introduction

The global environmental politics map has drastically evolved over the years. In the old configuration, negotiations typically involved a small number of pivotal players; the European countries - mainly France, Germany and the United Kingdom – at one end and the United States at the other. Furthermore, those key players were characterized by two main features. First, they have relatively high environmental preferences. For instance in the EU, the environmental policy is based on the precautionary principle and green parties have been continuously represented in the European Parliament since 1984 (Rüdig, 2019). Second, they have a strong political and institutional system referred to as *high institutional capacity* (Hughes and Urpelainen, 2015). An important feature of the agreements is the clear categorization of countries into two groups. While the first one mainly consisted of industrialized countries that were members of the OECD and countries in transition with a larger set of commitments, the second included developing countries and had no binding commitment. The negotiations resulted in agreements specifying precise commitments for the signatories. For instance, the Montreal Protocol (1987) states that

> *. . . the signatory states shall accept a series of stepped limits on Chloro-Fluoro-Carbons (CFC) use and production, including:*
> *from 1991 to 1992 its levels of consumption and production of the controlled substances in Group I of Annex A do not exceed 150 percent of its calculated levels of production and consumption of those substances in 1986;*
> *from 1994 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed, annually, twenty-five percent of its calculated level of consumption and production in 1986.*
> *from 1996 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed zero.*

A second example is the Convention on long-range transboundary air pollution in 1985 which states that *"The Parties shall reduce their national annual sulphur emissions or their transboundary fluxes by at least 30 percent as soon as possible and at the latest by 1993, using 1980 levels as the basis for calculation of reductions."*[1] This is referred to in the literature of International Environmental Agreements (IEA) as the *mitigation* approach where clear targets and goals are agreed upon. Since the main objective was to reduce greenhouse gas emissions in a way that would preserve the climate system (United Nations, 1992), mitigation has traditionally been the major focus of international environmental negotiations. An obvious advantage is that the success of mitigation can be easily measured by contrasting the targeted outcomes with the achieved ones.

In the recent years however, this scene has drastically changed. The number of pivotal players has increased to include fast-growing economies – such as China and India. The new players have rather heterogeneous institutional capacities and environmental preferences *and* there is uncertainty about those two characteristics. The impacts of climate change have become clearer and the need for integrating the non Annex I parties into the action plan increased.
Indeed, despite the apparent breakdown of the Copenhagen Meeting (2009), it shaped a new model of climate governance. For the first time, developing countries started to make commitments. This

[1] All treaties texts are retrieved from the United Nations Treaty Collection available at https://treaties.un.org.

introduced the *adaptation* approach into the global environmental politics. The style in which the Paris agreement (2016) was set-up is such that there is a global goal which is to hold the increase in the global average temperature to below 2°C above pre-industrial levels along with a set of principles and guidelines for signatories who then draft their own adaptation plans (see Article 7 of the Agreement[2]. States would then pledge the action they would be willing to take. In some cases, these pledges represented a real contribution to emissions reduction with measurable targets, but in others, they were vaguely stated.[3]

Against this background, this paper analyzes the impact of, as well as the rationale for, vagueness in IEAs, given heterogeneous institutional capacities of the negotiators. There are several aspects to this question. First, given that IEAs are agreements between sovereign countries and that there are no enforcement mechanisms, compliance cannot be taken for granted. Indeed, agreements drafted in a vague language then allow the signatories to submit their pledges in a way that conciliates their economic, social and environmental interests so that the likelihood of compliance and participation increases. The pitfall, however, would be that countries are complying with lower standards, which raises the question of whether this is more desirable than no compliance at all. Second, from a political economy perspective, vagueness reduces the cost of noncompliance. When the language of the agreement is sufficiently ambiguous, it will not be clear whether the policies of the signatories are consistent with the agreement provisions. Third, from a delegation problem perspective, and under the assumption that the institutional capacity of a country is its own private information, vagueness gives the country the necessary discretion to adapt its policy using its policy expertise (information advantage).

The theoretical model consists of a multi-stage game of the formation of an IEA with ratification constraints. Countries are assumed to be heterogeneous in their institutional capacity, each country's type being its private information. During the negotiations, a moderator - which represents the interests of the agreement - together with the representatives of different countries are assumed to negotiate over a degree of precision, rather than a uniform or differential commitment level. Moreover, the moderator has two types of concerns. The policy concerns of the agreement is to, ideally, move all countries' abatement policies towards the socially optimal level. The prestige concerns reflect the idea that the moderator wishes to reduce noncompliance since then the agreement would appear insignificant. So the basic idea is that vagueness involves a trade-off for the moderator between achieving the desired policy outcomes from the agreement and risking noncompliance. Given the level of ambiguity in the agreement, each country's representative formulates a policy proposal that is consistent with the agreement but does not necessarily coincide with the optimal cooperative policy since each country is allowed to use its discretion in interpreting the provisions of the agreement. The pivotal agent in each country then decides whether to ratify the agreement.

[2]Parties acknowledge that adaptation action should follow a country-driven, gender-responsive, participatory and fully transparent approach [...] Parties recognize the importance of support for and international cooperation on adaptation efforts [...] Parties should strengthen their cooperation on... assisting developing countries Parties in identifying effective adaptation practices.

[3]For an assessment of the national adaptation plans under the Paris agreement, see Morgan et al. (2019).

Our main findings can be summarized as follows. Asymmetric and uncertain institutional capacities are key in explaining the evolution of global environmental politics. Environmental negotiations between countries with distributions of institutional capacities that are skewed to the right (e.g. North/North agreements) or slightly skewed to the left (e.g. agreements between developed countries and emerging economies with moderate levels of institutional capacity) would, *a priori*, result in more precise agreements with higher levels of participation. By contrast, agreements where the distributional capacities of the key players are quite skewed to the left (e.g. South/South negotiations) or uniformly distributed are likely to involve a trade-off between precision and participation: policymakers would then either draft precise agreements that mandate a deep cooperation but induce limited participation or ones with high degree of ambiguity that attract more states at the cost of a reduced impact. Finally, countries with higher institutional capacities are more likely to ratify precise agreements *and* to comply to their obligations therein.

To test these predictions, we use a large panel of countries between 1980 and 2018 and focus on global environmental treaties and protocols to these treaties concerned with climate change, excluding amendments.[4] Precisely, our sample includes the Vienna Convention for the Protection of the Ozone layer (1985), the Montreal Protocol (1987), the United Nations Framework Convention on Climate Change (UNFCCC 1992), the Kyoto Protocol (1997) and the Paris Agreement (2016). Our aim is to answer two questions: on the one hand, whether vagueness and institutional differences induce more participation or not; on the other hand, how vagueness affects the effectiveness of IEAs measured by its effect on CO2 emissions. To measure agreements vagueness, we construct our own index of agreements precision by focusing on six criteria (specifity of controlled substances and time schedule; numerical mitigation targets; clarity of implementation mechanism; reporting, monitoring and review process; sanctions for non-compliance and incentives for developing countries). Our main findings show that there is a positive strategic effect on participation, (referred to as *the bandwagon effect*) where the higher the number of existing ratifiers, the more likely a country ratifies this agreement. Second, large institutional differences reduce *the bandwagon effect* and hence the likelihood of ratification. In addition, more vague agreements are associated to a lower probability of ratification. Yet, when countries ratify vague agreements, the latter are likely to be less effective, less binding and consequently are associated to more CO2 emissions as if countries agree to disagree when it comes to the implementation of the agreement.

The remainder of the paper is structured as follows. Section 2 presents a brief review of the related literature. In Section 3, we develop a model of vagueness in IEAs and discuss its implications. Following the theoretical framework, we present some stylized facts in Section 4. The econometric model testing the theoretical predictions is presented in section 5. Section 6 presents the empirical results and Section 7 concludes.

[4]The criteria for inclusion of an IEA in our sample is whether it introduces a large variation in the vagueness variable for ratifying countries. Although a given treaty and the related protocol are not fully independent, the degrees of precision can be sufficiently different to warrant inclusion of both. Amendments, however, are usually in the form of minor adjustments that do not alter the depth of the related treaty/protocol and are thus excluded from the analysis.

2 Related Literature

This paper borrows from and contributes to three strands of the literature: the literature on IEA, the political economy literature on delegation and the depth-participation dilemma in the international organization literature.

The IEA Literature

This literature can broadly be divided into participation and compliance models. The first set of models deals with the free-rider incentive; due to the public good nature of abatement efforts, countries have incentives not to participate in the IEA and free ride on the positive spillovers of the participants. Typically, these models analyze countries' incentives to join the coalition and determine the number of participants that would be sustained in a stable coalition. To this end, cooperative models use the stability concept of the core (Chander and Tulkens, 1992), the insights of which resemble to a great extent the cartel theory. Non-cooperative participation models on the other hand, rely on the criteria of internal and external stability. The internal stability criterion is that no signatory experiences an increase in welfare by leaving the coalition. The external criterion refers to the idea that no outsider to the coalition has incentives to join. This analysis resulted in rather pessimistic conclusions regarding the size of a stable coalition (Barrett, 1994). Several aspects of the agreements have since then been introduced into the analysis to explain the large number of participants frequently encountered in IEAs. Starting from the assumption that the gain from cooperation alone is insufficient to considerably improve the outcome over non-cooperative outcomes, and in the presence of asymmetries in costs of abatement between countries, these models consider different incentive instruments. Examples include monetary side payments, technological cooperation and issue linkage such as conferring benefits in trade agreements to the signatories (Barrett, 1997; Chou and Sylla, 2008). In the presence of abatement cost asymmetries, these instruments increase the incentives of countries that would lose, due to asymmetries, from signing the agreements and increase the size of stable coalitions.
The compliance models deal with the signatory's incentives not to comply with the obligations agreed upon in an IEA. The aim is then to test whether the coalition that has been formed can be sustained through some sanctions for deviators. Indeed, the regional penance is one of the strategies used (Asheim et al, 2006) which specifies a punishing mechanism whereby noncompliance is sanctioned through deviation of a group of countries.

A number of authors have studied the choice of abatement effort within the coalition. In particular, they investigate the relative efficiency of uniform versus differential rules. It is generally admitted that, under asymmetric cost of abatement, differential rules are more efficient (Hoel, 1992; Harstad, 2006). There are several reasons for the use of uniform rules however. They could seem fairer from the signatories' perspective which makes them more acceptable. Under incomplete information about the heterogeneous costs, negotiating over differentiated rules would be a complicated process (Larson and Tobey, 1994). Last, and perhaps this is the closest interpretation to the use of uniform abatement in our model, is that uniform rules could serve as a reference point, around which expectations of the negotiators would be coordinated (Schmidt, 1998).

