

# ERF<sup>2020</sup> 26<sup>TH</sup> Annual Conference

## Agree to Disagree? Making sense of Vagueness in International Environmental Agreements

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## Abstract

This paper explains vagueness in 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 makes several important contributions: (i) it contributes to a more realistic modeling of the treaty formation, (ii) it endogenizes the number of participants as well as their characteristics and (iii) it identifies the determinants of the optimal level of ambiguity in designing an IEA. It is shown 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 quite skewed to the left, suggesting a comparative advantage, in terms of precision and participation level, for environmental negotiations between countries with relatively similar levels of institutional capacity. In the case where institutional capacities are evenly distributed, more ambiguity is required to increase participation. Furthermore, the more noncompliance concerns are valued over policy concerns, the more vagueness is required in the agreement.

*JEL classification:* F53, H87, Q52, Q54.

*Keywords:* Vagueness, International Environmental Agreements, Institutional capacity, Noncompliance, Kyoto Protocol, Paris agreement.

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# 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 (1) 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 (Rüdiger, 2019), and (2) 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 Annex I and non-Annex I parties. The former mainly consisted of the industrialized countries that were members of the OECD and countries with economies in transition. This group had a larger set of commitments. The latter included the 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 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 per cent as soon as possible and at the latest by 1993, using 1980 levels as the basis for calculation of reductions."*<sup>1</sup> This is referred to in the literature of IEAs 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 the 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.

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

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<sup>1</sup>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. Article 7 of the Agreement states that

*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..*

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.<sup>2</sup>

This paper analyzes the impact of, as well as the rationale for, vagueness in International Environmental Agreements, 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. Agreements drafted in a vague language then allows 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 to 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 political 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 the different countries are assumed to negotiate over a degree of precision, rather than a uniform or differential commitment level.

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 then formulates a

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<sup>2</sup>For an assessment of the national adaptation plans under the Paris agreement, see (Morgan et al., 2019).

policy proposal, that is consistent with the agreement but does not necessarily coincide with the cooperative policy since each country is allowed to use its discretion in interpreting the provisions of the agreement. Finally, the pivotal agent in each country decides whether to ratify the agreement.

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 relatively skewed distributions of institutional capacities (negotiations North/North, South/South or at an even narrower scale) would, *a priori*, result in more precise agreements with higher levels of participation. Given a rather uniform distribution of institutional capacities, environmental negotiations are likely to result in agreements with high degree of ambiguity and little impact.

A preliminary attempt to test the predictions of the model is then presented. Using a panel probit country  $i$  participating in the IEA agreed upon in year  $t$  over the period 1998-2018, I test whether vagueness induces more participation. The aim is to assess the impact of vagueness on the participation decision of country  $i$ , controlling for two sets of variables : country-specific characteristics (institutional capacity, environmental preferences as measured by the number of environmental NGOs on its territory, GDP, checks and balances, political stability, exposure and vulnerability to climate change and CO2 emissions per capita) and environmental politics variables (total emissions in year  $t$  and dummy for whether the threshold for entering into force has been reached). Data on membership in IEAs is obtained from the United Nations Treaty Collection, and CO2 emissions per capita data and other macroeconomic data are retrieved from the World Development Indicators (WDI).

The remainder of the paper is structured as follows. Section 2 presents a brief review of the related literature. In section 3, I develop a model of vagueness in IEAs and discuss its implications. Following the theoretical framework, the econometric model testing the theoretical findings is presented in section 4. Finally, section 5 concludes.

## 2 Related Literature

This paper borrows from and contributes to two strands of the literature: the literature on International Environmental Agreements and the political economy literature on delegation.

### *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, 1995), the insights of which resemble to a great extent 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 (Barrett, 2003; Chou and Sylla, 2008), technological cooperation and issue linkage such (e.g. conferring benefits in trade agreements to the signatories). In the presence of abatement cost asymmetries, these instruments increase the incentives of countries who 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. 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 more fair 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, 2001). 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.

In a multi-stage game, 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 (which could be seen as the 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. This paper also focuses on the effect of ratification constraints, however I 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 uniform abatement effort at equilibrium is endogeneously determined by the number of ratifiers at equilibrium, (iii) the uniform abatement policy serves as a reference point since 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 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 provision. 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 I present in this paper fills many of the gaps outlined above. It contributes to a more realistic modeling of the treaty formation as it endogenizes the number of participants as well as their characteristics. It identifies the determinants of the optimal level of ambiguity in designing an IEA. It endogenizes the optimal level of abatement within the coalition by making it dependent on the number of participants which ultimately depends on the prior distribution of institutional capacities. And finally, it captures the important political economy dimension in the representatives objective function. Precisely, they are assumed to have both re-elections motives and reputational concerns as will be discussed in the model.