The political process through which the choice of abatement effort is made has been studied in the IEA literature. It was traditionally assumed that the abatement level in the coalition is one that maximizes joint welfare. However, this assumption is neither consistent with individual

rationality (which implies the use of non-cooperative theory) nor realistic (since the abatement levels frequently observed are not optimal). It is not until recently that insights from the political economy literature have been introduced to account for the bargaining process between negotiators and/or the effect of domestic politics on the content of the agreement. Marchiori et al. (2017) investigate the effect of lobbying activities in the domestic economy of the negotiator on his bargaining power and hence on the outcome of the negotiation process. In a multi-stage game of the agreement formation, Köke and Lange (2017) analyze the effect of the preferences of the pivotal agent - or median voter - in each country on the probability of ratification in the second stage, and then investigate how this probability would affect the terms of the agreement. The optimal agreement is then one that applies a uniform abatement level and specifies a ratification threshold such that the expected number of participants is maximized as well as their expected (collective) welfare gains. While our analysis also focuses on the effect of ratification constraints on the IEA terms, we depart from the analysis in Köke and Lange (2017) in two directions (i) by assuming heterogeneity and asymmetric information about the distribution of institutional capacities of the different countries, even though the cooperative abatement *policy* is common to all countries, the cooperative abatement *level* differs depending on the institutional capacity, (ii) the (cooperative) uniform abatement effort is endogenously determined by the number of ratifiers at equilibrium, and (iii) the outcome variable of the negotiation is a level of vagueness that specifies how far a country can deviate from the cooperative policy without being considered noncompliant.

In an interesting review of the literature on IEAs, Finus (2008) points out three main gaps in the theoretical analysis of IEAs. First, in the participation models, both cooperative and non-cooperative, compliance is exogenous. A country that joins the agreement is implicitly assumed to comply with its provisions. Second, in compliance models, participation is exogenous. Moreover, the IEA models make some exogenous assumptions about the choice of the abatement level within the coalition *and* the allocation among its members. The model we present in this paper fills many of the gaps outlined above. It captures the important political economy dimension in the representatives' objective function as they are assumed to have both re-elections motives and reputational concerns. In addition, it contributes to a more realistic modeling of the treaty formation as countries with heterogeneous institutional capacities are assumed to negotiate over a level of ambiguity rather than an abatement effort. Finally, it endogenizes the number of participants, their characteristics as well as their "compliant" policies given their identity and the level of ambiguity in the IEA design.

Vagueness in Delegation Models

By introducing ambiguity into the analysis, our model relates to the political economy literature on delegation with discretion. In a delegation model, a principal typically gives an agent instructions to carry out a certain task in order to achieve his desired outcome. If the principal is better informed than the agent about the expected outcome resulting from his choice of action, he ought to be specific about the action to implement so that the agent has no marge of maneuver and the desirable outcome can be achieved. However, if it is the agent that has an information advantage over the principal, the latter then ought to give the agent a discretion interval within which his choice of action should fall, instead of locking him in a choice of action that is not necessarily optimal. As argued in Epstein and O'Halloran (1999), conferring some degree of discretion to the

agent is required in cases where his policy expertise could improve on the outcome.[5]

Yet, Staton and Vanberg (2008) advocate for a more realistic modelling of delegation with discretion. He argues that the discretion interval approach is appropriate when the authority can be delegated with precision, so that it can be easily detected whenever the agent's action falls outside the specified interval. However, the very nature of discretion usually implies that the principal gives ambiguous instructions. He models vagueness in the judicial policymaking: the Supreme Court gives a judicial opinion to the legislature, who is better informed about the connection between the policy he implements and the outcome, and chooses the optimal level of ambiguity in drafting the opinion. On one hand, the Supreme Court has incentives to increase vagueness to allow the legislature to draw on his policy expertise. But on the other hand, the legislature could exploit his discretion to pursue his own interests and deviate from the Court's ideal point. Furthermore, ambiguity reduces the cost to the Court of being defied; when the Court's demand is sufficiently ambiguous, it is rather unclear whether the legislature's policy is inconsistent with the Court's demand. Thus, the model developed in our paper builds on Staton and Vanberg (2008), in particular, the idea of vagueness in delegation is used to model the negotiation stage between the different representatives and the coordinator which results in an optimal level of vagueness with the ideal points being the cooperative policy for the moderator (who represents the agreement) and the non-cooperative policy for the representative. By doing so, this paper contributes to models of vagueness in delegation by extending the analysis to the case of multiple agents with interdependent efforts (due to the public good nature of abatement).

The Depth-Participation Dilemma in International Organization

Ambiguity in the agreement language, being a key feature in the *institutional design* of international agreements, has received considerable attention in the international organization literature. IEAs vary to a great extent in the precision of provisions included therein, particularly those related to quantitative targets, monitoring and enforcement mechanisms, dispute resolution processes, financial assistance and funding mechanisms (Mitchell et al., 2020). Those features have important implications both in terms of participation and effectiveness of IEAs. A *depth-participation* dilemma (Bernauer et al., 2013) is then likely to emerge: while precise agreements with well-defined obligations mandate a deeper cooperation by requiring visible changes of practices and domestic policies from participating members to meet the IEA standards, specifity is likely to deter participation.

This depth-participation dilemma (DPD hereafter) can be explained by several factors. First, precision increases compliance costs of participating states, both in terms of required policy adjustments to meet obligations and loss of flexibility in their ability to respond to unforeseen contingencies without compromising compliance (Downs et al., 1996; von Stein, 2008). Second, clarity of IEA provisions makes noncompliance more easily detected, thus a state reneging on its obligations incurs high expected reputational costs (Staton and Vanberg, 2008). Third, while vagueness in the agreement language helps conceal its distributional effects among the countries involved, increasing precision leads to more visibility and hence a higher likelihood for distributional conflicts to emerge (Goldstein and Martin, 2000).[6]

[5]This is perhaps the case of the legislative delegating to the bureaucracy. Whereas in the case where the legislative delegates to the executive, a discretion interval is not necessarily desirable since the legislative usually has committees that provide it with technical and policy expertise.

[6]A relevant example is the U.S. Congress decision not to ratify the Kyoto Protocol. This protocol sets clear

The DPD hypothesis has been supported empirically. Using a dataset of 211 global environmental treaties, Bernauer et al. (2013) conduct a cross-section analysis to explain the total number of ratifying countries up to the year 2006 per agreement as a function of agreement design characteristics previously discussed as well as agreement-specific variables such as the nature of the public good the agreement deals with (whether it is global, national or sub-national) and the relevant issue (pollution, species, nuclear or habitat). Only the precision in the obligations set forth by the agreement are found to deter participation, but not the clarity in provisions related to monitoring and enforcement mechanisms.[7]

Spilker and Koubi (2016) study the ratification choice of 160 countries toward 220 multilateral environmental agreements from 1950 to 2000. Using a logit, in an approach similar to a survival analysis where the treaty-country pair per year is the unit of analysis, the model accounts for precision of the IEA[8] while also introducing country-specific characteristics (trade openness, intergovernmental organizations membership, political regime, GDP and SO2 emissions) as well as *contingent* behavior effects as represented by percentage of countries from the same geographical and income group that have already ratified the agreement. The authors find evidence to support the DPD hypothesis. Furthermore, contingent behavior appears to have an effect on ratification decision: while higher ratification from countries in the same income group discourages ratification, ratification of countries from the same region has the opposite effect. This latter effect is consistent with Balsiger and Prys's (2016) finding that states strongly prefer regional over global cooperation. Mohrenberg et al. (2019) extend the analysis in Spilker and Koubi (2016) to include years up to 2011 and expand the set of explanatory variables to include the agreement-specific variables in Bernauer et al. (2013) as well as variables related to the funding mechanism in the IEA. Their results suggest that including a fund in the IEA increases participation; in particular, if contributions to the fund are rather voluntary and when assistance is disbursed only to a selected group of countries.

Although this literature provides valuable insights regarding the design of IEAs, its findings and suggestions should be considered cautiously for two reasons. First, this literature rather than endogenizing the choice of depth of the agreement, tests the implications - in terms of participation - of the final design features of the treaty, thus neglecting the idea that depth itself is a bargaining outcome that depends on the characteristics of key negotiating countries. Second, in the empirical models, a given IEA design feature is typically coded as a binary variable, indicating the presence or absence thereof. However, many of these features exhibit more than binary variation. For instance, obligations in an IEA could be in the form of a global target for all countries, common quantitative targets for a set of countries or a binding numerical target for each country individually with a predetermined time schedule.

Against this backdrop, we attempt to fill these gaps by developing a theoretical model explaining the agreement design as a function of states' characteristics (especially institutional characteristics) and by testing its predictions on IEAs related to climate change while allowing for a more elaborate categorization for the agreement design features.

emissions targets for Annex I countries (including the U.S.), while countries defined as non-Annex I (such as China) were not asked to take up any obligations.

[7]The authors explain this result to be likely due to the fact that monitoring and enforcement provisions in IEAs are merely nominal and hence do not affect countries' decisions to ratify.

[8]Precisely, three aspects of precision are considered: quantitative targets, monitoring/enforcement mechanisms and dispute settlement procedures. An IEA is then considered a "hard treaty" and is coded 1 if at least two of those three features are present and 0 otherwise.

3 The Model

Our model builds on Köke and Lange (2017) and Staton and Vanberg (2008) to study the effect of heterogeneity in institutional capacities on the degree of precision of an IEA.

3.1 Preliminaries

Set-Up We consider an economy with a finite number $N \geq 2$ of countries which are denoted by $i = 1, \ldots, n$. Each country i must choose its abatement effort or policy $p_i \geq 0$ to reduce some global pollutant. Let q_i denote the abatement *level* resulting from country i's abatement policy such that

$$q_i = p_i + \lambda_i$$

where λ_i is a country-specific shock drawn from a continuous distribution in $[-\alpha, \alpha]$ with a cumulative density function $G(.)$ with mean zero and variance σ_λ^2; it represents country i's institutional capacity. For a given abatement effort, a country with higher institutional capacity is able to achieve a higher abatement level. For instance, if the target is to reduce CO_2 emissions to some specific level, the country would have to set a higher carbon tax the greater its tax evasion rate. While being heterogeneous among countries, institutional capacity λ_i is assumed to be a private information of the agents in country i at the time of negotiating the agreement.[9]

The heterogeneity assumption stems from the observation that countries vary in their level of economic development, technological progress and bureaucratic efficiency, and hence achieving a given abatement level requires varying degrees of efforts. The unobservability of institutional capacity means that, when a country implements a given policy, only the agents in this particular country know the expected outcome with precision.[10] Whereas the remaining countries may have some idea about the potential abatement level that results from country i's policy but cannot forecast it precisely. Note that, the larger the interval $[-\alpha, \alpha]$, the less certain the remaining countries are about the connection between policies and outcomes.

Costs of abatement are increasing and convex, precisely $C(p_i) = \frac{1}{2}cp_i^2$ where c is a positive parameter. Whereas benefits from abatement are linear and given by $B(Q) = bQ$ where $b > 0$ is the marginal benefit from abatement, assumed common to all countries, and $Q = \sum_i q_i(p_i)$ is the aggregate abatement level. The assumption that environmental preferences are equal in all countries allows us to focus solely on the impact of heterogeneity in institutional capacities. This linear-quadratic specification, which is prominent in recent literature on IEAs (Asheim and Holtsmark, 2009; Finus and Rübbelke, 2013) considerably simplifies the mathematical analysis by separating the reaction functions of the different countries, otherwise they would be interrelated through aggregate abatement.