### *Vagueness in Delegation Models*

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 manœuvre and the desirable outcome can be achieved. Now assuming 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. The delegation models have some interesting implications in political economy. This model has interesting implications on the policy making under separation of powers. 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. 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.

Staton (2005) advocates 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. The model developed in this paper builds on Staton (2005), 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).

### 3 The Model

Our model builds on Koke and Lange (2017) and Staton and Vanberg (2005) to study the effect of heterogeneity in institutional capacities on the degree of precision of an International Environmental Agreements (IEA).

#### 3.1 Preliminaries

##### *Abatement policy, abatement level and institutional capacity*

We consider an economy with a finite number  $N \geq 2$  of countries which are denoted by  $i = 1, \dots, n$ . 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  $\lambda_i$  is a country-specific shock drawn from a continuous distribution in  $[-\alpha, \alpha]$  with a cumulative density function  $G(\cdot)$  with mean zero and variance  $\sigma_\lambda^2$ ; 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 higher its tax evasion rate. Institutional capacity  $\lambda_i$  is assumed to be both (i) heterogeneous among countries and (ii) private information of the agents in country  $i$ . 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.<sup>3</sup> 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.

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<sup>3</sup>This could be the result of a learning process through repeated interactions between those agents and the bureaucratic system in their country.



Costs of abatement are increasing and convex, precisely  $C(p_i) = \frac{c}{2}p_i^2$  where  $c$  is a positive parameter. Whereas the benefits from abatement are linear. Denoting by  $Q = \sum_i q_i(p_i)$  the aggregate abatement level, benefits from abatement activities are  $B(Q) = bQ$  where  $b > 0$  is the marginal benefit from abatement. In order to focus solely on the impact of the institutional capacity distribution, we assume that environmental preferences are equal in all countries, that is the marginal benefit from abatement is common to all countries and equal to  $b$ . This linear-quadratic specification, which is prominent in recent literature on IEAs (Asheim and Holtmark, 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*

In the following, 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.

The players in this game are a moderator,  $N$  representatives and  $N$  pivotal agents. The *moderator* who 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,  $\lambda_i$ . Both the pivotal agent and the representative of country  $i$  their country's type but cannot observe those of the remaining  $N - 1$  countries. It is public knowledge however that  $\lambda_i$  follows a certain distribution with a probability density  $g(\cdot)$  and a cumulative distribution  $G(\cdot)$  with mean zero and variance  $\sigma_\lambda^2$ . 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.

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

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

$$p_i^{NC} = \operatorname{argmax}_{p_i} \{U_i^P(p_i)\} \iff p^{NC} = \frac{b}{c} \quad (2)$$

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

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

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

### 3.2 The Negotiation Stage

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).

#### A delegation game under asymmetric information

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* non-compliance of the signatories at a later stage, given the nature of environmental agreements where there are no enforcement mechanisms.

We model the moderator's behaviour 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,

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

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 over 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 obtains 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 behaviour 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 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 value  $k$ , 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

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

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 behaviour 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 agreement amounts 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 behaviour 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  $\lambda_i$  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 a 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

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

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 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  $p^{NC}$ . It is as if the negotiators agreed to disagree, each would implement the policy that he would have in the absence of the agreement. Second, as ambiguity

in the agreement decreases ( $a$  and  $\gamma$  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.<sup>4</sup> Intuitively, specificity 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. The logic behind this result is that, since institutional capacities are *ex ante* unobservable, the best negotiators can do is 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  $\lambda_i$ , the sufficient conditions are that (1) for the country with the lowest institutional capacity, it is never a best response to go beyond the fully cooperative policy and, for the country with the highest institutional capacity, it is never a 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  $\gamma$  for those inequalities to hold.

### 3.4 The Ratification Stage

Before we can plug the representative's response  $p_i^A(a)$  back into the moderator's objective to derive the optimal level of ambiguity, we 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.

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<sup>4</sup>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  $r \rightarrow \infty$ .

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<sup>5</sup>

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

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 were he 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

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

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

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

A simple comparative statics exercise allows us to formulate the following lemma.

**Lemma 1.** *For a given number of expected ratifiers and disregarding the strategic effect of agreement specificity on the participation level, a higher degree of precision narrows the participation interval.*

The intuition behind this result is that, As precision increases, the emphasis on conformity to the expected average outcome increases, this has different effects on the countries at the two ends of the distribution of institutional capacity due to the sign of the adjustment term  $-\gamma\lambda_i$  in (6). Countries with low  $\lambda_i$  will have to increase their policy effort to compensate for their lack of institutional capacity, which makes ratification costly. For countries with high  $\lambda_i$ , their non-cooperative policy already results in high abatement outcomes, so emphasizing the conformity concerns increases the pressure to move towards the cooperative policy which results in a welfare loss (since this is not the welfare-maximizing policy for country  $i$ ) that is not outweighed by any other gains since, up to this point, we have not introduced the strategic effect of country  $i$ 's ratification on the remaining countries.

Now it remains to specify the equilibrium condition that allows to obtain the number of participants at equilibrium which would then allow to analyze the strategic aspect of ratification. To study the equilibrium conditions, often referred to as the *stability of coalition*, the literature on International Environmental Agreements 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

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<sup>5</sup>In the case of a minimum ratification threshold, the pivotal's agent 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.

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

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

The impact of precision on the participation level can be obtained by implicit differentiation of (9) where  $\lambda_H(a, n)$  and  $\lambda_L(a, \hat{n})$  are defined by (8) which results in

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

where  $\gamma_a = \frac{1}{(1+ar)^2}$  is the derivative of  $\gamma$  with respect to precision which is always positive. The effect of the distribution of institutional capacity  $G(\cdot)$  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 sufficiently skewed to the left.*

This lemma indicates that precision is likely to increase the number of ratifying countries, i.e.  $n_a > 0$ , whether  $G(\lambda)$  is skewed to the right or quite to the left. When  $G(\lambda)$  is skewed to the right, this means that the negotiating countries are mainly those with high institutional capacity. Disregarding the strategic effect, an increase in precision decreases the high type's incentives to ratify since switching to the cooperative policy results in a welfare loss and their own non-cooperative abatement levels are quite high to start with. The only gain for this type that could make participation worthwhile even after an increased precision is what we call the *raising the bar* effect.

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 could offset the welfare loss due to switching from the non-cooperative to the cooperative policy. As increases in  $a$  increase the upper bound for participation  $\lambda_H$  (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 effective of inducing a high policy standard offsets the loss in welfare due to conformity, a higher participation and particularly from the high type becomes likely. If the majority of negotiating countries have relatively low institutional capacities, i.e. when  $G(\lambda)$  is quite skewed to the left, 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. That is, the outcome each individual country can achieve by implementing the cooperative policy on its own is much lower than if they all conform to a relatively high standard. If agreement is too vague, participation will be low as they expect a low standard to which participants will conform and so the benefit from joining, in terms of total abatement, does not outweigh its cost. We can conclude that a bandwagon effect is expected to take place when the negotiating countries have neighboring institutional capacities, whether they are at the high or the low end of the distribution.

### 3.4.1 The Uniform Distribution Case

So far we have considered the institutional capacities of the negotiators to follow a general form distribution  $G(\cdot)$ . Now we focus on the case where institutional capacities are drawn from a uniform distribution on  $[-\alpha, \alpha]$ ; the greater  $\alpha$ , the less certainty there is 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 the equilibrium will be that with the high participation. The equilibrium number of ratifying countries is then

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

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 lower 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.  $\square$

Now regarding the *identity* of the participants, it can be seen from (8) that a higher level of precision (a larger  $\gamma$  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  $\lambda_L$  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:

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

From the maximization problem, we get

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

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

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

**Proposition 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 non-compliance, 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 raised which raises the expected average abatement outcome within the coalition.

**Empirical Implications** Our theoretical model has some interesting empirical implications that we attempt to test. First, an increased level of precision in the agreement is likely to result in more abatement and hence more effective agreements. Second, given a relatively precise agreement, countries with higher institutional capacity are more likely to ratify since the required policy adjustments are less costly for this group. Third, the probability of ratifying a relatively precise agreement depends on the distribution of the signatories (or potential ratifiers) such that (i) probability of a high institutional country ratifying a relatively precise agreement increases when the distribution of institutional capacities of negotiating countries is skewed to the right, (ii) probability of a country with low institutional capacity ratifying a relatively precise agreement increases when the distribution of institutional capacities of negotiating is quite skewed to the left, and (iii) when institutional capacity is rather evenly distributed, probability of the high type ratifying decreases. Fourth, and this is a result of (i) and (ii), for environmental negotiations North/North, South/South or between countries with relatively similar levels of institutional capacity have a comparative advantage, in terms of precision, participation level and effectiveness, compared to the case where the distribution of institutional capacity is rather uniform.