Players, temporal and information structure Now, we consider a multi-stage game of the formation of an IEA where the N countries join the negotiation table to negotiate over the degree of precision in the elaboration of the standards agreed upon in the treaty. Then each country decides whether to ratify the agreement.

[9] We allow institutional capacity to be ex post observable by the remaining countries (public information), equivalently, it can be inferred in the implementation phase from the observed outcomes.

[10] This could be the result of a learning process through repeated interactions between those agents and the bureaucratic system in their country.

The players in this game are a moderator, N representatives and N pivotal agents. The *moderator* plays a role only during the negotiation stage. He conciliates between the different opinions during the negotiations and insures the purpose of the agreement is met. There are then two agents per country who have different roles in the political process: the representative and the pivotal agent. The *representative* is in charge of representing the interests of his country during the negotiation process. He then formulates a policy proposal to the voters in his country given the outcome of the negotiation (i.e. he translates the degree of vagueness in the IEA into an implementable abatement policy). The *pivotal* agent in country i, denoted P, is the player whose preferences are decisive in the ratification decision and who formulates the unilateral policy in case of non-ratification.

The timing of events goes as follows. At the outset of the game, nature determines country i's type as represented by its institutional capacity, λ_i. Both the pivotal agent and the representative of country i learn their country's type but cannot observe those of the remaining $N-1$ countries. It is public knowledge however that λ_i follows a certain distribution with a probability density $g(.)$ and a cumulative distribution $G(.)$ with mean zero and variance σ_λ^2. In period 1, the negotiation process takes place between the moderator and the N representatives. The resulting agreement has the following structure: it specifies a standard for abatement policy p^C along with a degree of precision, a, that allows for some discretion in the implementation of the recommended standard. In period 2, each representative makes a policy suggestion p_i^A to the pivotal agent in his country, given the degree of vagueness of the agreement language. Ratification of the agreement occurs in period 3. The N pivotal agents decide whether they ratify the proposed agreement. Ratification is assumed to take place simultaneously. Finally, ratifying countries implement their respective p_i^A while all other countries implement their non-cooperative policies p^{NC}.

Cooperative and Non-Cooperative Policies The utility function of the pivotal agent in country i has the linear-quadratic specification discussed above, i.e.

$$U_i^P(p_i) = b[q_i(p_i) + E(Q_{-i})] - \frac{1}{2}cp_i^2 \tag{1}$$

where $E(Q_{-i}) = \sum_{j\neq i}^{N} E(q_j)$ is the expected aggregate abatement of the remaining $N-1$ countries. If country i is not bound by an agreement, the representative R_i sets the abatement policy unilaterally so that it maximizes country i's own payoffs from abatement, disregarding the positive spillovers from its abatement efforts on the remaining countries. The non-cooperative policy is then

$$p_i^{NC} = \underset{p_i}{\text{argmax}}\{U_i^P(p_i)\} \iff p^{NC} = \frac{b}{c} \tag{2}$$

However, if country i becomes member of an agreement with $\hat{n}$ ratifiers (such that $\hat{n} \leq N$), its cooperative policy would, *optimally*, be set as to solve:

$$\underset{p^i}{max} \sum_{i=1}^{\hat{n}} [b(q_i(p_i) + \sum_{j\neq i}^{N} E(q_j))] - \frac{c}{2}p_i^2 \iff p^C = \frac{nb}{c} \tag{3}$$

That is, it accounts for the benefits that accrue to all signatories from own emissions abatement.

3.2 The Negotiation Stage: A Delegation Game under Asymmetric Information

We model the negotiation stage as a game of delegation under incomplete information played between the moderator M (the principal) and the representatives R (the agents). The moderator has an ideal point, which is the fully cooperative abatement policy and, he demands that the signatories' policies be set at his ideal point. By articulating his demand in a perfectly precise language, he makes clear the implications that follow from it so that the signatories know exactly the commitments and obligations that follow from entering the agreement. But on the other hand, he risks either non-participation of the negotiating countries due to the large obligations imposed by the agreement *and* noncompliance of the signatories at a later stage.

We model the moderator's behavior using a standard quadratic loss function where the level of precision of the agreement a is the strategic choice of the moderator that he uses in order to minimize his *policy losses* due to deviations from his ideal point, while also minimizing his *prestige losses* stemming from visible deviations from the terms of the agreement by the signatories. Precisely,

$$U^M(a) = -[\sum_{i=1}^{N}(p_i + \lambda_i) - Q^*]^2 - ak[\sum_{i=1}^{\hat{n}}(\bar{q}^C - q_i(p_i))]^2 \tag{4}$$

where $Q^* = \sum_{i=1}^{N} q_i$ is socially optimal level of aggregate abatement, $a \in [0,1]$ is the degree of precision of the agreement and k is the relative importance of noncompliance concerns overs policy concerns. Here we assume that, from a political standpoint, the moderator is benevolent in the sense that his ideal point is the socially optimal level of aggregate emissions abatement Q^*, this level is obtained when all negotiating countries simultaneously set their policies at the cooperative level.

The first term of the utility function represents the policy concerns of the moderator. The larger the deviation of the total abatement from its socially optimal level, the higher the policy loss of the moderator, i.e. the more the agreement fails to achieve its core objective. The second term represents the prestige concerns of the moderator. Beside the policy concerns, the moderator incurs some costs if the treaty agreed upon induces noncompliance from the part of signatories, i.e. when the terms of the agreement are not respected. This prestige loss depends on the degree of precision of the agreement, the weight attributed to noncompliance concerns over policy concerns and the magnitude of the deviation. For a perfectly vague agreement ($a = 0$), the interpretation of the commitments that follow from the agreement are rather discretionary. The moderator cannot lose in prestige since any behavior of the signatories could be viewed as compliant with the agreement. As the language of the agreement becomes more precise, the signatories' obligations become more precise and noncompliance becomes easier to detect.

Prestige loss of the moderator is also affected by the importance of image concerns, k, which could be a measure for the importance of having the treaty *per se* to the international community. A priori, an agreement aiming at transmitting a political message assigns a high k, whereas an agreement taking place after a global environmental crisis would presumably attribute more weight to the policy concerns. Finally, as deviations of the signatories from the average cooperative abatement become more severe, the moderator's prestige loss increases since it becomes increasingly obvious that the agreement is insignificant in the sense that it is unable to induce compliance.

Recall that the representative R_i is responsible for implementing the policies, representing his country at the negotiation table and making policy proposals to the pivotal agent. So R_i could be thought of as the government in country i and the pivotal agent as the voters constituency (or, more precisely, the median voter). His objective is given by a quadratic loss function that also consists of policy concerns as well as reputational concerns. The former refers to the idea that the government ought to please its electoral constituency in order to get re-elected (domestic politics). The latter denotes the government's interest in enhancing its image in front of the international community. The payoffs for R_i from implementing policy p_i is

$$U_i^R(p_i; a) = -(q_i(p_i) - q_i^{NC})^2 - ar(\bar{q}^C - q_i(p_i))^2 \tag{5}$$

where r denotes the importance of reputational concerns relative to policy concerns. The ideal point for R_i is the welfare-maximizing policy for his electorate, which amounts to the non-cooperative unilateral abatement policy p_i^{NC}. As the abatement policy deviates from p_i^{NC}, there are larger domestic welfare losses which could weaken the political stance of R_i in his home country. From an international politics perspective however, R_i ought to set the abatement policy such that the outcome is not too far from the average cooperative one to keep a responsible image. The reputational loss due to deviating from the cooperative behavior is larger the more precise the agreement, because then the requirements of the agreement in terms of policy adjustments are quite clear. At extreme, when the agreements amount to a set of guidelines and recommendations ($a = 0$), R_i is allowed to implement any policy without cost since hardly any policy is incompatible with the agreement.

The cost of noncompliance is smaller when the policymaker places a low value on the reputational concerns relative to the domestic policy concerns. A case in point is the presence of powerful lobbies and interest groups. An increase in the lobbying activities and pressure exerted by interest group increase is reflected by a smaller r since it increases the policymaker's responsiveness to the domestic pressure relative to that exerted by the international community. Finally, the magnitude of deviation from the cooperative behavior clearly makes noncompliance more visible and the reputational loss more important.

This is a classic delegation problem under uncertainty. The moderator has an information disadvantage since institutional capacity λ_i is country i's private information. So the moderator would like to draft the agreement in a rather vague language to allow the countries to exploit their political expertise since they can best determine their abatement efforts that leads to the desired outcome. However by doing so, the moderator gives the representatives a larger margin for interpreting the agreement provisions. He risks noncompliance since the representatives can use this increased discretion to move further from the cooperative policy and closer to their respective ideal points. Vagueness then involves a trade-off for the moderator between achieving the desired policy outcomes from the agreement and risking noncompliance. The optimal level of vagueness then depends on the expected response of the different representatives as well as the ratification constraints in each country at the final stage.

3.3 The Post-Agreement Phase

Once the agreement has been drafted and before ratification can take place, the various stakeholders in country i typically negotiate over mutually acceptable means to implement its provisions. In our model, this amounts to the policymaker R_i making a policy proposal - which accounts

for both the external and internal pressure - to its domestic voters constituency as represented by the pivotal agent. For a given level of precision, a, the representative R_i's best response is given by

$$p_i^A(a) = (1-\gamma)p^{NC} + \gamma p^C - \gamma\lambda_i \tag{6}$$

where $\gamma = \frac{ar}{1+ar}$ is the weight attributed to cooperation and under the condition stated in the following assumption.

Assumption 1. $\frac{2(N-1)b^2}{\alpha^2 c^2} \leq \gamma \leq \frac{N^2 b^2}{2\alpha^2 c^2}$

Several interesting results should be highlighted. First, if an agreement adopts a completely vague language ($a = \gamma = 0$), R_i is free-handed in exploiting his discretion to implement his ideal point, i.e. the non-cooperative policy p^{NC}: as if the negotiators agreed to disagree, each would implement the policy that he would have in the absence of the agreement.

Second, as precision in the agreement increases (a and γ increase), pressure to move policy towards the cooperative policy increases.

Third, when the language of the agreement is extremely precise defining a set of perfectly specific provisions and commitments, the agreement's ability to move the policymakers towards the agreement's ideal point - the average cooperative policy - is constrained by the weight assigned to reputational concerns over policy concerns. When $a = 1$, only when the representative assigns an excessively high weight to the image concerns (as r becomes arbitrarily large) will the signatory's policy approach the average cooperative one.[11] Intuitively, specifity in the agreement is not sufficient to induce signatories to comply, only when precision is coupled with a sufficiently high pressure from the international community to cooperate will the agreement induce compliance.