## 4 Empirical Analysis

The following section presents a preliminary attempt to test the model predictions. First, a panel probit is presented to assess the impact of institutional capacity (the GDP level is used as a

proxy)<sup>6</sup> on the probability of ratification, to test whether the probability of ratification is larger for country with high institutional capacity. Second, to test the effectiveness of the agreement (and hence whether policies moved towards their cooperative levels), a simple panel regression is presented where dummies for the Rotterdam Protocol and Kyoto Protocol are included.<sup>7</sup>

### *Data and Methodology*

In order to examine the determinants of signing and ratifying an environmental agreement, we run the following basic specification:

$$Pr(Agr.)_{it} = \alpha_0 + \alpha_1 Ln(Ind/GDP)_{it} + \alpha_2 Ln(GDP)_{it} + \varepsilon_{it} \quad (13)$$

$Pr(Agr.)$  is the probability of signing or ratifying an environmental agreement that takes the value of 1 if country  $i$  in year  $t$  has signed or ratified the agreement and zero otherwise.  $Ln(Ind/GDP)_{it}$  measures the share of industry in total value-added since the manufacturing sector is among the most polluting sectors.  $Ln(GDP)_{it}$  is the natural logarithm of the Gross Domestic Product in constant USD (of 2010) and  $\varepsilon_{it}$  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.

In order to determine the effect of the size of the number of members, we extend this model as follows:

$$Pr(Agr.)_{it} = \beta_0 + \beta_1 Ln(Ind/GDP)_{it} + \beta_2 Ln(GDP)_{it} + \beta_3 Ln(Num.Members)_t + \varepsilon_{it} \quad (14)$$

where  $Ln(Num.Members)_{it}$  is the number of ratifying/signatories 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. Yet, this effect being non-linear, we have to include the squared term of the number of members. Indeed, if a certain threshold is reached, new members can have less incentives to join the agreement.

This is shown in equation (3) as follows:

$$Pr(Agr.)_{it} = \gamma_0 + \gamma_1 Ln(Ind/GDP)_{it} + \gamma_2 Ln(GDP)_{it} + \gamma_3 Ln(Num.Members)_t + \gamma_4 Ln(Num.Members)_t^2 + \varepsilon_{it} \quad (15)$$

We apply this empirical exercise for mainly two agreements: Kyoto Protocol and the Agreement of Rotterdam.<sup>8</sup> Our data come mainly from two main sources. While  $Ln(Ind/GDP)_{it}$  and

<sup>6</sup>In the next draft, other measures for institutional quality will be used, as a robustness check, such as the readiness measure provided by the NDGAIN which measures the readiness of the economy for adaptation plans.

<sup>7</sup>The same regressions could not be ran for the Paris Agreement due to the agreement being relatively recent. The idea was to contrast different agreements with different levels of precisions and different distributions of the signatories.

<sup>8</sup>The aim was to include Paris agreement as well but because of data availability and given that it is a very recent one, it could not be done.

	Pr(Sig. KYO)	Pr(Ratif. KYO)	Pr(Sig. ROT)	Pr(Ratif. ROT)
Ind/GDP	-0.627*** (0.0447)	-0.294*** (0.0369)	-0.562*** (0.0446)	-0.319*** (0.0402)
Ln(GDP)	0.255*** (0.00864)	0.116*** (0.00727)	0.230*** (0.00862)	0.181*** (0.00786)
Constant	-4.863*** (0.189)	-2.134*** (0.161)	-4.544*** (0.195)	-3.902*** (0.179)
Observations	7,420	7,420	7,443	7,443

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1: Basic Specification

$Ln(GDP)_{it}$  come from the World Development Indicators, we constructed the other two variables ( $Agr$  and  $Num.Members$ ) from the respective websites of each agreement. The sample includes around 190 countries between 1960 and 2017.

### Empirical Findings

Table (1) shows that, as expected, the higher the share of industry to GDP the less likely a country will sign and ratify the agreement. This, obviously, shows how polluting countries will have less incentives to join any environmental agreement. This finding applies for both Kyoto Protocol and Rotterdam agreement. Moreover, the higher the level of GDP of a country, the higher the likelihood it will sign and ratify the agreement.

To examine how the number of signatories/ratifying countries affect the probability of joining an agreement, Table (2) shows that the higher the number of those signed (ratified) the agreement, the more likely a country will sign (ratify) it. 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 environment 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. Yet, this effect is not linear, since when we include the squared term of the number of members, the coefficient is negative and statistically significant showing that, when the number of countries reaches a certain threshold, this reduces the incentives of signing or ratifying the agreement. While the result holds especially for ratifying Kyoto and Rotterdam, signing Kyoto is not affected by the squared term.