Fourth, the larger the institutional capacity of country i, the lower the agreement compliant policy will be and hence the less costly compliance is. The logic behind this result is that, since institutional capacities are *ex-ante* unobservable, the best negotiators can do is to agree to conform to the average abatement level. For countries with high institutional capacity, this is an easy task since the abatement policy required to conform to the average is quite low. However, for countries at the low end of the distribution of institutional capacity, conforming to the average requires setting the abatement policy at a relatively high level. It is important to note that the policy proposal, logically, should not exceed the socially optimal cooperative policy $p^* = \frac{Nb}{c}$ nor fall below the non-cooperative one for any given country i. Since the policy proposal is always decreasing in λ_i, the sufficient conditions are that for the country with the lowest institutional capacity, it is never the best response to go beyond the fully cooperative policy and, for the country with the highest institutional capacity, it is never the best response to go below its non-cooperative policy, i.e. $p_i^A(\lambda_i^{min}) \leq \frac{Nb}{c}$, and $p_i^A(\lambda_i^{max}) \geq \frac{b}{c}$. Assumption (1) states the conditions on the value of γ for those inequalities to hold. The following lemma summarizes the main results discussed above.

Lemma 1. *Compliance to the the International Environmental Agreement depends on the level of precision such that:*

- *precision in the IEA design increases compliance, and*
- *compliance to a relatively precise agreement is less costly for countries at the high end of the distribution of institutional capacity.*

[11] Mathematically, for $a = 1$, R's best response is $\frac{p^{NC} + r(p^C - \lambda_i)}{1+r}$ which approaches $\bar{q}^C$ only as $r \to \infty$.

3.4 The Ratification Stage

It is now possible to derive the conditions under which country i ratifies the agreement. Three assumptions are made to allow for this derivation. Ratification decisions of all countries are assumed to take place simultaneously and under asymmetric information about institutional capacities. In case of non-ratification of the agreement, country i sets its abatement policy at the non-cooperative level p_i^{NC}. Whereas in the ratification scenario, country i adopts the policy proposal of its representative $p_i^A(a)$. Furthermore, commitment levels in that case are assumed to be dependent on the number of ratifying countries n at equilibrium, that is $p^C = \frac{nb}{c}$. It is also assumed that no country views its ratification decision as decisive for the agreement to enter into force. This is different from the analysis in Köke and Lange (2017) where there is a ratification threshold and each country views its decision to ratify as necessary to reach the threshold, otherwise all countries would implement their non-cooperative policies. We believe this last assumption is justifiable given that the agreement involves a level of ambiguity and hence a degree of discretion to the member countries, consequently, country i expects the ratification threshold to be easily attained and does not view its decision to ratify as being decisive.

Under the abovementioned assumptions, the pivotal agent in country i ratifies the agreement, for a given degree of precision a and a given expected number $\hat{n}$ of ratifying countries, whenever[12]

$$U_i^P(p_i^A; \hat{n}) \geq U_i^P(p^{NC}; \hat{n} - 1) \tag{7}$$

By joining the agreement, the pivotal agent incurs the cost of a reduced welfare due to implementing a suboptimal policy $p_i \neq p^{NC}$ that he would not choose where he is not bound by the agreement. This cost is larger for countries with low institutional capacity. There are two gains from ratifying on the other hand. The ratifier benefits from increased level of abatement due to both his own increased policy level and through inducing a higher standard for all participants. Solving for the condition in (7), we find that country i ratifies the agreement whenever

$$\lambda_L(a, \hat{n}) \leq \lambda_i \leq \lambda_H(a, \hat{n}) \tag{8}$$

where $\lambda_L(a, \hat{n}) = \frac{b}{c}[(\hat{n} - 1) - \sqrt{\frac{2(\hat{n}-1)}{\gamma}}]$ and $\lambda_H(a, \hat{n}) = \frac{b}{c}[(\hat{n} - 1) + \sqrt{\frac{2(\hat{n}-1)}{\gamma}}]$, and the probability of country i ratifying is given by

$$p_i(a, \hat{n}) = G[\lambda_H(a, \hat{n})] - G[\lambda_L(a, \hat{n})]$$

Now, it remains to specify the equilibrium condition that allows to obtain the number of participants at equilibrium. To study the equilibrium conditions, often referred to as the *stability of coalition*, the literature on IEAs has extensively used the concepts of the internal and external stability criteria (Finus, 2003). A coalition is said to be internally stable if no signatory has incentives to defect from the agreement. The external stability criterion refers to the idea that no non-signatory has incentives to join the coalition. We employ this widely accepted concept to define our equilibrium condition. The equilibrium level of participation is then defined as the number of participants at which no country would be willing to change its ratification decision, i.e. it is the level at which the expected number of participants $\hat{n}$ is equal to the actual number of participants n so that

$$n = N \times (G[\lambda_H(a, n)] - G[\lambda_L(a, n)]) \tag{9}$$

[12] In the case of a minimum ratification threshold, the pivotal agent's incentive to ratify the agreement is to ratify whenever $U_i^P(p_i^A; \hat{n}) \geq U_i^P(p^{NC}; 0)$, which considerably complicates the mathematical analysis.

The impact of precision on the participation level can be obtained by implicit differentiation of (9) which results in

$$n_a = \frac{-\frac{1}{2}\frac{b}{c}[2(n-1)]^{\frac{1}{2}}\gamma^{-\frac{3}{2}}\gamma_a[g(\lambda_H)+g(\lambda_L)]N}{1-N\frac{b}{c}\gamma_a\left([g(\lambda_H)-g(\lambda_L)]+\frac{\sqrt{2}}{2}\gamma^{-\frac{1}{2}}(n-1)^{\frac{1}{2}}[g(\lambda_H)+g(\lambda_L)]\right)} \tag{10}$$

where $\gamma_a = \frac{1}{(1+ar)^2}$ is the derivative of γ with respect to precision which is always positive. The effect of the distribution of institutional capacity $G(.)$, which is reflected in the sign and value of the term $[g(\lambda_H) - g(\lambda_L)]$, is shown in the next lemma.

Lemma 2. *An increased level of precision in the agreement is likely to*

- *increase participation ($n_a > 0$) when the distribution of institutional capacities of negotiating countries is skewed to the right or slightly skewed to the left, and*
- *reduce participation ($n_a < 0$) when institutional capacities are quite skewed to the left or follow a uniform distribution.*

This lemma indicates that precision is likely to increase the number of ratifying countries, i.e. a depth-participation dilemma is not present, whether $G(\lambda)$ is skewed to the right or slightly skewed to the left. When $G(\lambda)$ is skewed to the right, this means that the negotiating countries are mainly those with high institutional capacity. The direct effect of increasing precision is then to emphasize the conformity concerns which increases the pressure to move towards the cooperative policy thus resulting in a welfare loss (since this is not the welfare-maximizing policy for country i). Recall that we assumed the cooperative policy to be dependent on the total number of ratifiers at equilibrium. This introduces a strategic dimension to country i's decision. By ratifying the agreement, it sets a higher standard for the cooperative policy since now a larger number of participants is on board ($p^C = \frac{nb}{c}$ increases). This gain always offsets the welfare loss due to switching from the non-cooperative to the cooperative policy for this set of countries, especially since compliance is relatively not costly for this particular group and given that the increased precision would guarantee some degree of compliance from the remaining participants. Countries then have incentives to ratify in order to *raise the bar* for others.

The case where $G(\lambda)$ is slightly skewed to the left as the *"avoiding rock bottom"* scenario. Even though participation is more costly for the low types, this cost is offset by the gain in total abatement terms from inducing a high standard as country i expects the neighboring countries in the distribution to reason similarly through a bandwagon effect. As increases in a then unambiguously increases the upper bound for participation λ_H (see (8)), a higher precision then shifts the participation interval to the right. Country i then expects the participants to be of the high type. Thus, the positive effect of inducing a high policy standard offsets the loss in welfare due to conformity, despite being costly, a higher participation and particularly from the high type becomes likely.

Finally, when $G(\lambda)$ is either quite skewed to the left or follows a uniform distribution (as will be discussed further below), countries do not hold strong beliefs that bandwagon effect will prevail since for a large set of countries the increase in precision renders compliance too costly and raising the bar would then be pointless. Strategic motives are insufficient to enhance participation and the depth-participation dilemma emerges ($n_a < 0$).

The Uniform Distribution Case Here we focus on the case where institutional capacities are drawn from a uniform distribution on $[-\alpha, \alpha]$; the greater α, the less certainty we have about the connection between policies and outcomes of all other countries. The equilibrium condition reduces to

$$n = \frac{Nb}{\alpha c}\sqrt{\frac{2(n-1)}{\gamma}}$$

which yields two possible equilibria given by $n = \frac{Nb[Nb \pm \sqrt{N^2b^2 - 2\alpha^2c^2}]}{\alpha^2c^2\gamma}$. Assuming that the coordination problem could be solved so that whenever multiple equilibria obtain, the higher participation equilibrium prevails. This could be explained by pressure from international organizations or minimum ratification threshold being set to ensure that the equilibrium will be the one with the high participation. The equilibrium number of ratifying countries is then

$$n(\gamma) = \frac{4N^2b^2}{\alpha^2c^2\gamma}[1 + \sqrt{\frac{1 - \alpha^2c^2\gamma}{2N^2b^2}}] \tag{11}$$

The following lemma shows the effect of the agreement precision on the participation level.

Lemma 3. *Given a uniform distribution of institutional capacities, increased precision in the agreement results in*

(i) less participation: a smaller number of countries ratifying the agreement,

(ii) participation being restricted to countries with relatively higher institutional capacity.

Proof. Equation (11) can be written as

$$n = \psi\left(1 + \sqrt{1 - \frac{2}{\psi}}\right)$$

where $\psi(\gamma) = \frac{N^2b^2}{\alpha^2c^2\gamma}$ Then,

$$\frac{dn}{d\gamma} = \frac{dn}{d\psi} \times \frac{d\psi}{d\gamma}$$

It can be easily seen that $\frac{dn}{d\psi} > 0$ and $\frac{d\psi}{d\gamma} < 0$, so it is always the case that $\frac{dn}{d\gamma} < 0$ in the uniform distribution scenario. □

Now regarding the *identity* of the participants, it can be seen from (8) that a higher level of precision (a larger γ which is always accompanied by a smaller n in the uniform case) unambiguously decreases the upper bound for participation (that is $\frac{d\lambda_H}{d\gamma}$ is always negative) i.e. increased precision always dissuades countries with high institutional capacity from ratifying the agreement while its effect on the lower bound λ_L may be positive or negative. Recall that the only gain that could make participation worthwhile for the high type is the strategic gain of raising the bar. However, when precision reduces participation, this never occurs and hence countries with high institutional capacity prefer to implement their non-cooperative policies.

Introducing the subgame perfect equilibrium in the objective function of the moderator:

$$EU^A(a) = -\frac{b^2}{c^2}[N^2(N-1)^2 + \frac{2}{3}n^2(n-1)\frac{ar + \frac{k}{r}}{1 + ar}] \tag{12}$$

From the maximization problem, we get

$$\frac{dEU^A(a)}{da} = -\frac{2}{3}\frac{b^2}{c^2}\Phi(a^*) = 0$$

where $\Phi(a^*)$ in an implicit function of a^* and the parameters and $\Phi'(a^*) > 0$. Precisely,

$$\Phi(a^*) = [(ar + \frac{k}{r})(3n^2 - 2n)n_a + \frac{1-k}{1+ar}n^2(n-1)] = 0$$

Lemma 4. *Given a uniform distribution of institutional capacities, the more noncompliance concerns are valued over policy concerns (the larger the value of k) the more vagueness is required in the agreement.*

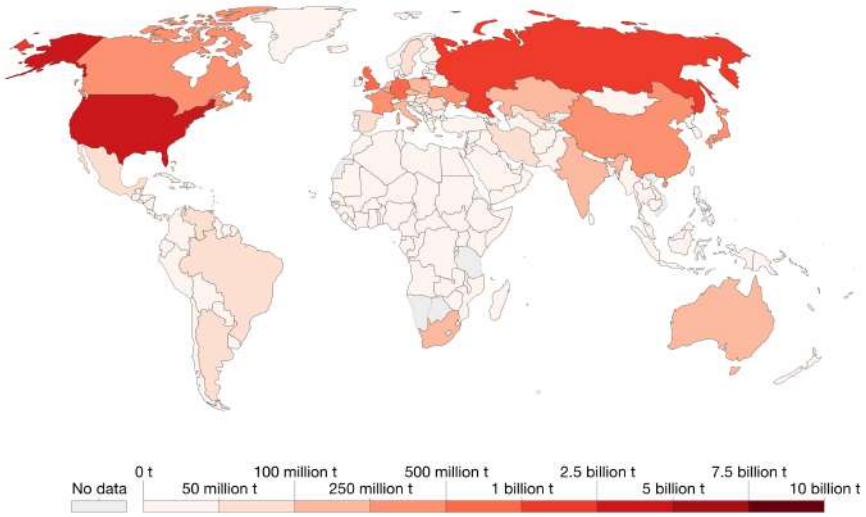
Apart from the direct effect of reducing precision to keep institutional prestige in case of noncompliance, a high degree of vagueness increases participation and, particularly, of the high types who now have a double motive to participate: induce participation of the low types who tend to over-deliver, without putting too much emphasis on conformity. Hence, the average institutional capacity of participants is rose which raises the expected average abatement outcome within the coalition.

Testable predictions Our theoretical model has some interesting predictions that we attempt to test empirically. First, a country is more likely to ratify a given agreement the larger the number of its ratifiers *and* the closer its institutional capacity relative to that of the other ratifiers (the bandwagon effect). Second, precision in IEAs enhances compliance but does not necessarily reduce participation (the depth-participation dilemma). Third, a higher institutional capacity implies more compliance to the ratified IEAs since the required policy adjustments are then less costly (institutional capacity and compliance). Yet, before we proceed to the empirical part, we will first present some stylized facts on IEAs vagueness, institutional differences and the agreements effectiveness.

4 Data and Stylized Facts

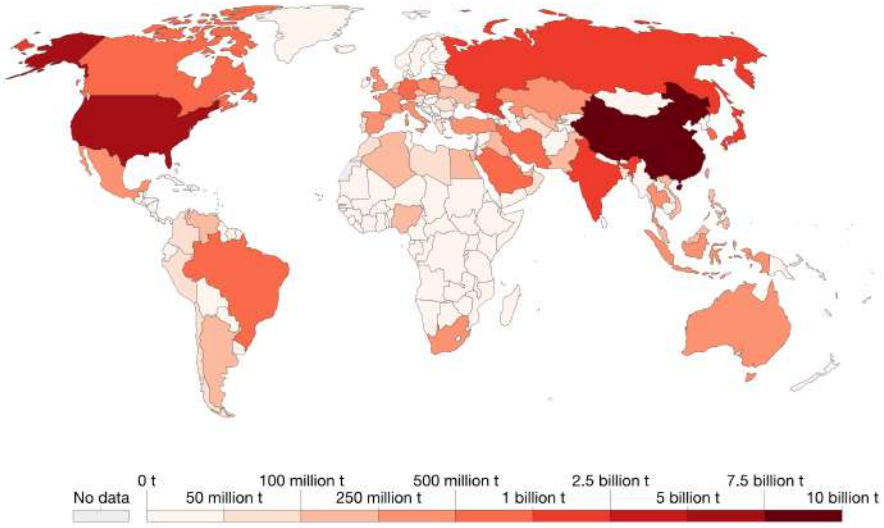
Data used in our analysis come from four main sources. For CO2 emissions, we rely on the Global Carbon Project run by Carbon Dioxide Information Analysis Centre (CDIAC). To measure the quality of institutions, we use the World Governance Indicators (WGI) dataset. Moreover, in order to measure the agreements vagueness, we construct our own index using the agreements websites as it will be shown later. Finally, the Wolrd Development Indicators (WDI) was utilized to obtain some control variables (GDP, share of industry to GDP, etc.)

When we compare Figures 1 and 2, it is clear that the landscape of CO2 emissions has changed over the last 50 years. Indeed, while Figure 1 shows that most of the emissions were chiefly concentrated in the United States, the European Union and Russia in 1965, China and other Asian countries joined the group of the main emitters as shown in Figure 2. The common feature between the two figures is that we have a small number of pivotal players in terms of CO2 emissions. Currently, the top five countries that produce the most CO2 are China, U.S., India, Russia, and



Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC).

Figure 1: CO2 Emissions in 1965

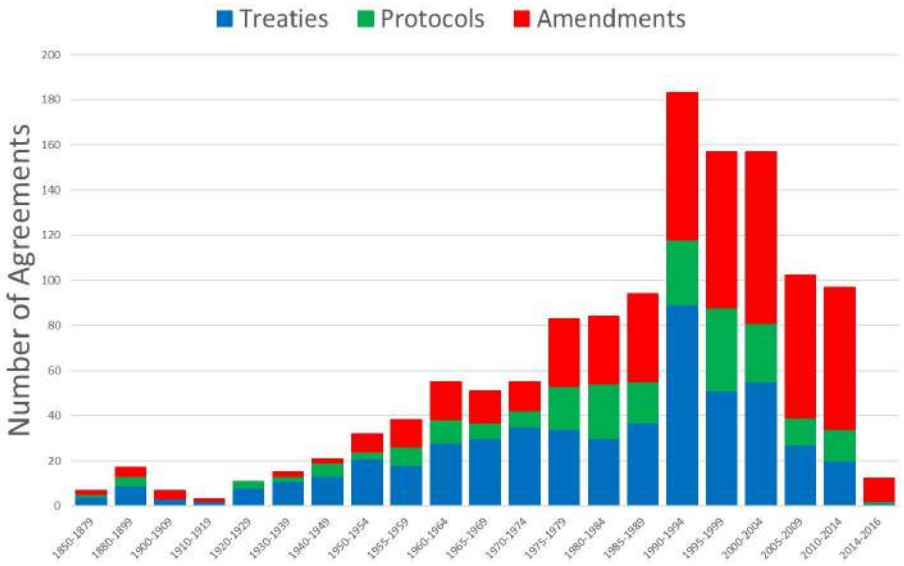


Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC).

Figure 2: CO2 Emissions in 2015

Japan because of exponential growth in manufacturing activities and fossil fuel use.

At the same time, this increase in CO2 emissions has been coupled with a proliferation in IEAs (see Figure 3). The latter cover a wide range of categories ranging from nature conservation, species protection, pollution reduction, habitat and oceans and energy and nuclear issues. These IEAs can take three main forms: either a treaty or a protocol or an amendment. Treaties or conventions refer to a final agreement between several governments. Protocols generally amend existing convention or create additional restrictions or commitments on various countries. Yet, it is important to note that signatories/ratifiers of a treaty are not bound to sign/ratify protocols. This is why we can observe a large discrepancy between those who sign/ratify each agreement and its amendments. This reflects to what extent key players have varying environmental preferences with varying power to destroy if they do not abide by the agreements.

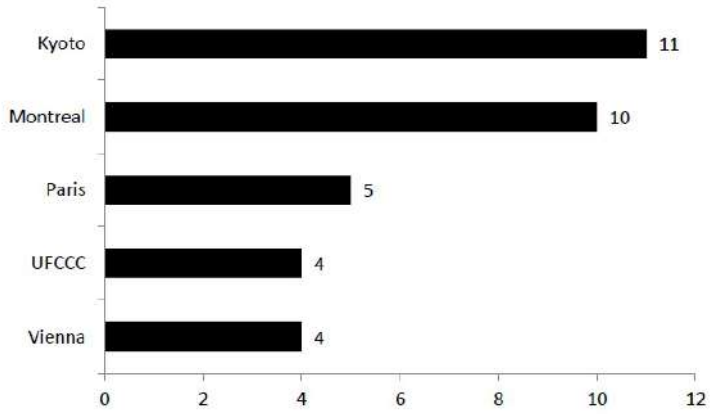


Source: International Environmental Agreements (IEA) Database Project.

Figure 3: Evolution of Environmental Agreements

As it has been proven in the theoretical model, and according to the depth-participation dilemma, the level of precision in IEAs can enhance compliance but does not necessarily reduce participation. Figure 4 presents the index of vagueness that we constructed using the agreements text. To do so, we relied on five main criteria: the specifity of controlled substances and time schedule; numerical mitigation targets; clarity of implementation mechanism; reporting, monitoring and review process; sanctions for non-compliance; and incentives for developing countries. Across these items, a value of 0 was assigned if the item is not mentioned in the agreement, 1 if it is vaguely mentioned and 2 if it is precisely mentioned (see Appendix 1 for more details). Figure 4 shows that, based on these elements, the Kyoto protocol is the most precise followed by the Montreal protocol. It is important to note that the Kyoto Protocol extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) to limit greenhouse gas emissions

with specific targets for six greenhouse gases. Paris agreement is rather vague followed by the Vienna Convention for the Protection of the Ozone Layer.



Source: Authors' own elaboration using the agreement texts.