Finally, to measure the effectiveness of the agreement, we regress CO2 emissions on the same controls and whether the country has ratified/signed the agreement. Table (4) shows that whereas the share of industry to GDP increases, as expected, CO2 emissions, the level of GDP reduces it. In terms of the effectiveness of the agreements, Table (4) confirms that there is a negative

	Pr(Sig. KYO)	Pr(Ratif. KYO)	Pr(Sig. ROT)	Pr(Ratif. ROT)
Ind/GDP	-0.512*** (0.0524)	0.139** (0.0598)	-0.433*** (0.0501)	-0.0421 (0.0540)
Ln(GDP)	0.256*** (0.0107)	0.00307 (0.0120)	0.197*** (0.00986)	0.162*** (0.0111)
Number of mem.	0.0381*** (0.00234)	0.0204*** (0.000356)	0.0271*** (0.000913)	0.0203*** (0.000410)
Constant	-7.824*** (0.316)	-2.743*** (0.272)	-5.631*** (0.234)	-5.966*** (0.266)
Observations	7,420	7,420	7,443	7,443

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2: Extended Specification (1)

	Pr(Sig. KYO)	Pr(Ratif. KYO)	Pr(Sig. ROT)	Pr(Ratif. ROT)
Ind/GDP	-0.517*** (0.0526)	0.127** (0.0601)	-0.434*** (0.0502)	-0.0525 (0.0546)
Ln(GDP)	0.258*** (0.0108)	0.00430 (0.0121)	0.197*** (0.00987)	0.166*** (0.0113)
Number of mem.	0.157 (1.775)	0.0305*** (0.00155)	0.0508*** (0.00917)	0.0364*** (0.00186)
Number of mem. sq.	-0.00100 (0.0118)	-5.16e-05*** (7.54e-06)	-0.000313*** (0.000121)	-9.90e-05*** (1.08e-05)
Constant	-10.84 (65.80)	-2.934*** (0.278)	-5.699*** (0.236)	-6.341*** (0.277)
Observations	7,420	7,420	7,443	7,443

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 3: Extended Specification (2)

	Ln(CO2)	Ln(CO2)	Ln(CO2)	Ln(CO2)
Ind/GDP	0.108*** (0.00610)	0.108*** (0.00606)	0.114*** (0.00605)	0.110*** (0.00606)
Ln(GDP)	-0.0175*** (0.00254)	-0.0126*** (0.00288)	-0.0239*** (0.00255)	-0.0175*** (0.00271)
Sig. Kyoto	-0.0287*** (0.00450)			
Ratif. Kyoto		-0.0242*** (0.00352)		
Sig. Rot.			-0.00285 (0.00450)	
Ratif. Rot.				-0.0186*** (0.00380)
Constant	0.468*** (0.0600)	0.351*** (0.0672)	0.591*** (0.0608)	0.457*** (0.0638)
Observations	6,522	6,522	6,539	6,539
Number of code	192	192	193	193

Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 4: Agreements Effectiveness

association between signing and ratifying Kyoto and ratifying Rotterdam agreement on the one hand and the emissions of CO2 on the other.

To extend the empirical analysis, our research agenda includes several dimensions. First, we are planning to include the quality of institutions and its skewness to test prediction (4). Second, we are also planning to include the vulnerability of a country to climate change as the latter is likely to increase its incentives to join an environmental agreement. Third, we will also include the readiness index that measures how ready are the government, sectoral composition and society for environmental adaptation. Finally, in order to test the effect of the precision of the agreement, we will construct our own index and introduce in the aforementioned econometric specifications.

## 5 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 my knowledge, have not been previously analyzed. Asymmetric and uncertain institutional capacities are key in explaining the evolution of global environmental politics.

The theoretical analysis shows 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 quite skewed to the left, suggesting a comparative advantage, in terms of precision and participation level, for environmental negotiations North/North, South/South or between countries with relatively similar levels of institutional capacity. Second, 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 is evenly distributed, a high level of vagueness is expected and lower effectiveness is to be expected. If the distribution is rather skewed, 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 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.

It would be perhaps interesting to analyze the model in a dynamic setting to capture the idea of the Conference of the Parties (CoPs) whereby signatories meet to revise the degree of vagueness agreed upon and investigate whether vagueness decreases over time, in which case, ambiguity should not be an issue to environmental politics.

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