Figure 4: Precision Level of Different Agreements

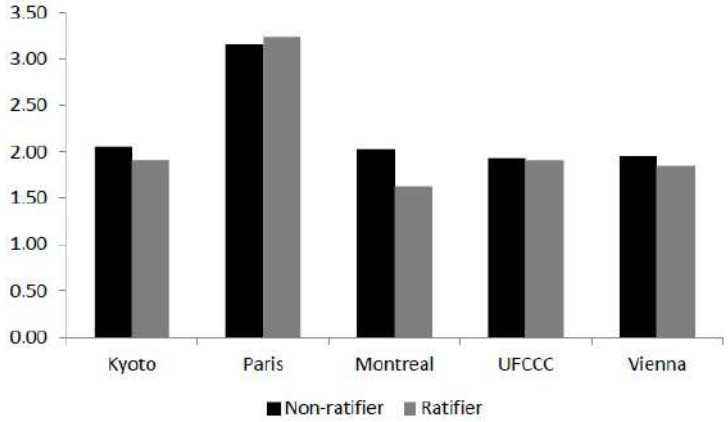
As it is shown in Table 1, a more thorough analysis of these agreements points out that the specifity of controlled substances and time schedule as well as the numerical target are precisely mentioned in Montreal and Kyoto Protocols. As per the clarity of implementation mechanism, Vienna agreement and Kyoto protocol rank first followed by Montreal Protocol and Paris Agreement. When it comes to monitoring and reporting, it seems that Montreal Protocol and Paris Agreement are doing better as they require measurable statistics and reports that are constantly reviewed. Financial sanctions are mainly present in the Kyoto Protocol through either paying a monetary fine or accepting trade sanctions imposed by other signatory nations. Finally, the Montreal Protocol provides the highest incentives for developing countries in order to comply with the agreement. In a nutshell, we do observe a clear heterogeneity among the agreements in terms of their level of precision.

Criteria	Vienna (1985)	Montreal (1987)	UNFCCC (1992)	Kyoto (1997)	Paris (2015)
Specifity of Controlled Substances and Time Schedule	1	2	1	2	1
Numerical Mitigation Targets	0	2	1	2	1
Clarity of implementation mechanism	2	1	0	2	1
Reporting, Monitoring and Review Process	0	2	1	1	2
Sanctions for non-compliance	0	1	0	2	0
Incentives for developing countries	1	2	1	1	0

Source: Authors' own elaboration using the agreement texts.
Notes: 0 refers to the absence of this item from the agreement, 1 refers to an item that is mentioned but vaguely, 2 refers to an item that is mentioned precisely

Table 1: Precision Level of Different Agreements – by Component

Ratification status generally depends on the quality of institutions. In fact, a country is more likely to ratify an agreement if its institutional capacity is close to that of the other ratifiers (the bandwagon effect). Figure 5 shows that, using the World Governance Indicators, institutional differences are lower among ratifying countries when compared to those who did not ratify, especially in the cases of Kyoto and Montreal Protocol and Vienna.



Source: Authors' own elaboration.
Note: Institutional differences are measured by the absolute difference between the quality of institutions of each country and the median level of institutions of ratifiers for each agreement.

Figure 5: Institutional Differences and Ratification Status

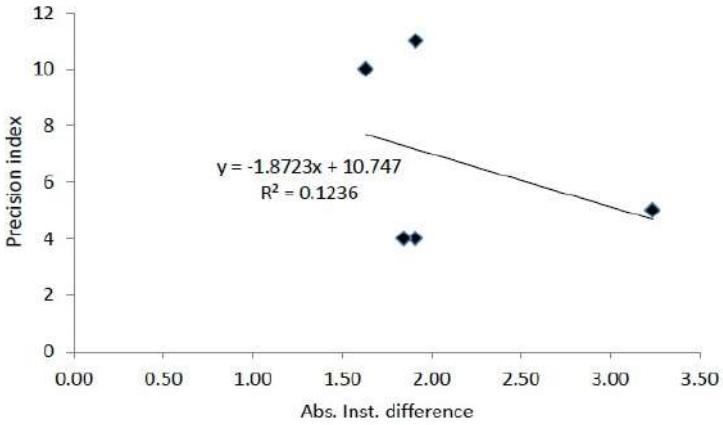
Moreover, the pivotal players at the world level have heterogeneous institutional capacities and environmental preferences. Figure 6 shows that a negative association between institutional differences of ratifying countries of each agreement and its level of precision. In other words, the lower the institutional differences between countries that ratify an agreement, the higher the level of precision and consequently, the more binding the agreement.

This is confirmed by Figure 7 that shows that for ratifying countries, CO2 emissions are lower. This points out to what extent more compliance to the ratified IEAs is observed since the required policy adjustments are then less costly. This observation holds for most of the agreements with the exception of Kyoto Protocol from which the US together with some other countries decided to retreat in 2001.

After presenting this preliminary assessment of agreements vagueness, institutional differences and compliance, the next section provides an empirical exercise to test our theoretical predictions.

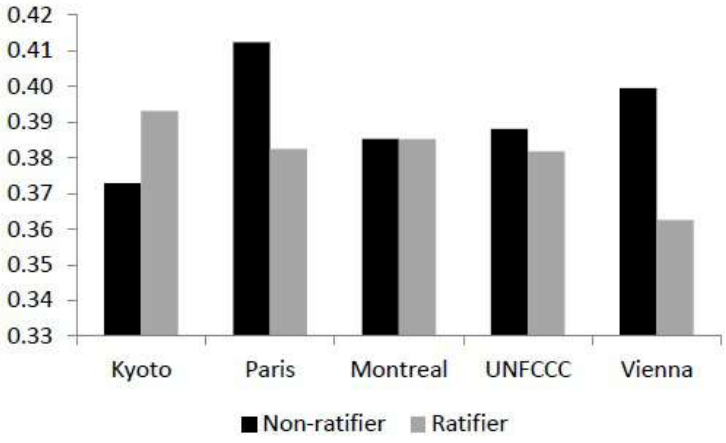
5 Econometric Specifications

To test our theoretical predictions, we run several regressions. We run a first specification to see if a country is more likely to ratify a given agreement when the number of exisiting ratifying



Source: Authors' own elaboration using the agreement texts.

Figure 6: Correlation between Institutional Differences and Precision Index



Source: Authors' own elaboration.
Note: Figures reported are the average of the logarithm of CO2 by country.

Figure 7: Average CO2 emissions and Agreements Ratification Status

countries increases and when its institutional capacity relative to that of the other ratifiers is close (the bandwagon effect) as follows:

$$Pr(Ratif)_{it} = \alpha_0 + \alpha_1 Ln(Ind/GDP)_{it} + \alpha_2 Ln(GDP)_{it} + \alpha_3 Num.Ratif_t + \epsilon_{it} \quad (13)$$

Where $Pr(Agr.)$ is a dummy variable that takes the value of 1 if country i ratified the agreement in year t and zero otherwise, $Ln(Ind/GDP)_{it}$ measures the share of industry in total value-added since the manufacturing sector is the among the most polluting sectors. $Ln(GDP)_{it}$ is the natural logarithm of the Gross Domestic Product in constant USD (of 2010) and ϵ the error term. The expected sign of Ln(Ind/GDP)it is negative (since the higher the share of industry to GDP, the higher the level of pollution and the less likely a country will sign/ratify the agreement). By contrast, the effect of Ln(GDP)it is likely to be positive as the higher the level of development, the more likely it will sign/ratify the agreement. $Num.Ratif_t$ is the number of ratifying countries of each agreement in year t. This variable is likely to have a positive effect on the likelihood of a country to sign/ratify the agreement as, thanks to the domino effect, the latter will have more incentives to join the agreement.

Second, as it was shown before, the cost of compliance is larger for countries with low institutional capacity. This is why, when the institutional difference between each country and the other ratifying countries is small, the country in question is likely to ratify the agreement as follows:

$$Pr(Ratif)_{it} = \beta_0 + \beta_1 Ln(Ind/GDP)_{it} + \beta_2 Ln(GDP)_{it} + \beta_3 InstDiff_{it} + \nu_{it} \quad (14)$$

Where the variable $InstDiff_{it}$ is calculated as the absolute difference between the average of the WGI index of country i in year t and the median WGI index of the other ratifying countries. This sign of this variable has to be positive to show that the smaller the institutional differences, the lower the required policy adjustments and hence the higher the likelihood of ratification. Clearly, this is also related to the fact that, with an efficient institutional setup, the ratifier benefits from increased level of abatement due to his own increased policy level and higher standards for all participants. ν is the error term.

To test the fact that precision in IEAs enhances compliance but does not necessarily reduce participation (the depth-participation dilemma), our preferred specification includes all these variables and adds to the previous specifications the vagueness index as follows:

$$Pr(Ratif)_{it} = \lambda_0 + \lambda_1 Ln(Ind/GDP)_{it} + \lambda_2 Ln(GDP)_{it} + \lambda_3 InstDiff_{it} + \lambda_4 Num.Ratif_t + \lambda_5 Vague_{it} + \eta_{it} \quad (15)$$

Where $Vague_{it}$ is a measure of vagueness of country i in year t. This index has been calculated at the country level by multiplying the vagueness index of each agreement by 1 if the country ratified this agreement and 0 otherwise. The advantage of this index is twofold. First, it introduces in our variable more variability (as we have one value for each agreement and five values for all the agreements we consider). Second, it is a measure of environmental preferences of each country (whether a country prefers or not vague vs. precise agreements). The expected sign of this variable can be positive or negative because of the depth-participation dilemma. η is the error term.

Finally, we aim also at examining the effectiveness of the agreements. Thus, we run a similar regression where the dependent variable is the natural logarithm of the CO2 emissions of country i in year t. The latter is regressed on the same set of control variables. Yet, we add also the GDP squared for two reasons: first, in order to control for the environmental Kuznets curve according to which growth initially leads to a deterioration in the environment up to a certain threshold where the economy experiences a decreasing level of environmental degradation. Second, introducing this variable helps us model the strategic dimension of country i's decision.

$$Ln(CO2)_{it} = \mu_0 + \mu_1 Ln(Ind/GDP)_{it} + \mu_2 Ln(GDP)_{it} + \mu_3 Ln(GDP)^2_{it} + \mu_4 InstDiff_{it} + \mu_5 Vague_{it} + \eta_{it} \quad (16)$$

Several remarks are worth to be mentioned. First, we introduce year and country fixed effects in our regressions to control for unobservables at both the country and year levels. Second, we run our regressions using a linear probability model to obtain elasticities. Finally, we apply this empirical exercise for mainly the five agreements we presented above. Our data come mainly from three main sources. While $Ln(Ind/GDP_{it})$ and $Ln(GDP)_{it}$ come from the World Development Indicators, we constructed the other two variables from the respective websites of each agreement. Institutional differences come from the World Governance Indicators dataset.

6 Empirical Findings

Table 2 presents the results of the bandwagon effect. Indeed, the higher the number of those ratified the agreement, the more likely a country will ratify it. This is due to the fact that the cooperative policy is dependent on the total number of ratifiers at equilibrium. Since a larger number of participants is on board, more countries will ratify the agreement. This is in line with the domino effect highlighted by the international trade literature. In fact, the domino theory postulates that signing a free trade agreement induces outside countries to join the agreement since the trade diversion effect of the agreement creates new political economy forces in excluded nations. If we mirror this on the environmental agreements case, the higher the number of the countries who join, the higher likelihood a new country will sign and ratify the environmental agreement. This is line with Karp and Zhao (2010) who argue that paying a fine or agreeing to the withdrawal of WTO-mandated trade concessions can promote participation in an agreement. It is worthy to note that this result holds for all agreements.

As per our control variables, while the share of industry to GDP is insignificant for most of the agreements, the higher the level of GDP of a country, the higher the likelihood it will sign and ratify the agreement.

	Kyoto	Paris	Montreal	UNFCCC	Vienna	Any agreement
Ln(Ind)	0.0352**	0.0123*	0.00132	0.00524	0.0192	-0.0126
	(0.0155)	(0.00701)	(0.0161)	(0.0135)	(0.0160)	(0.00934)
Ln(GDP)	0.0301**	0.0105	0.0124	0.0160	0.0342**	0.00384
	(0.0148)	(0.00672)	(0.0155)	(0.0129)	(0.0154)	(0.00896)
Num. Ratifiers	0.00511***	0.00484***	0.00500***	0.00508***	0.00510***	1.050***
	(0.000184)	(9.29e-05)	(0.000195)	(0.000158)	(0.000190)	(0.0263)
Constant	-1.369***	-1.183***	-0.410	0.433	-0.0123	-0.0881
	(0.328)	(0.149)	(0.343)	(0.287)	(0.342)	(0.201)
Country dum.	YES	YES	YES	YES	YES	YES
Year dum.	YES	YES	YES	YES	YES	YES
Observations	6,118	6,118	6,118	6,118	6,118	6,118
R-squared	0.811	0.910	0.763	0.847	0.767	0.633

Notes: (i.) Standard errors in parentheses.
(ii.) ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

Table 2: Agreements Ratification - Baseline Specification

Table 3 extends our analysis by introducing the effect of institutional differences on the likelihood of ratification. This is confirmed by the negative sign of this variable in the case of Kyoto and Vienna agreements and in the case of the dummy variable that we created for all agreements (a dummy variable that takes the value of one if the country ratified any agreement and zero otherwise).

Our third testable hypothesis is related to the effect of vagueness on ratification. We found that more vagueness is associated to a lower ratification (see Table 4). Recall that the *direct* effect of vagueness is to reduce the cost of ratifying an IEA by reducing the policy adjustments required to meet the (ambiguous) obligations and by making noncompliance more difficult to detect. A priori, one would expect ambiguity to increase the probability of ratification. However, vagueness weakens a country's *strategic* incentives to ratify an IEA. Recall from the theoretical analysis that countries engage in IEAs partially to raise the bar for other participants by setting a high standard for cooperation. As ambiguity increases, compliance becomes less likely and this strategy of raising the bar becomes less appealing. This explains why vagueness reduces the probability of ratification despite the reduction in participation costs it implies. This result also suggests that the underlying distribution of institutional capacity for each of the IEAs in our sample is one that does not involve a depth-participation trade-off.[13]

Our most preferred specification is the one that includes all the variables at the same time.

[13]That is, the distribution of institutional capacities is either skewed to the right or slightly skewed to the left since these are the two forms identified in the theoretical analysis for which the depth-participation dilemma does not exist.

	Kyoto	Montreal	UNFCCC	Vienna	Any agreement
Ln(Ind)	0.0376	-0.0466*	-0.0294	-0.00495	-0.0363**
	(0.0373)	(0.0248)	(0.0236)	(0.0246)	(0.0152)
Ln(GDP)	-0.0668	-0.107***	-0.0661**	0.0710**	-0.0132
	(0.0454)	(0.0300)	(0.0287)	(0.0298)	(0.0184)
Inst. Diff.	-0.0157*	0.0121	0.00222	-0.0146**	-0.0175***
	(0.00867)	(0.00831)	(0.00695)	(0.00647)	(0.00594)
Constant	2.112**	2.568***	2.712***	-0.269	1.476***
	(0.973)	(0.644)	(0.610)	(0.633)	(0.391)
Country dum.	YES	YES	YES	YES	YES
Year dum.	YES	YES	YES	YES	YES
Observations	2,715	2,715	2,715	2,715	2,715
R-squared	0.727	0.726	0.733	0.726	0.449

Notes: (i.) Standard errors in parentheses.
(ii.) ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

Table 3: Agreements Ratification and Institutional differences

	Kyoto	Paris	Montreal	UNFCCC	Vienna	Any agreement
Ln(Ind)	0.0397***	0.0172***	0.00412	0.00746	0.0204	-0.00276
	(0.0149)	(0.00536)	(0.0159)	(0.0133)	(0.0160)	(0.00185)
Ln(GDP)	0.0257*	0.00588	0.00977	0.0139	0.0330**	-0.00546***
	(0.0143)	(0.00514)	(0.0153)	(0.0127)	(0.0153)	(0.00178)
Vagueness	-0.529***	-0.561***	-0.325***	-0.257***	-0.147***	-1.138***
	(0.0241)	(0.00868)	(0.0258)	(0.0215)	(0.0259)	(0.00300)
Country dum.	YES	YES	YES	YES	YES	YES
Year dum.	YES	YES	YES	YES	YES	YES
Observations	6,118	6,118	6,118	6,118	6,118	6,118
R-squared	0.825	0.947	0.769	0.851	0.768	0.986

Notes: (i.) Standard errors in parentheses.
(ii.) ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

Table 4: Agreements Ratification and Vagueness

Indeed, Table 5 confirms our previous findings since institutional differences, vagueness and the number of ratifiers have the expected sign and are statistically significant.

	Kyoto	Montreal	UNFCCC	Vienna	Any agreement
Ln(Ind)	0.0661*	-0.0376	-0.0213	-0.00387	-0.00605
	(0.0344)	(0.0244)	(0.0233)	(0.0246)	(0.00402)
Ln(GDP)	-0.0469	-0.100***	-0.0617**	0.0716**	0.00447
	(0.0419)	(0.0296)	(0.0283)	(0.0298)	(0.00486)
Vagueness	-1.091***	-0.330***	-0.302***	-0.0396	-1.107***
	(0.0517)	(0.0367)	(0.0351)	(0.0370)	(0.00605)
Inst. Diff.	-0.0152*	0.0144	0.00508	-0.0143**	-0.00330**
	(0.00799)	(0.00818)	(0.00686)	(0.00647)	(0.00157)
Num. Ratifiers	0.00393***	0.00253***	0.00394***	0.00576***	-2.341***
	(0.000211)	(0.000632)	(0.000631)	(0.000665)	(0.112)
Constant	0.855	2.253***	2.330***	-0.665	3.330***
	(0.924)	(0.659)	(0.629)	(0.662)	(0.195)
Country dum.	YES	YES	YES	YES	YES
Year dum.	YES	YES	YES	YES	YES
Observations	2,715	2,715	2,715	2,715	2,715
R-squared	0.768	0.735	0.741	0.726	0.961

Notes: (i.) Standard errors in parentheses.
(ii.) ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

Table 5: Agreements Ratification - Full Specification

Finally, to measure the effectiveness of the agreement, we regress CO2 emissions on the same controls. Table 6 shows that whereas the share of industry to GDP increases, as expected, CO2 emissions, the Kuznets curve holds with a positive coefficient of GDP and a negative one of GDP squared. Finally, in the fourth column with the most comprehensive specification, vagueness is associated to more emissions. This is in line with our theoretical finding where vagueness reduces the cost of noncompliance. In fact, when the language of the agreement is ambiguous, it will not be clear whether the policies of the ratifying countries comply with the agreement provisions. This is why countries are likely to have more CO2 emissions.

	Ln(CO2)	Ln(CO2)	Ln(CO2)	Ln(CO2)
Ln(Ind)	0.0789***	0.0199**	0.0790***	0.0195**
	(0.00653)	(0.00862)	(0.00653)	(0.00862)
Ln(GDP)	0.386***	0.350***	0.383***	0.342***
	(0.0337)	(0.0639)	(0.0337)	(0.0640)
Ln(GDP) sq.	-0.00931***	-0.00920***	-0.00931***	-0.00917***
	(0.000705)	(0.00134)	(0.000705)	(0.00134)
Institutions		-0.000779		-0.00113
		(0.00318)		(0.00318)
Vagueness			0.0210	0.0309**
			(0.0131)	(0.0120)
Constant	-3.741***	-2.759***	-3.673***	-2.583***
	(0.400)	(0.758)	(0.402)	(0.761)
Country dum.	YES	YES	YES	YES
Year dum.	YES	YES	YES	YES
Observations	5,291	2,669	5,291	2,669
R-squared	0.112	0.112	0.112	0.115
Number of code	193	171	193	171

Notes: (i.) Standard errors in parentheses.
(ii.) ***, ** and * represent respectively statistical significance at the 1%, 5% and 10% levels.

Table 6: Effectiveness of IEA

7 Conclusion

By combining insights from both the literature on International Environmental Agreements and vagueness in delegation models, this paper captures many important aspects of the treaty making that, to the best of our knowledge, have not been previously analyzed.

Our main findings show that an increased level of precision in the agreement is likely to increase participation when the distribution of institutional capacities of negotiating countries is skewed to the right or slightly skewed to the left, suggesting a comparative advantage, in terms of precision and participation level, for environmental negotiations North/North or between developed countries and emerging economies with moderate levels of institutional capacity. Second, agreements where the distributional capacities of the key players are quite skewed to the left (e.g. South/South negotiations) are likely to involve a trade-off between precision and participation; weak agreements with less ambitious obligations are then the only means to increase participation. Third, in the case where institutional capacities are evenly distributed, the more noncompliance concerns are valued over policy concerns, the more vagueness is required in the agreement. This result could be seen in reverse, if a coalition is stable and countries in the coalition are quite heterogeneous in their institutional capacities, then its effectiveness can be deduced from the prior distribution of institutional capacities. If institutional capacities are evenly distributed, a high level of vagueness is to be inferred and a low effectiveness is to be expected. If the distribution is rather skewed to the right, the agreement is likely to be precise and effective. The model also explains that countries with high institutional capacities (which could be viewed as the developed

countries) have incentives to participate in environmental agreements inasmuch as it raises the bar for those with lower institutional capacities, thus providing a rationale for the non-ratification - and even sometimes withdrawal - of developed countries from agreements if it fails to impose a high level of commitment on less developed countries.

Using a large panel of countries between 1980 and 2018, our main findings show that there is a positive strategic effect on participation, (referred to as *the bandwagon effect*) where the higher the number of existing ratifiers, the more likely a country ratifies this agreement. Second, large institutional differences reduce *the bandwagon effect* and hence the likelihood of ratification. In addition, more vague agreements are associated to a lower probability of ratification. Yet, when countries ratify vague agreements, the latter are likely to be less effective, less binding and consequently are associated to more CO2 emissions as if countries agree to disagree when it comes to the implementation of the agreement.

From a policy perspective, this paper highlights several important implications. First, institutions matter for the protection of the environment. As it has been shown before, when countries are characterized by a high institutional capacity, they are more likely to ratify and abide by an IEA. This will clearly reduce CO2 emissions and hence improve the environment. Second, in line with the Sustainable Development Goals, in particular SDG13 (climate action), SDG16 (strong institutions) and SDG17 (partnership for the goals), our study confirms that better institutions are a key aspect of effective international agreements that aim at protecting the environment. In particular, if the environmental Kuznets curve is inevitable, in the sense that early stages of economic growth are necessarily accompanied by high levels of environmental degradation and pollution, then enhancing institutional capacities of emerging countries - the future key players - ought to be a priority so that future environmental negotiations are not jeopardized.

References

[1] Asheim, G.B., Froyn, C.B., Hovi, J., Menz, F.C., 2006. Regional versus global cooperation for climate control. Journal of Environmental Economics and Management, 51(1), 93–109.

[2] Asheim, G.B., Holtsmark, B., 2009. Renegotiation-proof climate agreements with full participation: conditions for Pareto-efficiency. Environmental and Resource Economics, 43, 519–533.

[3] Balsiger, J., Prys, M., 2016. Regional Agreements in International Environmental Politics. International Environmental Agreements: Politics, Law and Economics, 16(2), 239-260.

[4] Barrett, S., 1994. Self-enforcing international environmental agreements. Oxford Economic Papers, 46, 878–894.

[5] Barrett, S., 1997. The strategy of trade sanctions in international environmental agreements. Resources and Energy Economics, 19, 345–361.

[6] Bernauer, T., Kalbhenn, A., Koubi, V., Spilker, G., 2013. Is there a "Depth versus Participation" dilemma in international cooperation? Review of International Organizations, 8(4), 477–497.

[7] Chander, P. and H. Tulkens. 1992. Theoretical Foundations of Negotiations and Cost Sharing in Transfrontier Pollution Problems. European Economic Review, 36(2–3), 388–399.

[8] Chou, P.B., Sylla, C., 2008. The formation of an international environmental agreement as a two-stage exclusive cartel formation game with transferable utilities. International Environmental Agreements, 8(4), 317–341.

[9] de Zeeuw, A., 2015. International environmental agreements. Annual Review of Resource Economics, 7(1), 151–168.

[10] Downs, G. W., Rocke, D. N., Barsoom, P. N., 1996. Is the Good News About Compliance Good News for Cooperation? International Organization, 52(3), 379–406.

[11] Epstein, David, and Sharyn O'Halloran. 1999. Delegating Powers: A Transactions Cost Politics Approach to Policy Making under Separate Powers. Cambridge: Cambridge University Press.

[12] Finus, M., 2008. Game theoretic research on the design of international environmental agreements: insights, critical remarks and future challenges. International Review of Environmental and Resource Economics, 2, 1-39.

[13] Finus, M., Rübbelke, D.T.G., 2013. Public good provision and ancillary benefits: the case of climate agreements. Environmental and Resource Economics, 56, 211–226.

[14] Goldstein, J., Martin, L. L., 2000. Legalization, Trade Liberalization and Domestic Politics: A Cautionary Note. International Organization, 54(3), 603–632.

[15] Harstad, B., 2006. Flexible integration? Mandatory and minimum participation rules. The Scandinavian Journal of Economics, 108(4), 683–702.

[16] Hoel, M. 1992. International Environment Conventions: The Case of Uniform Reductions of Emissions. Environmental and Resource Economics, 2(2), 141–159.

[17] Hughes, L., Urpelainen, J., 2015. Interests, institutions and climate policy: Explaining the choice of policy instrument for the energy sector. Environmental Science and Policy, 54, 52-63.

[18] Karp, L., Zhao, J., 2010. International Environmental Agreements: Emissions Trade, Safety Valves and Escape Clauses. Revue économique, 61(1), 153-182.

[19] Köke, S., Lange, A., 2017. Negotiating environmental agreements under ratification constraints. Journal of Environmental Economics and Management, 83, 90-106.

[20] Larson, B., Tobey, J., 1994. Uncertain Climate Change and the International Policy Response. Ecological Economics, 11, 77-84.

[21] Marchiori, C., Dietz, S., Tavoni, A., 2017. Domestic politics and the formation of international environmental agreements. Journal of Environmental Economics and Management, 81, 115-131.

[22] Mitchell, R. B. (2002–2008). International Environmental Agreements Database Project. http://iea.uoregon.edu/.

[23] Mitchell, R. B., Andonova, L. B., Axelrod, M., Balsiger, J., Bernauer, T., Green, J. F., Hollway, J., Kim, R. E., Morin, J-F., 2020. What we know (and could know) about International Environmental Agreements. Global Environmental Politics, 20(1), 103-121.

[24] Mohrenberg, S., Koubi, V., Bernauer, T., 2019. Effects of Funding Mechanisms on Participation in Multilaternal Environmental Agreements. International Environmental Agreements: Politics, Law and Economics, 19(1), 1-18.

[25] Morgan, E., Nalau, J., Mackey, B., 2019. Assessing the alignment of national-level adaptation plans to the Paris Agreement. Environmental Science and Policy, 93, 208-220.

[26] Rüdig, W., 2019. Green Parties and elections to the European Parliament, 1979-2019, pp.3-49, *in* Ward, L., Brady, J., 2019, *Greens for a better Europe: Twenty years of UK Green Influence in the European Parliament, 1999-2019.* London Publishing Partnership.

[27] Schmidt, C., 1998. Incentives for international environmental cooperation: Theoretic models and economic instruments. Nota di Lavoro, No. 56.1998, Fondazione Eni Enrico Mattei (FEEM), Milano.

[28] Spilker, G., Koubi, V., 2016. The effects of treaty legality and domestic institutional hurdles on environmental treaty legality and domestic institutional hurdles on environmental treaty ratification. International Environmental Agreements: Politics, Law and Economics, 16(2), 223-238.

[29] Staton, J.K., Vanberg, G., 2008. The Value of vagueness: delegation, defiance and judicial opinions. American Journal of Political Science, 52(3), 504-519.

[30] Subramanian, N., Urpelainen, J., 2014. Addressing cross-border environmental displacement: When can international treaties help? International Environmental Agreements: Politics, Law and Economics,14(1), 25–46.

[31] Takashima, N., 2018. International Environmental Agreements between asymmetric countries: A repeated game analysis. Japan and the World Economy, 48, 38-44.

[32] United Nations Treaty Collection available at https://treaties.un.org.

[33] von Stein, J., 2008. The international law and politics of climate change: Ratification of the United Nations Framework Convention and the Kyoto Protocol. The Journal of Conflict Resolution, 52(2), 243–268.

Appendix 1: Index Calculation

The index we calculated relies on the text of different agreements. We opt for an equal weight for each criteria to avoid any arbitrary weights.

1. Specifity of Controlled Substances and Time Schedule:
   0: Substance not identified.
   1: Polluants are listed as a group but not detailed individually.
   2: Each pollutant is accurately specified as well as its polluting effect/CO2 equivalence.

2. Numerical Mitigation Targets:
   0: Global target for all parties.
   1: Numerical targets for a set of countries.
   2: Binding numerical targets for each party individually with a predetermined time schedule.

3. Clarity of implementation mechanism
   0: Means to achieving mitigation targets are vaguely mentioned.
   1: Some mechanisms are developed.
   2: Implementation mechanism is detailed and institutionalized.

4. Reporting, Monitoring and Review Process
   0: Reporting is a procedural obligation that does not require any particular result or standard
   1: Measurable statistics and information that should be included in reports are specified
   2: Measurable statistics and reports undergo expert review and/or there is monitoring.

5. Sanctions for non-compliance:
   0: No sanctions.
   1: Sanctions with no enforcement mechanisms.
   2: Financial sanctions (emissions trading system) or more stringent emission targets in case of non-compliance

6. Incentives for developing countries:
   0: Recognition of complying parties' efforts (reputational incentives).
   1: Technical assistance and alternative technology transfer.
   2: Financial assistance through particular institutions.

Appendix 2: List of Countries

Aruba	Congo, Rep.	Greenland
Afghanistan	Cook Islands	Guatemala
Angola	Colombia	Guam
Albania	Comoros	Guyana
Andorra	Cabo Verde	Hong Kong SAR, China
United Arab Emirates	Costa Rica	Honduras
Argentina	Cuba	Croatia
Armenia	Curaçao	Haiti
American Samoa	Cayman Islands	Hungary
Antigua and Barbuda	Cyprus	Indonesia
Australia	Czech Republic	Isle of Man
Austria	Germany	India
Azerbaijan	Djibouti	Ireland
Burundi	Dominica	Iran, Islamic Rep.
Belgium	Denmark	Iraq
Benin	Dominican Republic	Iceland
Burkina Faso	Algeria	Israel
Bangladesh	Ecuador	Italy
Bulgaria	Egypt, Arab Rep.	Jamaica
Bahrain	Eritrea	Jordan
Bahamas, The	Spain	Japan
Bosnia and Herzegovina	Estonia	Kazakhstan
Belarus	Ethiopia	Kenya
Belize	Finland	Kyrgyz Republic
Bermuda	Fiji	Cambodia
Bolivia	France	Kiribati
Brazil	Faroe Islands	St. Kitts and Nevis
Barbados	Micronesia, Fed. Sts.	Korea, Rep.
Brunei Darussalam	Gabon	Kuwait
Bhutan	United Kingdom	Lao PDR
Botswana	Georgia	Lebanon
Central African Republic	Ghana	Liberia
Canada	Gibraltar	Libya
Switzerland	Guinea	St. Lucia
Chile	Gambia, The	Liechtenstein
China	Guinea-Bissau	Sri Lanka
Côte d'Ivoire	Equatorial Guinea	Lesotho
Cameroon	Greece	Lithuania
Congo, Dem. Rep.	Grenada	Luxembourg

Latvia	Papua New Guinea	Tonga
Macao SAR, China	Poland	Trinidad and Tobago
St. Martin (French part)	Puerto Rico	Tunisia
Morocco	Korea, Dem. People's Rep.	Turkey
Monaco	Portugal	Tuvalu
Moldova	Paraguay	Tanzania
Madagascar	West Bank and Gaza	Uganda
Maldives	French Polynesia	Ukraine
Mexico	Qatar	Uruguay
Marshall Islands	Romania	United States
North Macedonia	Russian Federation	Uzbekistan
Mali	Rwanda	St. Vincent and the Grenadines
Malta	South Asia	Venezuela, RB
Myanmar	Saudi Arabia	Vietnam
Montenegro	Sudan	Vanuatu
Mongolia	Senegal	Samoa
Northern Mariana Islands	Singapore	Yemen, Rep.
Mozambique	Solomon Islands	South Africa
Mauritania	Sierra Leone	Zambia
Mauritius	El Salvador	Zimbabwe
Malawi	San Marino	
Malaysia	Somalia	
North America	Serbia	
Namibia	São Tomé and Principe	
New Caledonia	Suriname	
Niger	Slovak Republic	
Nigeria	Slovenia	
Nicaragua	Sweden	
Netherlands	Eswatini	
Norway	Sint Maarten	
Nepal	Seychelles	
Nauru	Syrian Arab Republic	
New Zealand	Turks and Caicos Islands	
Oman	Chad	
Pakistan	Togo	
Panama	Thailand	
Peru	Tajikistan	
Philippines	Turkmenistan	
Palau	Timor-Leste	